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Editorial
Climate Change

Gerhard Meisenberg

Everything keeps changing, even the climate. Scientists are not very good at explaining past climate change. They cannot fully explain the causes of the periodic ice ages that occurred over the last 2 million years and the much milder climate fluctuations that took place during the present interglacial, which started about 12,000 years ago. The causes of presently ongoing climate change, however, are easily explained: mainly, the burning of fossil fuels causing a rise in atmospheric carbon dioxide (CO_2). CO_2 is a "greenhouse gas" that raises the temperature because it allows visible light to reach Earth's surface but absorbs the infrared wavelengths that beam the absorbed energy from the sun-heated surface back into outer space.

The process raises important research questions at many levels: First, we want to project the future course of Earth's climate on a time scale of centuries. This is not mere physics, but requires an understanding of the dynamic that drives the evolution of modern industrial societies. Secondly, we need to assess the positive and negative impacts of present and projected future climate changes on humans world-wide: Who are the winners and who are the losers? Thirdly, there is the question of whether and how humans can adapt to a changing climate. Finally, we have to study how people — both ruling elites and commoners — integrate (mis)information about climate change into their worldviews.

First, the facts about ongoing climate change. An unusual world-wide warming trend beyond the small earlier changes has been documented unequivocally since the 1980s, a time when CO_2 emissions began to rise steeply because China and many other developing countries were industrializing rapidly. Industrialization is not possible without large amounts of energy to keep machines, vehicles and, more recently, information processing devices running, and fossil fuels have so far been the cheapest source of energy. Rising atmospheric CO_2 has so far raised average temperatures by about 1°C in the tropics and 3°C in the Arctic. Why this difference? Because of positive and negative feedback loops. In the tropics, warming is kept within limits by a negative feedback: Higher temperature raises evaporation, causing more clouds to form that limit further warming because they prevent direct sunlight from reaching Earth's surface. In the Arctic, by contrast, there is a positive feedback through snow cover: Snow is white, meaning it beams most of the energy brought in by the sunlight back into outer space directly as visible light, rather than indirectly as infrared radiation. Climate warming means less snow, therefore more sunlight absorbed and turned into heat by the snow-free dark surface, causing even more warming.

And what about the impact of climate change on humans? First, there is the "greening of the Earth" effect, meaning that all green plants on Earth are now growing faster than they did in the past. Crop yields are rising, although also the weeds are growing faster. Greening of the Earth is caused directly by elevated CO_2, for the simple reason that atmospheric CO_2 is a limiting substrate for photosynthesis. Human activity has raised atmospheric CO_2 by at least 50% so far, from 0.028% to 0.043%. Therefore predictably, "carbon fertilization" makes all plants grow faster (Zhu et al., 2016).

It is equally obvious that arctic regions are the biggest beneficiaries of climate change. At least, to my knowledge Putin never complained about man-made climate change making Siberia a few degrees warmer. Tropical countries need to be more concerned because a warming climate means less comfort for everyone and higher energy costs for air conditioning in the homes and offices of the rich. The effects for farmers are more ambiguous. Higher temperature means more evaporation, raising the impact of droughts especially in semi-arid and seasonally dry regions; but more evaporation also means more rainfall, which is a most welcome effect in arid regions. We know, for example, that the ice ages were dry periods in Africa during which the rainforest became fragmented (Piñeiro et al., 2021).

The atmospheric content of water vapour increases by about 7% for each 1°C rise in air temperature (Trenberth, 2011). Therefore, climate warming can worsen extremes of rainfall and make flooding more severe even in areas where the total amount of rainfall does not increase.

Importantly, people can not only benefit passively from the desirable effects of climate change, such as less ice in the Arctic Ocean and increased rainfall in arid areas. They can also adapt actively to the undesirable effects of climate change. In the worst case they have to respond effectively to climate-related disasters such as flooding, trying to limit the damage after the event. One article in this issue of *Mankind Quarterly*, by Annastarsia Taunyane and Joseph Rukema, describes how the residents of an affected urban area in South Africa responded to severe flooding that may have been aggravated by climate warming — although it would have been better to be proactive, for example by constructing better dams and drainage systems. Adaptation, especially of the proactive kind, is indeed almost always possible.

Farmers in particular need to adapt. To give one example, on the Caribbean island of Dominica, the commercial citrus varieties cannot be grown at sea level because they get affected by a deadly virus. For unknown reasons, this disease is not a big problem at higher altitudes, presumably because of the lower temperature. Applying the rule of thumb that a 100 meter gain in altitude reduces the temperature by 0.5°C, a 1°C rise in average temperature raises the altitude beyond which citrus can be grown by 200 meters. If the country had an effective agricultural extension service, extension officers would advise the farmers to grow citrus trees like oranges and grapefruits only at the highest elevations because even the mid-altitudes will soon become unsuitable for citrus cultivation. At these mid-altitudes, they should instead plant heat-loving trees such as mango, coconut and sapodilla.

Adaptation to climate change and climate extremes is the theme of an article by Nik Burhan and his co-workers in this issue of *Mankind Quarterly*. These researchers studied the roles of adaptive capacity and technology adoption for adaptation of local farmers to climate variability and climatic extremes. Their study site was the Muda River Basin in peninsular Malaysia, a rice-growing area with an average annual temperature of 26-28°C and annual rainfall between 2,160 and 3,000 mm. Unsurprisingly, episodic floods are the main climate-related challenge in this environment. The Malaysian researchers use Rational Choice Theory as their theoretical framework. This can be described as a theory of selfish individualism, as it emphasizes that humans act rationally to maximize their personal gain (Scott, 2000). Economists usually assume that financial gain and improved standard of living is what people pursue most of the time, but they also speak more generally of "utility" in order to include gains in intangible assets such as reputation, aesthetic enjoyment, self-esteem, cognitive consistency, and moral righteousness. Even economists must acknowledge the old wisdom that man does not live by bread alone (*Deuteronomy* 8:3; *Matthew* 4:4).

The assumptions behind this research in Malaysia are fundamentally different from climate change discourse in Western countries. Nothing in this rather lengthy and thorough Malaysian study suggests any "net zero" ambitions related to this research. The assumption is simply that Malaysian farmers have always faced climate-related challenges, many of these challenges are likely to become more serious, and people need to take rational action in order to adapt to them. Also, when the Malaysian researchers mention "climate anxiety", they mean something different from its meaning in the Western context. In Malaysia, it is anxiety stemming from actual experiences with flooding and other disasters. In the West, however, climate anxiety is not caused by experiences with inclement weather, but by (mis)information about the nature of climate change which is hyped as a catastrophe by the media: a truly astonishing disconnect between belief, real-life experience, and rationality. Researchers in Western countries have already created at least 12 different rating scales to diagnose climate change anxiety as a psychiatric disorder (Clayton, 2020; van Dijk et al., 2025).

Curiously, Western-style climate change hysteria and anxiety has reached epidemic proportions only in countries that actually benefit from climate change! Rational Choice Theory seems to be applicable to Malaysians but not to Westerners, but this first impression may no longer be true when we take the intangible benefits of human beliefs into account. In Western countries, belief in the catastrophic nature of climate change has become an article of faith rather than of science or personal experience (McCright & Dunlap, 2011), the apocalyptic element in a religion-like postmodern belief system that Western intellectuals have concocted after rejecting traditional religion — something that educated Malaysians have not yet done.

This is a field of research in its own right. The study of human responses to climate change, or information about climate change, is known in anthropology under the heading of "climate change reception studies" (de Wit & Haines, 2022). Properly done, it is an inquiry into the psychological processes that shape the diverse elements of religious and ideological beliefs and that link these elements into more-or-less coherent worldviews in which the material, moral and spiritual worlds are inextricably linked — although we must also study the very tangible interests of those who create and sell the narratives that people desire.

Anthropogenic climate change is self-limiting, being restricted to an intermediate stage in the evolution of industrial civilization. Exit from this stage can be in two directions: Either people become unable to maintain modern industrial civilization and regress to a pre-industrial state; or they progress to a more advanced stage by learning how to use reliable alternative energy sources such as nuclear fusion. Which one of these two possibilities will materialize depends above all on the evolution of human intelligence during the next generations and centuries. The most important lesson is this: If you want to know what the future brings, do not observe how the climate is changing. Observe instead how the people are changing.

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International Student Assessments Measure Cognitive Ability: A Response to Rutkowski et al. (2024)

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Abstract

Rutkowski et al. (2024) questioned whether international comparative student assessments (e.g., PISA, TIMSS, PIRLS) also measure intelligence. In addition, they framed the research of other scholars as being on the side of political evil (e.g., the "holocaust") and accused them of having sinister intentions (e.g., "eugenics"). To determine what a diagnostic instrument measures, one can choose a content-cognitive-psychological or an empirical-correlative approach. To begin with, however, it is necessary to define terms and constructs. We define intelligence as the ability to think and the broader cognitive ability (or cognitive competence) as the ability to think, the disposal of knowledge and its use in an understanding way. Analyses show that the cognitive demands of the tasks in intelligence tests and student assessment tests are similar and can be solved using similar cognitive processes and strategies (e.g., finding information and reasoning). Correlative and factor analytic analyses at different data levels show a high empirical similarity and a strong common factor. The causal factors for individual development and for individual, national and historical differences in IQs and ILSA (international large-scale assessment) are also similar. Rather than distinguishing between intelligence tests and student assessments, it is recommended to distinguish between thinking and knowledge. Finally, the introduction of political ideology is not helpful; science is damaged when hatred and agitation are spread. The Nazis, for example, also denigrated intelligence research, which from their perspective was part of a Jewish-modernist ideology.

Keywords: Student achievement; Intelligence; Cognitive ability; International large-scale assessment (ILSA)

1 Terms and concepts: Intelligence as the ability to think vs. knowledge

Rutkowski et al. (2024) questioned whether international comparative student assessment studies (PISA, TIMSS, PIRLS and regional studies) also measure intelligence.[1] When considering what a test does or does not measure, one should first establish a definition of the psychological constructs in question, then analyze the tests and compare the results with those constructs (content-cognitive-psychological analysis). By failing to provide definitions of its central terms and constructs, the paper by Rutkowski et al. (2024) leaves the meaning of "intelligence", "learning" and "student assessment" indeterminate, thereby undermining the significance of its purported contribution. One cannot claim that a test fails to measure something ("A") but measures something else ("B") if neither "A" nor "B" has been defined. In this paper, an attempt is made to rationally reconstruct the approach of Rutkowski et al., beginning with proposed definitions and then testing their claims.

Intelligence is understood here as the ability to think, a rather knowledge-reduced mental capacity that is ideally free of specific knowledge (Rindermann, 2018, p. 43). Intelligence comprises:

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[1] PISA: Programme for International Student Assessment; TIMSS: Trends in International Mathematics and Science Study; PIRLS: Progress in International Reading Literacy Study.

- *Problem solving*: to solve new problems by thinking rather than simple knowledge recall,
- *Reasoning*: to infer (to conclude and reason, to draw inductive and deductive-logical conclusions including finding patterns in information, to correctly generalize, to apply rules for new examples and to solve syllogisms),
- *Abstract thinking*: to categorize, to form concepts, to process abstract information in the form of verbal and numerical symbols, in the form of abstract figures and in the form of general rules,
- *Understanding*: to recognize and construct relationships, structures, contexts and meaning, to have insight.[2]

The complementary term to intelligence (i.e., the concept with which it is most appropriately contrasted) is not student achievement or assessment — which is undefined in terms of content and could include areas such as sports — but rather knowledge. *Knowledge* is the possession of true and relevant information: statements that accurately describe reality (e.g., the Earth is round, the Romans lived around 2,000 years ago, tigers and whales are mammals, etc.).[3] *Cognitive ability* comprises the ability to think (intelligence), knowledge, and the intelligent use of this knowledge. "Cognitive competence" can be used interchangeably.[4] Knowledge is not independent of intelligence because thinking abilities are essential for acquiring and using knowledge: New information must be detected, connected to existing knowledge in long-term memory, integrated into the existing network, and linked appropriately. This process also requires the formation of hierarchical categories and abstraction. In the process of thinking, knowledge must be purposefully retrieved and often newly combined.

Student achievement (or educational achievement) is primarily the recognizable performance of students in school examinations that are graded by teachers (Rindermann, 2018, p. 51). Student achievement can be measured more objectively via student achievement or assessment tests. Compared to intelligence tests, they should rather measure the knowledge acquired at school. Rutkowski et al. suggest that student assessment tests measure "learning". This is not correct, because "learning" primarily refers to a process: the action or the process of acquiring knowledge. It would be better to say that they measure the *result* of learning.

So, what psychological traits do the given student assessment tests measure? To answer this, I will briefly look at the tasks, cognitive demands and processes as well as empirical correlations.[5]

2 Content validity: Analyses of tasks and cognitive processes

In a systematic rating study, eight PISA tasks and four TIMSS tasks were assessed by 68 persons (teachers and psychology students; Rindermann & Baumeister, 2015). They rated the content and the cognitive competences and processes required for solving the tasks. Intelligence was considered more important than

[2] This is similar to Gottfredson's (1997, p. 13) definition: "Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience."

[3] A colleague pointed out that "knowledge" may not be true and that the truth value of knowledge may change over time. This is an important objection to help clarify the term. An older philosophical-normative and a younger psychological-descriptive concept can be distinguished: In the first concept, knowledge stands for intellectual contents that are subjectively and objectively certain, in contrast to mere opinion and belief. In the second concept, knowledge stands for any mental content, everything that is stored in memory. The first also fits in with the concept of knowledge that is transmitted at school and that is to be assessed through classic student achievement tests. The second fits better with a cognitive psychology perspective. However, both concepts can be understood as the opposite of intelligence as the ability to think. In the context of student achievement studies, the first concept makes more sense. Knowledge, in the sense of this second concept, is best understood as the storage of any information.

[4] There are further cognitive constructs such as mental speed, memory, problem solving, creativity etc., which are for the purpose of this paper less relevant.

[5] One reviewer mentioned that correlations are always empirical, which, of course, is correct. Nevertheless, the term "empirical" is used here to emphasize the complementarity of empirical-statistical and qualitative analyses.

knowledge for solving nine of twelve tasks (or alternatively measured, six out of eight tasks). If a task is examined in more detail, e.g., "Lake Chad" from PISA 2000[6], it becomes obvious that it is a general cognitive ability rather than knowledge that is being measured (Rindermann, 2018, p. 51ff): It is necessary to read the given text, figures and numbers, retrieve and understand information, conclude/infer/reason and take the perspective of others. The retrieval of specific knowledge acquired in class rarely plays a role (Rindermann & Baumeister, 2015).

In any case, it is clear that student achievement tests are not school knowledge tests, nor were they ever intended to be. PISA and PIRLS, in particular, were designed to measure "literacy", conceptualized as the ability to solve cognitive tasks encountered in school, at work, and in everyday life in modern societies.[7] This is *not* a bad idea, and it is not criticized here. Rather, it makes both the construct and the tests relevant to the cognitive challenges of modernity, while at the same time positioning them further from school knowledge and closer to intelligence. The intention behind international school assessments should also be mentioned. As the PISA organizers state:

> *"PISA goes beyond assessing whether students can reproduce what they have learned in school. To do well in PISA, students have to be able to extrapolate from what they know, think across the boundaries of subject-matter disciplines, apply their knowledge creatively in novel situations and demonstrate effective learning strategies." (OECD, 2019, p. 5)*

Interestingly, this is also a useful definition of an important aspect of intelligence. The PISA researchers seem to assume that one of the primary purposes of schooling is to make children better thinkers. This assumption is supported by empirical evidence suggesting that IQ rises as a result of school education (Ritchie & Tucker-Drob, 2018).

3 Empirical correlations

Rutkowski et al. (2024, p. 3) wrote: "ILSAs have never been validated as measures of intelligence at the individual or population level." Additionally, they wrote (p. 5): "Each dimension serves as an aggregated measure of learning in the respective content domain." Neither statement is consistent with the empirical literature ("validated" is understood as "investigated and confirmed"). Given the extensive research, it seems odd to make such a claim ("never been"): There are many studies at different levels of data that Rutkowski et al. failed to take into account.

(1) Correlational and factor analytical studies at the *individual* level including or excluding intelligence tests.

(2) Correlational and factor analytical studies at the *population* level including or excluding intelligence tests.

(1) A correlation study by Brunner (2008), published in the same journal *Learning and Individual Differences* as Rutkowski et al. (2024), provided initial evidence: The average manifest and latent correlations between PISA-Reading and PISA-Math were smaller than their average correlations with psychometric CogAT-scales (Cognitive Abilities Test; averaged manifest $r_{\text{PR-M}} = .45$ vs. $r_{\text{P-C}} = .47$, latent $r_{\text{PR-M}} = .80$ vs. $r_{\text{P-C}} = .86$).

In another study by Pokropek et al. (2022), the correlations among the PISA dimensions of reading, mathematics, and science at the latent level averaged $r = .86$. The correlation between these three PISA dimensions and Raven's figural intelligence test was $r = .73$ (also latent). Here was a specific PISA factor, which perhaps does not represent student achievement, but rather a PISA method factor. In any case, there were no content-specific PISA factors:

[6] Sample collection of tasks: https://nces.ed.gov/surveys/pisa/pdf/items2_reading.pdf

[7] "PISA measures 15-year-olds' ability to use their reading, mathematics and science knowledge and skills to meet real-life challenges." (OECD, 2024)

> *"The domain-specific factors are not reliable enough to be interpreted meaningfully. They lie somewhere between unreliable measures of domain-specific abilities and nuisance factors reflecting measurement error." (Pokropek et al., 2022, p. 1121)*

This means that empirically, the PISA scales do not clearly measure reading, mathematics or science, but rather a general ability that sometimes even correlates more strongly with figural intelligence than with any other PISA scale. As a consequence, discriminant validity is not given. Of course, it is then possible to calculate a total PISA value, as Altinok and Diebolt (2024) have done, for example. This also means that it makes sense to use a summary value for cognitive human capital in economic, political, and sociological analyses, because the specific effects are rather small — although they do exist for some theoretically justified questions, e.g., mathematics vs. language tilt (Becker et al., 2022).

Independent of ILSAs (international large-scale assessments), Deary et al. (2007) reported a correlation between the central compulsory English school exam GCSE (General Certificate of Secondary Education for 15- to 16-year-old students) and the CAT (or CogAT, Cognitive Abilities Test) of $r = .69$ (latent $r_l = .81$), with the CAT figural scale alone $r = .66$. The correlations are probably underestimated as there was a four to five year gap between CAT and GCSE (11 year olds and 15 to 16 year olds). This high correlation means that, regardless of the test construction specifics of the ILSAs, student achievement itself is highly correlated with intelligence. Many other studies using conventional student achievement and intelligence tests came to similar results (e.g., Kaufman et al., 2012; Zaboski et al., 2018). As early as 1954, Coleman and Cureton spoke of a "jangle fallacy" if intelligence and student achievement tests were given different names. They replicated with a correlation of $r = .83$ to $.84$ (between the Otis Quick-Scoring Test Beta and the Stanford Achievement Test) and with their term "jangle fallacy", what Kelley (1927) had already found and formulated in the 1920s with other samples (in his case between intelligence and student achievement tests corrected for measurement error $r_l = .90$; p. 196). Kelley put it aptly (1927, p. 64):

> *"Contaminating to clear thinking is the use of two separate words or expressions covering in fact the same basic situation, but sounding different, as though they were in truth different. The doing of this latter the writer will call the 'jangle' fallacy. 'Achievement' and 'intelligence' sound as though they were different; they have different 'jangles', and thus we treat them as though they were different in truth."*

Jussim (2020) calls it briefly and succinctly in his Orwelexicon, picking up on the current political situation in academia and media: "IQaphobia: Fear of measuring intelligence because one believes that only Nazis and Eugenicists do that."

(2) There are numerous studies that show a high correlation between student assessments and intelligence tests at the population level (e.g., Boman, 2023, $r = .766$ between PISA-2018 and national IQs of Lynn & Becker, 2019, in 77 countries). This leads to a very strong G factor (see Figure 1).

This correlation is also independent of which student achievement and intelligence test collections are used. For example, if we take the latest World Bank ILSA collection (Altinok & Diebolt, 2024) and the intelligence test collection by Lynn and Becker (2019; only measured data), the result is a correlation of $r = .77$ ($N = 108$ country means). Warne (2023, his Table 1) reported correlations with similar but somewhat older student achievement data sets in the range of $r = .79$ to $.83$. Within Germany, at the level of 16 states, the correlation between PISA and intelligence is $r = .71$ (Rindermann, 2024).

4 Summary on what international student assessments measure

Applying a narrow concept of intelligence (as thinking) and a more operational concept of student achievement (relatively knowledge-intensive performance of students in school exams) and based on analyses of content,

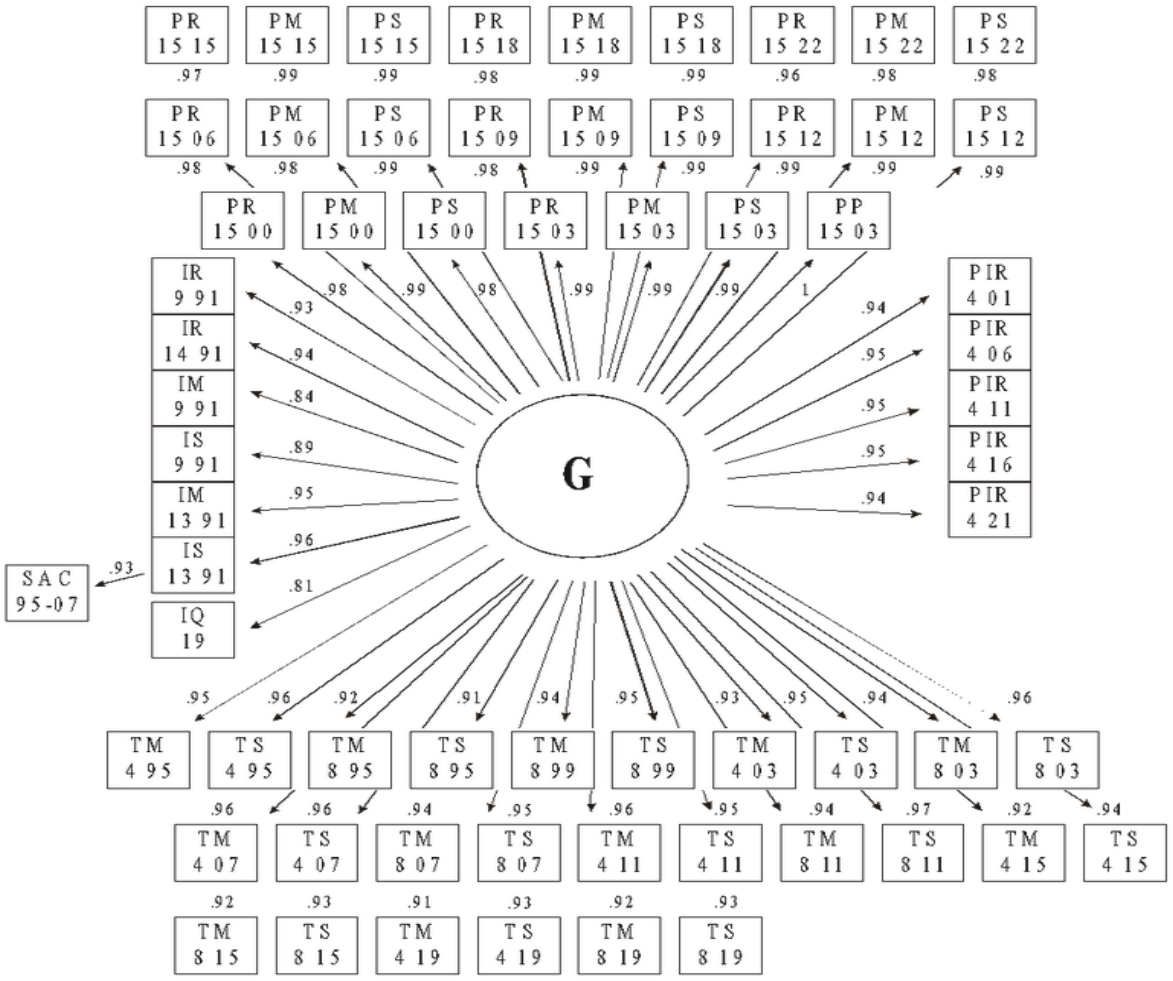

Figure 1: *G* factor of international differences in 64 student achievement and intelligence test scales (PR: PISA Reading, PM: Math, PS: Science, PP: Problem solving, 15 year old students and survey year; PIR: PIRLS, reading in 4th grade and survey year; TM: TIMSS Math, TS: TIMSS Science, 4th or 8th grade and survey year; IR: IEA Reading, IM: IAEP Math, IS: IAEP Science, 9 or 13 year old students and survey year; SAC: SACMEQ, waves I, II and III from 1995 to 2007; IQ: Lynn & Becker measured data published 2019; on arrows loadings max. 1, average loading is $\lambda = .95$, based on uncorrected national means; from Rindermann, 2018, p. 95, updated)

of cognitive processes and of empirical relations, student assessment tests also measure intelligence. While intelligence can be clearly defined, student achievement is a psychologically less clear-cut construct. For theoretical reasons, it would be better to distinguish between thinking and knowledge than between intelligence and student achievement.

However, it should be mentioned that in addition to this rather narrow concept of intelligence proposed here, there are others that (I believe) are even more widespread in research. If, for example, we take Cattell's model (1987/1971), which distinguishes between fluid intelligence (pure reasoning) and crystallized intelligence (application of knowledge, explicitly including knowledge), then student assessment tests and what they measure would certainly be part of the intelligence construct. Many widely used intelligence tests include knowledge-based questions or tasks that rely on content typically learned in school, such as fractions or geometry, as seen, for example, in the CogAT (Lohman & Hagen, 2002). These tasks cannot be solved without prior knowledge acquired at school. Another example are tests from the Wechsler tradition (WISC and WAIS).[8]

[8] WISC: Wechsler Intelligence Scale for Children; WAIS: Wechsler Adult Intelligence Scale.

Although the aspect of content validity is in the foreground and is the decisive one, there are also other approaches. In another view of "what a variable measures", a test or variable measures everything with which it correlates, even if it has a different content. For example, it is possible to "measure" gender with hair length or weight with height. Similarly, to "measure" ability levels in math, variables such as reading, gender, parental education, migration background, class and school average can be used. Such correlations are used in international student assessment studies in particular, for example, to extrapolate ability scores in reading and maths for students who only completed science tasks (e.g., NEPS, n.d.).[9]

That is exactly what successful companies do: Everyone who buys dog food is also likely to be interested in collars. That is applied thinking, intelligence in practice. Nevertheless, it would be better, in such cases not to speak about "measurement" but about "estimation". Although they are correlated, we should continue to distinguish thinking from knowledge. The analysis of *content* and *cognitive processes* cannot be replaced by purely correlational approaches (for example, if one were to consider only correlations with any characteristics).

This is *not* to suggest that student achievement tests are inherently bad. Rather, they are not strictly knowledge-based and bear strong similarities to intelligence tests.[10]

5 Common causes for results in IQ tests and ILSAs

Another argument in favour of intelligence tests and student assessments measuring similar or identical constructs is that the results in them depend on similar or identical causes:

(1) *Genetic factors* most probably have a global rather than a specific influence on cognitive ability (e.g., Bartels et al., 2002; Haworth et al., 2008; Shakeshaft et al., 2013).

(2) *Basic cognitive competences* like attention control, mental speed and working memory exert a rather global influence on more complex cognitive competences (e.g., Jensen, 2006; Schneider & Niklas, 2017).

(3) *Environmental factors* such as physical, cultural-familial and school environment show also global influence (Hattie, 2023; Rindermann, 2018; Steinberg, 1996).

(4) During development, there are *positive interactions between several subsystems*, for example, between reasoning and knowledge, interest and competence (Harackiewicz et al., 2008; Rindermann et al., 2010; Vu et al., 2024).

(5) Similar cognitive processes are required for *solving tasks* from different tests and scales, for example, attention control, concept formation, inductive and deductive reasoning, knowledge retrieval and knowledge application (Burgoyne & Engle, 2020; Kovacs & Conway, 2019; see also above Rindermann & Baumeister, 2015).

(6) In a *test situation*, *similar personality traits* are important for being successful in different tasks such as diligence, effort and low test anxiety (e.g., Mammadov, 2022; Stanek & Ones, 2023).

[9] The estimation methods in more detail in quotations, e.g., for PISA: "In practice, plausible values are generated through multiple imputations based upon pupils' answers to the subset of test questions they were randomly assigned and their responses to the background questionnaires." (www.oecd.org/pisa/data/httpoecdorgpisadatabase-instructions.htm). For the German NEPS (National Educational Panel Study), there exists a list of variables for calculating plausible values for reading (Scharl et al., 2020, Table 6, p. 18): "Mathematics competence [s], Procedural metacognition (mathematics) [s], Reading speed [s], Procedural meta-cognition (reading) [s], Reading activity (in hours): off the job [s], Reading activity (in hours): on the job [s], Age at wave 3 [s], Migration background of test target [s], Female [s], ISEI-08 (Socio-economic status) [p], Employment status [p], ISCED-97 (Educational level) [p], Years of education [p]." ([p] and [s] are added by HR) This means that parental characteristics [p], such as SES, and child characteristics [s], such as migration background, which theoretically have nothing to do with an ability (no content validity), are used as variables correlated with abilities to estimate abilities.

[10] We have not addressed here that the claim that student achievement is unrelated to intelligence may also be strategic in nature. A testing organization might make such a claim to avoid politically motivated resistance to testing, a strategy that would be instrumentally rational. There is no indication that Rutkowski et al. are adopting such a strategic position.

All these factors additionally confirm what was found in content-related cognitive analyses: What intelligence and student achievement tests measure is similar. They behave similarly, and a sum value can be used for predictive or causal analyses.

Country data represent averaged individual data. This means that intelligence and student achievement at the country level can also be traced back to similar factors. In addition, there are factors at the country level such as wealth, politics and, above all, culture, which also have a global rather than a specific effect on intelligence and student achievement (e.g., Rindermann, 2025, Table 3).

5.1 Correlation with effort

Rutkowski et al. (2024, p. 5f., with reference to OECD) assume that international differences in ILSAs depend on invested effort:

> *"These findings indicate that reported achievement represents performance on the test but it may not reflect actual proficiency. This point especially undermines the previously reviewed literature, which views ILSA scores as infallible measures of innate intelligence that are hardly or not at all influenced by motivation."*

Apart from the fact that there is no one who takes the position that "ILSA scores [are] infallible measures of innate intelligence"[11], the sentence contains an (indeed plausible and) empirically testable statement: effort increases results in ILSA scores.

At the individual data level, there is only a slight positive effect of effort on cognitive performance ($d = 0.17$; Bates & Gignac, 2022). According to Cohen's (1992) usual interpretation standards, this is below a small effect ($d = 0.20$). And what is the situation at the international level? The data can be taken up and correlated with the PISA results (average at the country level).[12] The PISA 2018 figure provides country averages for three effort variables:

(1) Average effort invested in the PISA test,

(2) Average effort students would have invested in the PISA test if scores on the test were going to be counted in their school marks,

(3) Percentage of students indicating that they invested less effort in the PISA test than if their scores were going to be counted in their school marks.

Variable (1) stands for effort invested, variable (3) for low effort (large numbers mean low effort resp. reduction in effort) and variable (2) is an unusable conjecture. The results are these: (1) More effort means lower PISA 2018 ability results ($r = -.43$, $N = 79$ country means) and (3) reduced effort means higher PISA 2018 results ($r = +.54$, $N = 79$).[13] The more effort students in a country report, the lower are the results in this country. Motivation-related self-assessments are not comparable across countries due to frame of reference problems. As is often said, "A beautiful theory killed by ugly facts." But this is science and that is how it should be done. Now, the relevant thing here is why Rutkowski et al. put forward a theory (effort→ILSA country results), but did not test it. *This is not science*. The result is exactly the opposite of what they assumed.

[11] Intelligence tests measure phenotypic, observable intelligence, not genotypic intelligence. Polygenic scores (as correlated with or causally effective genes) are used as indicators of innate, genotypic intelligence. No one has claimed that there are "infallible measures", and Rutkowski et al. provide no citations to support their statement – they are simply asserting it.

[12] OECD (2019, p. 200), Figure I.A8.2 Self-reported effort in PISA 2018.

[13] The second conjecture variable: $r = +.21$ ($N = 79$) – if they "have invested less effort in the PISA test because it is not relevant for marks". The results here are somewhat better, but their meaning is unclear.

6 ILSA results adjustments

Rutkowski et al. (2024, p. 4) criticized "a downward score adjustment of 42 points for countries with study participants that are an average of one year older than ... the international mean age for grade-based studies" done by Rindermann in older analyses. However, they did not describe why such adjustments were made. The goal was to find population estimators of cognitive ability, not only results from youth in school. There are four problems with student assessment studies:

(1) Students are of different ages in grade level studies (TIMSS and PIRLS) – older students have an advantage, younger students have a disadvantage.

(2) Enrollment rates differ between countries. It can be assumed that children outside of school have lower cognitive ability (fewer learning opportunities plus selection effects).

(3) In some countries, only certain regions took part. Participating regions are expected to have better schools, smarter, more modernized populations, etc.

(4) In some countries, the results are very implausible, suggesting sampling errors or fraud (e.g., Kazakhstan in TIMSS 2007, Cuba in LLECE 1997 and 2005/2006).[14]

If one is interested in national cognitive ability scores to explain economic growth (which is also in the interest of an economic organization like the OECD, which runs PISA), one has to correct this. As reported by Rutkowski et al., in 2007, Rindermann corrected one year of over- or under-age with 42 SASQ points.[15] In 2018, Rindermann only applied a 14 SASQ points correction (see a longer five-page description and justification in Rindermann, 2018, Appendix, pp. 7–11). The corrections are now substantially smaller, but are the corrected values better than the uncorrected ones? Rutkowski et al. (2024, p. 4) speculated:

> *"These adjustments, with few exceptions, further penalize lower performing, Southern hemisphere countries and reward, especially, Northern and Western European countries."*
>
> However, this is not true, as the author wrote in 2018 (Rindermann, 2018, Appendix, p. 11):
>
> *"Countries with the largest gains due to all corrections are (for CA total {cognitive ability}): Brunei (+6 IQ points), Belize and Tunisia (+5), Comoros and Cambodia (+3) and Korea-North (+2). The greatest downward corrections are observable for: Tajikistan and Uzbekistan (-7), Vietnam (-6), Mauritania and Gabon (-5), and Belarus (-4)."*

All adjustments serve the purpose of finding better estimates of the cognitive ability level of a *society* in order to explain, for example, prosperity, politics, and the successful management of technological modernity (cognitive human capital theory). A corrected student assessment study compared to an uncorrected one always showed slightly higher correlations with different GDP indicators (Rindermann, 2018, p. 227, Table 10.1: $r = .77$ vs. $.74$, $.78$ vs. $.76$, $.47$ vs. $.43$, $.68$ vs. $.66$, $.55$ vs. $.51$, $.68$ vs. $.66$, $.59$ vs. $.57$, $.69$ vs. $.66$.

The aim here is not to find the *absolute* truth, but to search for *relatively* more truth. We have to live with a certain degree of uncertainty in research (from a psychological point of view: one needs tolerance for ambiguity). The pattern of correlations shows that the corrections are on the right track. Critics of the corrections (a legitimate critique) are expected to propose alternative, more robust estimation methods. Of course, there are additional problems in these analyses — for example, that the individuals tested are students, not economically active adults, and that the relationship between cognitive ability and wealth is likely reciprocal, making unidirectional assumptions simplistic. Finally, the relationships can also be curvilinear.

[14] LLECE: Laboratorio Latinoamericano de Evaluacion de la Calidad de la Educacion.

[15] SASQ: Student assessment studies quotient, the scale that student assessment studies use with $M = 500$ and $SD = 100$ (Rindermann, 2018, p. 93).

7 Lynn and Vanhanen's IQ estimates based on neighbouring countries

Rutkowski et al. (2024, p. 4) criticized Lynn and Vanhanen's IQ estimates based on neighbouring countries: "such an approach is patently wrong". As above, such a claim can be tested empirically. For example, we can use the 2012 data set (Lynn & Vanhanen, 2012) and compare the measured results added here with the earlier estimated results (Lynn & Vanhanen, 2002). The correlation is $r = .92$ ($N = 48$ countries). The mean IQ estimated in 2002 for these 48 countries was 82.25, the measured IQ of 2012 was 81.04. The results measured later were marginally lower than Lynn's estimates. The same was done with the 2019 added measured data (Lynn & Becker, 2019) resulting in a lower but still high correlation ($r = .79$, $N = 52$ countries) and a slightly larger mean difference (2002 estimated $>$ 2019 measured: IQ = 83.31 vs. 81.06). This means that the estimation procedure worked well. Additionally, the estimates based on neighbouring countries did not underestimate the population IQs, but rather slightly overestimated them. I had always suspected that estimates derived from values of countries participating in studies overestimate the values of countries not participating in studies, but what the studies show is that my old corrections of -5 or -3 IQ points for estimated values were too high (Rindermann, 2007, p. 677; Rindermann, 2018, Appendix, p. 10). A similar analysis was carried out by Recueil (2025):

> *"The simplest way to check the robustness of Lynn's national IQs is to compare his imputed national IQs to subsequently sampled national IQs. I'll do this with his much maligned 2002 and 2012 national IQs. To assess the validity of the imputed IQs I'll correlate them with our current best national IQs {Jensen & Kirkegaard, 2024} and the World Bank HLOs {Harmonised Learning Outcomes; Angrist et al., 2021}. Lynn's 2002 imputed national IQs correlate at r = .90 with our current best national IQs and .72 with HLOs. 102 countries were imputed which we now have estimates for. . . . Lynn's 2012 imputed national IQs correlate at $r = .92$ with our current best national IQs and .76 with HLOs. 66 countries were imputed which we now have estimates for."*

As before, the question remains why Rutkowski et al. did not simply calculate this themselves. Then their criticism would have been unnecessary. Is this a correct procedure in terms of the usual scientific standards?

Finally, let me emphasize that there is no such thing as error-free data at the international level. The data on GDP, for example, are sometimes bizarre (see Rindermann, 2025).[16] It cannot be a realistic requirement to use only error-free data. Instead, it is necessary to take account of errors in analyses and correct them where possible or check the robustness of results using other data and methods (Hu, 2024). The data from sub-Saharan Africa in particular are of dubious quality, are often missing, and imputations are also of little help here. However, there are some regional student achievement studies for sub-Saharan Africa that can be used (e.g., SACMEQ, MLA, PASEC).[17]

8 Accusations of "fixed" and "trend" analyses of intelligence

Rutkowski et al. (2024) accused international comparative intelligence research of advocating a concept of fixed, static intelligence (e.g., p. 2): "Idea that differences in intellectual functioning are largely genetic and that there is little room to improve learning or intelligence through, for instance, external support or

[16] For example, according to the International Monetary Fund (IMF), Ireland (as of 2023) is the richest country in the world, Guyana is wealthier than France, and Japan is poorer than Andorra. Moreover, there are large discrepancies between different sources for the same variable. In the case of Ireland, for instance, the IMF reports a per capita GDP of $145,196; the World Bank, $126,905; and the CIA, $102,500. Although the data are not from exactly the same year (ranging from 2021 to 2023), such wide variations should still be surprising. Source: https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita (16 August 2023).

[17] SACMEQ: Southern and Eastern Africa Consortium for Monitoring Educational Quality; reading and mathematics in sixth grade. MLA: Monitoring Learning Achievement; literacy, numeracy and life skills in fourth grade. PASEC: Programme d'Analyse des Systemes Educatifs; French and math in second and fifth grade.

intervention." However, the known high heritabilities relate to inter-individual differences, not to individual development or historical developments, for example, the FLynn effect in the 20th century.[18] Patterns of inter-individual differences and patterns of country-specific differences can be quite stable and at the same time, (non-restandardized) intelligence can increase significantly with age or over time. To my knowledge, there are no researchers who exclude environmental factors (also see an analysis of educational factors for country differences; Rindermann & Ceci, 2009). One year of schooling increases cognitive ability by about 3 IQ points (Ritchie & Tucker-Drob, 2018).

Simultaneously accusing one of representing a concept of fixed intelligence and mentioning and criticizing a trend analysis of changes in intelligence over time is contradictory. However, our attempt at a statistical trend analysis (Rindermann & Becker, 2023, p. 8) explicitly stated that a purely statistical approach is not satisfactory:

> *"Predictions based solely on a statistical model, i.e. predictions based only on past developments of a few decades and extrapolating them into the more distant future, are very likely to be wrong."*

At least some theoretical assumptions (e.g., about the choice of a linear or curvilinear model, both of which were compared) are always necessary. Another problem is the usually arbitrary historical starting point of a development that is used to extrapolate future developments (depending on the availability of data; also see for the US: Rindermann & Pichelmann, 2015). Theory-based forecasting models are probably superior (e.g., Rindermann, 2018, 2023b).

Rutkowski et al. (2024, p. 5) also pointed out that the prediction uncertainty increases the further into the future the predictions extend. This is certainly a sensible suggestion that should be taken up in future predictions.

9 Framing, nonsense, politics and integrity (research ethics and behavior of researchers)

Some readers of the article by Rutkowski et al. (2024) may find the sober, fact-based response presented here unworldly and quixotic, as if the criticism by Rutkowski et al. were genuinely about science and the advancement of knowledge. Whether it actually concerns science is questionable for several reasons; at the very least, it is doubtful that this qualifies as good science. Why? Rutkowski et al. (2024) made several scientifically dubious claims without providing adequate arguments or empirical evidence:

- It denied that a test measures a construct without defining the construct.
- It denied that a test measures a psychological construct without providing analyses of content and cognitive processes.
- It claimed that there are no correlation studies and made the accusation of "ecological fallacy" (p. 4) when there are several studies at different data levels.
- It claimed that effort explains the differences in country results in ILSAs without conducting an empirical analysis, but such an analysis shows the opposite: higher effort is associated with lower PISA results (in country comparisons).
- It claimed that the result adjustments are wrong without comparatively examining their utility.
- It claimed that estimates are wrong without comparing them with measured data.

[18] Two researchers, Flynn and Lynn, or Lynn and Flynn, rediscovered the secular IQ rise, which is why we call it the "FLynn effect".

- It simultaneously criticized a concept of intelligence as fixed and a historical trend analysis of intelligence.

Added to this are blatant mistakes, such as fictitious or false first names: Rutkowski et al. (p. 3) began their chapter on "important developments in intelligence research" with the mention of an "important figure at the outset of intelligence research" "Alfred Simon"; however, this person did not exist, but a "Théodore Simon" did. Then there is also a strangely obsessive preoccupation with recapitulation theory (five times in the text), which is unknown in intelligence research.

Rutkowski et al. (p. 3) then repeat the frequently mentioned claim (e.g., Gould, 1981) that Goddard (1917) allegedly stated that "83% of Jews, 80% of Hungarians, 79% of Italians, and 87% of Russians are feeble-minded." However, Goddard never made this claim. He emphasized several times in his article that such statements should not be made – for example, in the second sentence of the summary: "2. The study makes no determination of the actual percentage, even of these groups, who are feeble-minded" (Goddard, 1917, p. 243). His sole aim was to test whether the newly developed IQ tests would also be useful for identifying mental disabilities in migrants from preselected groups. His aim is evident from the original text ("no determination of the actual percentage"), which Rutkowski et al. did not consult; Goddard is cited only via a secondary source. How can anyone demonstrate such egregious negligence and spread misinformation and hostility toward scientists?

Political framing is particularly important to Rutkowski et al. They devoted three to four pages of their six-page text to political topics and free associations that came to mind. Names like Ernst Haeckel, Charles Darwin, Jean-Baptiste Lamarck, Herbert Spencer and Henry Goddard appear. What on earth could Ernst Haeckel possibly have to do with PISA? Rutkowski et al. have spent a lot of text and space expressing, in a negative way, what they do not appreciate; examples of words that they used: "debunked science", "shoddy data", "death of millions", "holocaust", three times "inferior", seven times "racial hierarchy" and no fewer than thirteen times "eugenics". To what extent are these people and attributes relevant to answering the question of whether ILSAs measure intelligence?

They construct questionable associations and engage in skewed comparisons, which prevent them from recognizing the scientific positions of others amidst the haze of their own ideological bias. One gets the impression that they were so obsessed with political issues that they lacked both the time and the mental energy to empirically test their own theories. It is up to the reader to decide whether the article by Rutkowski et al. was more about politics and spreading hate against other researchers (see the words quoted above) than about the progress of science.

Intelligence researchers have faced threats in the past, which in extreme cases have resulted in some requiring police protection (e.g., Arthur Jensen) and others being dismissed (often overturned by the courts as unlawful, e.g., Helmut Nyborg) (Nyborg, 2003; Scarr, 1987). Since Rutkowski et al. are part of a prevailing (left-wing) zeitgeist in universities and the media, they appear less compelled to adhere to truth and intellectual integrity (Rindermann, 2023a). There is a great asymmetry of power here, intelligence researchers are in a small minority and are attacked as a minority and are hardly listened to. For members of a dominant majority, the disregard of scientific rules is tolerated within their milieu. Three further passages from the text can exemplify this:

(1) Example 1. On page 5, Rutkowski et al. (2024) wrote:

> *"Given that the authors {Rindermann & Becker, 2023} use the concept of 'genotypic intelligence' and 'genetic intelligence' (p. 205), the conclusion that entire populations are intellectually disabled on measures of intelligence is particularly disturbing, given that a deterministic view on intelligence leaves little room for these countries to improve."*

First of all, we used the term "genotypic intelligence" to describe the work of *other* authors:

> *"Despite the observable rise in intelligence test scores, other researchers assume that genotypic intelligence has been declining for some time. The 'co-occurrence model' assumes two simultaneous processes: an increase in IQ test scores that has nothing to do with the g-factor of*

intelligence and a decrease in genetic intelligence that would be on g ({two publications of other authors cited}).” (Rindermann & Becker, 2023, p. 1).

Rutkowski's approach here is clearly disingenuous, as they misrepresent a description of the state of research as the position of its authors. Second, our study deals with changes over time, leading to an increase of about 10 IQ points in the 21st century, from the abstract: “IQs would increase by about 10 IQ points by 2100 (international mean IQ 101).” (p. 1) And the increases are predicted to be especially large in developing countries, about 15 to 22 IQ points. A quote from our text: “The slowdown of the FLynn effect in developed countries, but its persistence in developing countries, may lead to a reduction in international disparities.” (p. 8) We explicitly wrote about changes and improvements!

(2) Example 2. Rutkowski et al. (2024) start and end their article with referring to Stephen J. Gould and his book “The Mismeasure of Man”. In this book, Gould alleged that researchers had cheated due to a racist motif. This was particularly ascribed to Samuel George Morton (1799–1851), an American anthropologist. With the help of craniometry, Morton's conclusion was that Europeans have, on average, larger brains than Native Americans and Africans. Gould claimed that this outcome was the result of an unconscious manipulation of the data by Morton, motivated by his “prejudices” (“finagling”). However, a student (Michael, 1988) reviewed Morton's data and found no systematic error, only a lack of precision. Michael's results were confirmed by Lewis et al. (2011), who saw systematic errors in Gould's book, but only unsystematic errors in Morton's work. These unsystematic errors actually led to lower estimates of racial group differences – so if there is still some kind of prejudice involved, it may be more of an effect of some egalitarian agenda:

“Clearly, Morton was not manipulating samples to depress the ‘Indian’ mean, and the change was trivial in any case (0.3 in^3). In fact, the more likely candidate for manipulating sample composition is Gould himself in this instance. In recalculating Morton's Native American mean, Gould reports erroneously high values for the Seminole-Muskogee and Iroquois due to mistakes in defining those samples and omits the Eastern Lenape group entirely, all of which serve to increase the Native American mean and reduce the differences between groups. ... The summary table of Morton's final 1849 catalog has multiple errors. However, had Morton not made those errors his results would have more closely matched his presumed a priori bias. Ironically, Gould's own analysis of Morton is likely the stronger example of a bias influencing results.” (Lewis et al., 2011, pp. 3, 5; references omitted)

John Michael sent his results to Stephen J. Gould but he never responded. However, considering the results of others and dealing with criticism is essential for an epistemic attitude (searching for truth) and for scientific progress (finding new truth). And not dealing with them indicates a non-epistemic attitude (pursuing goals other than truth; Rindermann, 2018).

Psychologically, it is striking that Gould accused others of bias while displaying bias himself. Such a projection is indicative of a poorly integrated cognitive system. E.g., Blinkhorn (1982, p. 506) on Gould:

“The theme of this {Gould's} particular book is that since science is embedded in society, one must expect to find the prejudices of the age presented by scientists as fact. Most authors, given such a theme, would be content to document and catalogue instances in support of the proposition. Gould, however, goes one better by writing a book which exemplifies its own thesis. It is a masterpiece of propaganda, researched in the service of a point of view rather than written from a fund of knowledge.”

This makes Gould far less credible than those he criticizes for lacking integrity. Other researchers, such as Russell Warne (2019), even charged Gould with explicit “lying”, which Gould presumably regarded as politically legitimate:

“It is likely that Gould thought that his ‘rhetorical strategies,’ if I can call them that (. . .), were justified because of his high-minded politics. In this way, he was not unlike the pious religious

> *fanatic who believes that inventing stories of miracles is acceptable if it strengthens the faith of others and adds more believers to the flock. Instead of 'lying for God,' though, Gould was lying for social justice."*

Gould's bias and his errors have been known for a long time and have been published by different authors at different times in different journals (e.g., the several articles mentioned above or Rushton, 1997). Those who still refer to Gould today are guided by political considerations, do not value careful work, or approach the criterion of truth with less rigor. What would Harry G. Frankfurt call it? If a contribution shows no interest in the truth and the expansion of our knowledge, that would mean that it stands for "bullshit" (Frankfurt, 1986). The reader should decide whether this also applies to Rutkowski et al.

(3) Example 3. Rutkowski et al. are particularly obsessed with the Nazi theme. Like a dealer in verbal devotional objects, they throw around terms such as "holocaust", "racial hierarchy" and "eugenics". Contrary to what Rutkowski et al. suggest, the National Socialists themselves *opposed* intelligence research — a position they share with Rutkowski et al. A striking parallel can also be seen in their mode of argumentation: Ideas they reject on ideological grounds are equated with moral evil within their worldview and consequently regarded as false. In the National Socialist view (Jaensch, 1938), intelligence measurement would be an instrument "of Jewry" to "fortify its hegemony" (p. 3), the selection in schools according to intelligence would stand for a "testing system of Jewish origin" (p. 4), especially the concept of intelligence as a "one-dimensional scale" (p. 3) (quotes translated by HR).[19] In such a climate of hate and hatred, scientific principles are no longer respected (Cofnas, 2016).

Agitation against intelligence research is nothing new, but over time, good data and scientific approaches have established many facts about intelligence, including what ILSA tests and intelligence tests have in common.

10 Concluding remarks

The work of Rutkowski et al. (2024) is riddled with glaring errors and reveals ignorance — and even folly — by failing to recognize that claims must be supported by evidence and empirical testing. Particularly egregious are Rutkowski et al.'s invention of false first names and their attribution of statements to scientists taken from secondary sources. The publication of such work constitutes a scandal for which not only the authors, but also the reviewers and editors of the journal, bear responsibility. There is no justification for publishing substandard work or for promoting hostility toward scientific reasoning and scientists. Moreover,

[19] Documentation of the difficult-to-access text, original text describing the Nazis' political-polemical position *against* intelligence research:

> *"Die Art, in der die Intelligenzprüfung und Auslese in der verklingenden Epoche vollzogen wurde, hatte den Erfolg, die Herrschaft des Gegentypus und damit auch die Vormachtstellung des Judentums innerhalb der Kulturvolker immer mehr zu befestigen." {"The way in which the testing of intelligence and selection were performed in the bygone epoch was successful in further fortifying the hegemony of the antagonistic typus, and with it also the pre-eminence of Jewry within the civilized nations."} (Jaensch, 1938, p. 3)*

> *"Aber die Intelligenzprüfung der verklungenen Epoche ruhte durchweg auf zwei fehlerhaften Voraussetzungen, die sich für unsere Volkwerdung in verhängnisvoller Weise auswirken mußten: 1. Man stellte sich die Intelligenz als eine eindimensionale Größe vor, in der es nur eine Abstufung nach 'Größer' und 'Geringer' gibt; der Physiker wurde sagen, als einen 'Skalar'." {"But the intelligence testing of the bygone epoch rested throughout on two faulty preconditions which were bound to affect our nation's development in a disastrous way: 1. One posited intelligence as a one-dimensional scale in which there exists only a gradation of "greater" or "lesser"; the physicist would say, as a 'scalar'."} (Jaensch, 1938, p. 3)*

> *"Unter diesen Umständen musste so gut wie zwangsläufig ein Prüfungssystem jüdischen Ursprungs zur Herrschaft gelangen, da ja das Judentum den Gegentypus, seine Normen und ‚Werte', in besonders reiner Form vertritt." {"Under these circumstances it was nearly inevitable that a testing system of Jewish origin would achieve predominance, because Jewry represents the antagonistic typus, its norms and 'values', in its purest form."} (Jaensch, 1938, p. 4)*

as in the case of Samuel Greiff, editor of *Learning and Individual Differences*, denying a response violates fundamental scientific and ethical standards.

Declaration of competing interest

The author has no competing interests.

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Climate Change Sensitivity, Adaptive Capacity, and Technology Adoption: Implications for Farmers' Economic Well-Being in Malaysia's Muda River Basin

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Abstract

The Muda River Basin (MRB), Malaysia's largest granary area, faces increasing climate extremes that threaten agricultural productivity and farmer livelihoods. Understanding how farmers perceive climate risks is critical for developing effective adaptation strategies. In this study, climate change sensitivity is defined as farmers' perception of economic, political, cultural, and institutional susceptibility to climate-related impacts. This study investigates how these dimensions of sensitivity influence adaptive capacity and technology adoption, and how these factors, in turn, affect economic well-being. Data were collected from 382 farmers across five districts in Kedah using a structured questionnaire, and analysed with partial least squares structural equation modelling (PLS-SEM). The findings show that both adaptive capacity ($\beta = .60$, $p < .01$) and technology adoption ($\beta = .18$, $p < .01$) significantly enhance economic well-being. Adaptive capacity was strongly shaped by all four sensitivity dimensions, while economic and cultural sensitivity also directly influenced technology adoption. Climate anxiety, included as a control variable, reduced both adaptive capacity and adoption rates. These results underscore the importance of institutional support and cultural considerations in strengthening farmers' adaptive responses. Policy measures that promote access to technology, build farmer trust in institutions, and integrate mental health awareness such as climate anxiety into extension programs can enhance resilience and improve economic well-being in the MRB.

Keywords: Economic wellbeing; Muda River Basin; Climate change sensitivity; Technology adoption; Adaptive capacity; Agricultural community

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1 Introduction

The Muda River is the longest river in Kedah, Malaysia, measuring 180 kilometres. It is critical for sustaining agriculture in the Muda River Basin (MRB) and water supply in the country's northern states. It is primarily used to water rice fields and move local fishing boats in the area surrounding its estuary (Abd Halim et al., 2018; Lee et al., 2013; Sim et al., 2018). In the last few decades, the area has experienced severe and drastic weather and climate conditions, including droughts caused by the El Niño phenomenon in 1997 and floods caused by the La Niña phenomenon in 2011/2012. Severe thunderstorms have also been known to occur on an annual basis, accompanied by windstorms, flash floods, and landslides. Monsoonal floods have also resulted in losses, including the deaths of people in other parts of the country affected by monsoon winds. The 2010 flood in Kedah was one of Malaysia's worst monsoon floods. It resulted in significant financial losses and increased pressure on the government's budget (Chan, 2014).

The MRB lies in Malaysia's humid tropical climate, with mean annual temperatures ranging from 26 to 28°C and annual rainfall between 2,160 and 3,000 mm, conditions that have long supported paddy farming. These stable climatic conditions, however, make the region especially sensitive to climate variability and warming (Tan et al., 2019; Zainal et al., 2014). Even a modest rise of 1 to 2°C can intensify the hydrological cycle, increase evapotranspiration, alter rainfall patterns, and elevate flood risks. Such changes directly threaten paddy farming, which relies heavily on predictable rainfall and stable water management systems. This illustrates the concept of climate sensitivity, where relatively small climatic shifts can trigger disproportionate impacts on agriculture and livelihoods.

The MRB's climate appears to have changed recently, with frequent occurrence of extreme weather conditions. Climate change continues to pose a significant threat to the basin as temperatures rise, precipitation patterns shift, and extreme weather events become more common (Luhaim et al., 2021). Droughts have also become more frequent and intense as a result of reduced rainfall, particularly during the southwest monsoon, and increased evapotranspiration caused by high temperatures. Droughts have the greatest impact on agriculture, and therefore the economy. For example, Alam et al. (2010b) discovered that increasing temperature and rainfall above the optimal level reduced paddy output. These crop yield reductions also reduce farmers' income, increasing the incidence of poverty and temporary unemployment (Alam et al., 2010a, 2012).

Climate change causes annual floods in the MRB, which is a major concern. Flooding is defined as the condition in which water from the river catchment area overflows and causes the river level to rise, resulting in floods (Hyndman & Hyndman, 2016). Ghani et al. (2010) reported in their work that flooding in the MRB catchment area is a recurring event during the rainy season, though the extent of the flooding varies from year to year. Flooding in 1988, 1998, and 2003 resulted in significant property and human loss, as well as a reduction in agricultural production. For example, a flood in October 2003 affected an estimated 45,000 people (Julien et al., 2006). According to Rehan et al. (2024) the wet planting season, which coincides with the northeast monsoon, is the most damaging for paddy farming due to flooding. This indicates the need to take precautions to avoid flooding. Floods also have a significant impact on rice yield, leading to fluctuations in food production and supply (Rehan et al., 2020). Sah et al. (2021) and Ercan et al. (2013) described the effects of climate change on Kedah's farmlands, with heavy rains being attributed to climate change. These rains have altered tide and sea levels, resulting in seawater intrusion and an impact on water and soil salinity.

While global sea levels have risen by approximately 10 cm over the past century and are projected to rise by about 30 cm by 2100 (IPCC, 2021), the inland geography of the MRB limits the direct effects of sea-level rise. Thus, concerns such as seawater intrusion are less relevant here than in coastal regions. However, farm production has been affected. According to Mei et al. (2020), floods pose a threat to fishing in the MRB because they are likely to affect fish stocks that are critical to the community's livelihood (Ghani et al., 2010; Omar et al., 2003). Although extreme weather events like floods and droughts are rare, their severity and impact on livelihoods necessitate attention. While attributing trends in their frequency directly to climate change remains challenging due to data limitations and natural variability, the consequences of such events for agricultural communities in the MRB justify their centrality in this study.

Climate change poses a threat to the MRB's agriculture sector due to episodes of drought and flood. Flooding and other forms of extreme weather reduce crop yields, present economic challenges, and make farmers' lives difficult. It has been established that these climatic conditions force farmers to devise strategies to increase their resilience and maintain their source of income, thereby involving also the government. Akhtar et al. (2019) discovered that farmers in Kedah who are more climate change resilient tend to have higher crop yields than those who are only moderately adapted to climate change.

This may reflect a broader pattern in which farmers who are able to adapt effectively to climate change also tend to manage other agricultural challenges more successfully, such as pest infestations and plant diseases, suggesting a general adaptive competence. This connection is plausible, as adaptive behaviour is often influenced by underlying traits such as problem-solving ability, risk perception, and access to resources. There are opportunities to improve extension services and government support for farmers by providing grants and training to increase flexibility and agricultural productivity.

Afroz et al. (2017) discovered in a survey that Malaysian rice farmers are increasingly willing to invest in crop insurance as a disaster coping mechanism, reflecting a farmer-led adaptation strategy. Such strategies also include adjusting practices, enhancing awareness, and using available resources to manage risks. At the same time, effective adaptation depends heavily on institutional and political support. This includes government-backed grants, training, and timely disaster response. As Chan (2014) points out, political and institutional factors, particularly the efficiency and timeliness of government action, play a critical role in shaping national capacity to manage climate-related hazards. Together, these farmer-led and institutional responses highlight the dual pathways of adaptation that underpin resilience in the MRB.

Building on this dual perspective, our study examines how climate change sensitivity influences farmers' adaptive capacity, technology adoption, and economic well-being in the MRB. It focuses on farmers' perceptions of economic, political, cultural, and institutional sensitivities, the four dimensions of the social system's sensitivity to climate change identified by Fenton et al. (2007) and Marshall et al. (2010). By analysing these perceptions, the study explores how they shape adaptive capacity and technology adoption, which in turn affect farmers' economic well-being. This study is distinctive because it looks into how farmers perceive the economic and cultural consequences of climate extremes, as well as the effectiveness of political systems and institutions in responding to these challenges from their perspective. Finally, this study predicted that these four dimensions of climate change sensitivity would have an impact on farmers' economic well-being by influencing their ability to adapt and adopt technology in response to changing climate conditions. Figure 1 depicts the hypothesized relationships between these variables, with adaptive capacity and technology adoption serving as mediators. They play an important role in mitigating the impact of climate change on the economic well-being of MRB farmers.

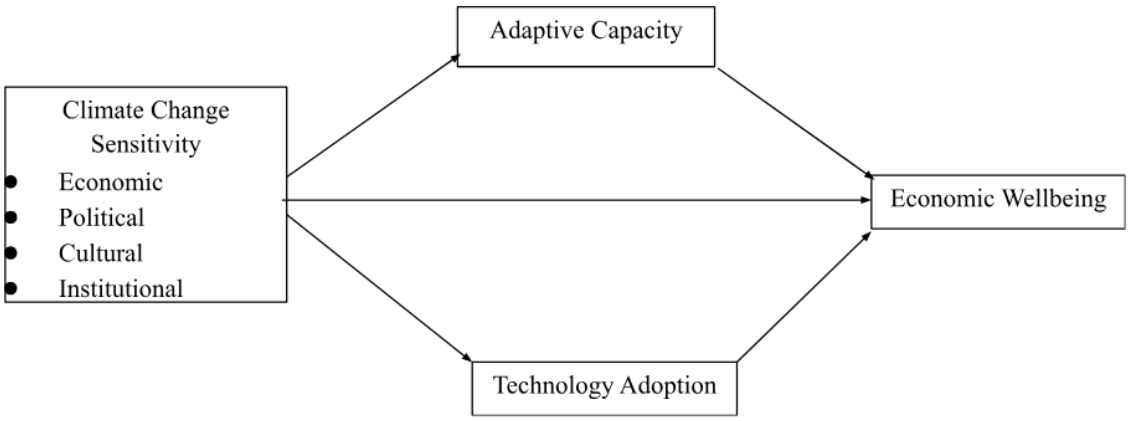

Figure 1: The hypothesised relationships between climate change sensitivity, adaptive capacity, technology adoption, and economic wellbeing. Source: Author's illustration.

This study sought to integrate Rational Choice Theory (RCT) by assuming that farmers, as rational

individuals, would consider the available knowledge and options that would allow them to maximise their farming productivity and sustainability. These outcomes could be achieved through increased adaptability and technology adoption, as expected. Farmers are unlikely to change unless confronted with external forces, such as climate extremes, because improving adaptive capacity and adopting new technology, while beneficial, require effort and money. Thus, it cannot be ignored that farmers' willingness to cope with climate extremes is determined by a trigger factor known as climate change sensitivity. In this study, perceived sensitivities are viewed as sources of raising awareness, acquiring information, or knowledge about uncertainties. These factors may lead farmers to act, such as selecting strategies from the available choices or options, increasing efforts to become more adaptive, or adopting technology in responding to climate extremes in order to achieve optimal results in their agricultural or economic endeavours.

The remaining sections of this work are organised as follows: Section 2 discusses rational choice theory and farmers' responses to climate change. Section 3 describes the specific concepts and definitions for the variables used in this study. Section 4 discusses other studies that have been conducted to determine the relationship between climate change sensitivities, technology adoption, adaptive capacity, and economic wellbeing. Section 5 discusses the methodology, Section 6 presents the research findings, and Section 7 concludes.

2 Rational Choice Theory and farmers' adaptation to climate change

According to Rational Choice Theory (RCT), people make decisions based on the potential gain and loss associated with the available options in order to maximise their benefits. RCT could help farmers understand why they choose specific adaptive measures to improve their adaptive capacity to climate change. While farmers do not need to explicitly understand rational choice theory, their decision-making process can still align with its assumptions if they behave rationally in weighing options. The application of RCT to climate adaptation can shed light on the decision-making system that drives farmers' actions in response to climate change, which is critical given ongoing climate change superimposed on long-standing climate variability.

Farmers are rational people who are constantly looking for the best ways to maintain or improve their standard of living. Climate change has an impact on agriculture in a variety of ways, including crop production, pest and disease management, and irrigation water availability. Farmers must decide which of the following strategies to use to adapt to changing conditions: adopting technology, selecting new crop varieties, planting at different times, or investing in irrigation. According to RCT, individuals are generally expected to choose the strategy they believe will reduce costs while providing the greatest benefit. Therefore, RCT is best understood as a descriptive theory, as it helps explain how farmers actually make decisions in practice rather than prescribing how they should ideally decide. For example, a farmer may decide to use a drought-tolerant crop variety if the expected benefit (e.g., high yields during dry conditions) outweighs the cost. According to Deressa et al. (2009), factors influencing decision-making include the farmer's level of information, financial capacity, and social network. These factors help farmers evaluate the potential benefits of different adaptive measures.

RCT assumes that people understand the consequences of their decisions. However, when it comes to climate change, there is much uncertainty about the consequences of farmers' actions. The issue is that climate projections are frequently uncertain, and the viability of adaptive measures can vary depending on the context. However, this does not preclude the use of RCT because farmers' behaviour is influenced by their subjective perception of risks and uncertainties (Grothmann & Patt, 2005). As a result, farmers may choose to implement less risky measures such as crop rotation over more drastic measures such as changing the entire farming system. These decisions demonstrate a clear effort to maximise expected payoffs in risky conditions, which is a key tenet of RCT (Cinner et al., 2009). Farmers with access to better climate information or who have experienced previous climate events may be willing to accept high-cost strategies in exchange for higher long-term returns.

RCTs have primarily been used to explain decision-making by self-interested individuals, but social and institutional factors are equally important for climate adaptation. For example, social networks can provide farmers with valuable information about effective adaptive measures, lowering the costs of experimentation

and increasing the perceived returns on various approaches (Adger et al., 2005b). Furthermore, the government and other institutions can help to reduce the costs of implementing adaptive measures by introducing new technologies or incentives such as subsidies or providing farmers with information on how to best proceed, all of which can influence farmers' cost-benefit analyses. Institutions can also create structures that promote or limit the development of adaptive capacity (Nkonya et al., 2015). In this way, RCT can be broadened to investigate how farmers reason about the costs and benefits of their climate change actions.

RCT can be used to assess farmers' technology adoption and adaptive capacity to climate change because it explains how and why certain actions are taken. RCT allows for a better understanding of why one adaptation strategy is preferred over another by taking into account the costs, benefits, risks and uncertainties that farmers face, as well as the social and institutional environment in which decisions are made. This approach emphasises the importance of providing farmers with adequate awareness and information, financial resources, and institutions to reduce the costs of adopting technology and adapting to climate change, thereby improving their ability to deal with climate extremes.

3 Definition of terms

This section provides definitions for the terms used in this work. It is difficult to define every concept or term in a way that is agreed upon by all scholars. The existing literature is used to develop conceptual definitions of economic well-being, adaptive capacity, technology adoption, and climate change sensitivity (economic, political, cultural, and institutional).

a) Economic well-being

Economic well-being refers to people's ability to cope with economic stressors, meet their needs and wants, plan for the future, and achieve financial security both now and in the future. This entails having enough financial resources to meet any type of economic challenge that one may face in life, attaining the required level of income that meets one's needs, ensuring that one has enough funds to meet his or her needs at any given time, saving for unforeseen incidences, managing one's finances in the right manner, and being able to sustain oneself financially in the event of job loss or even during the retirement period (Brou & Zeigler-Hill, 2020; Graham, 2011; Joo, 2008; OECD, 2013, 2020; Osberg, 2020; Stiglitz et al., 2009; Wilmarth, 2021; Yassin et al., 2015).

b) Adaptive capacity

Adaptive capacity refers to the ability of individuals, households, and communities to prepare for, cope with, and recover from the effects of climate change on their livelihoods and other socioeconomic activities. It addresses climate change preparedness, adaptability by employing new skills and strategies, financial and social stability, and community and extra-community support systems that reduce vulnerability to climate shocks (Adger et al., 2005a,b; Brooks et al., 2005; Engle, 2011; IPCC, 2007; Marshall et al., 2010; Nelson et al., 2007; Smit & Wandel, 2006; Yohe & Tol, 2002). This is essentially the same capacity needed to deal with past climate variability such as floods, droughts, and storms. Such events may become more frequent as the climate changes, although this is difficult to confirm due to limited data. The link between climate change and extreme events remains uncertain, and public debate is often influenced more by fear of change than by scientific evidence.

c) Technology adoption

Technology adoption refers to individuals' or organisations' willingness and capacity to adopt and use new agricultural technologies to mitigate the effects of climate change. This includes comprehending the competitiveness, compatibility, complexity, and tangibility of these technologies in improving the effectiveness and sustainability of agricultural management (Davis, 1989; Feder et al., 1985; Li et al., 2024; Rodríguez-Barillas et al., 2024; Rogers, 2003).

d) Sensitivity to climate change

Marshall et al. (2010) defined sensitivity in the context of climate change adaptation by the International Union for Conservation of Nature (IUCN) as the system's ability to effectively respond to climate change. The sensitivity of a social system to climate change is linked to economic, political, cultural, and institutional contexts, as described by Fenton et al. (2007) and Marshall et al. (2010). As a result,

these factors can either exacerbate or mitigate the negative economic impact of climate change. According to Marshall et al. (2007), social systems based on a natural resource that is vulnerable to climate change will be more sensitive to its effects. When developing a climate change adaptation plan, it is necessary to assess the extent to which local people and resources are exposed to climate change. Scholars such as Marshall et al. (2010) and Fenton et al. (2007) believe that the sensitivity of the social system is determined by the economic, political, cultural, and institutional contexts.

- *Economic sensitivity*

Economic sensitivity to climate change refers to how people perceive climate change's impact on their income, financial security, sources of living, cost of living, employment, job security, business, and the overall economy. It considers the adaptation costs, likely economic impacts, and gains from adaptation measures (IPCC, 2007; O'Brien & Leichenko, 2000; Stern, 2007; Tol, 2009; World Bank, 2010).

- *Political sensitivity*

Political sensitivity to climate change refers to people's perceptions of the political system's ability and effectiveness in dealing with climate change. It includes perceptions of political willingness, the impact of political systems on strategies for mitigation and adaptation, the effects on political systems, and participation in decision making and lobbying for good policies (Adger et al., 2013b; Barnett & Adger, 2007; Buhaug, 2010; Gemenne et al., 2014; McCright & Dunlap, 2011).

- *Cultural sensitivity*

Cultural sensitivity to climate change is defined as people's perceptions of how climate change affects cultural systems and norms, beliefs and practices, and thus cultural heritage and social fabric. The development of adaptation and response to climate change focusses on cultural heritage, traditional ecological knowledge, and community identity (Adger et al., 2013a; Berkes et al., 2000; Crate & Nuttall, 2016; Ford et al., 2006).

- *Institutional sensitivity*

Institutional sensitivity to climate change is defined as people's perceptions of the ability and willingness of relevant institutions or organisations to respond to climate change. This entails the ability of these institutions to put in place measures that can be used in the implementation of climate change policies, as well as to support adaptation, mitigation, and resource management (Biermann et al., 2009; Gupta et al., 2010; Ostrom, 2010; World Bank, 2010; Young et al., 2008).

4 Literature review

Climate change gradually forces farmers to change their strategies in order to ensure sustainability and manage economic resources. Technology adoption and adaptive capacity play a significant role in determining farmers' ability to deal with such challenges.

4.1 Adaptive capacity and technology adoption promote farmers' economic well-being

The use of technology in agriculture significantly increases productivity and effectiveness: efficient farming tools, water-saving irrigation systems, and genetically modified crops. For example, using GPS-enabled tractors and remote sensing improves resource efficiency and productivity (Sishodia et al., 2020; Soussi et al., 2024), and drip irrigation increases water use efficiency and crop yield while lowering costs. Some crop varieties are genetically modified to be less susceptible to pests and diseases, increasing yield (ISAAA,

2017). Technological advancement also reduces production costs. Mechanisation and automation, such as automated harvesters, reduce labour costs and therefore production costs, which is critical in areas with a workforce shortage (Yoshida et al., 2022). Furthermore, technology integration in supply chain management reduces losses after the farm gate and transportation costs, thereby increasing returns (Sonka et al., 2023).

Improved technology promotes marketers and expands farmers' market access. E-commerce platforms and digital marketing tools improve market visibility and revenue generation (Lemma et al., 2018). Blockchain technology improves supply chain assessment and accountability, meeting consumers' demand for sustainable products (Azevedo et al., 2023). Improved market access can help farmers earn more money and potentially create a steady income. Technology can also help with agricultural risk management and climate change resilience. Accurate weather forecasting systems and climate models help farmers decide when to plant and harvest to avoid storms or extreme weather conditions (Challinor et al., 2018). Crop insurance and risk management technologies are additional measures that help farmers deal with financial risks associated with crop losses and price fluctuations (Velandia et al., 2009).

Adaptive capacity refers to the farmer's ability to adjust to new conditions and ways of working, and thus adopt new practices. Flexibility, creativity, and the ability to learn and use technology are key indicators of high adaptive potential. Farmers with high adaptive capacity are better positioned to experiment with new technologies and practices, resulting in higher productivity and thus higher economic returns. For example, conservation tillage can improve soil health and reduce erosion, potentially increasing the long-term return on investment (Cafer & Rikoon, 2018; Rizzo et al., 2024). The availability of resources and support systems is one of the most important factors influencing adaptive capacity. This implies that farmers who have good access to financial services, extension services, and technical support will be better positioned to adopt and benefit from new technologies. Subsidies and low interest rates can help farmers overcome technological and innovation barriers. Extension services and technical training programs provide the knowledge and skills required to implement new technologies (Davis et al., 2012).

Social networks and collaboration also improve adaptive capacity. Farmers who have strong social networks can share information, knowledge and resources, thereby increasing the adoption of new methods and technologies. Farmer cooperatives and associations are examples of community-based approaches for promoting group-based climate change adaptation (Wigboldus et al., 2016). These networks encourage knowledge sharing and problem solving. This improves farmers' ability to deal with shocks and stresses, as well as their overall economic situation. To build strong adaptive capacity, it is also necessary to have strong institutional and policy support. Policies such as R&D incentives, financial incentives, and technology promotion can significantly improve farmers' adaptive capacity (Nelson et al., 2010). Climate change-friendly policies that fund research into climate-friendly crops and technology can eventually provide farmers with the necessary tools to deal with climate change. Land tenure and property rights should allow farmers to invest for the long term and adopt new technologies.

The use of technology and the development of adaptive capacity have an impact on the farmer's income, stability, and growth. Technological advancement can increase productivity and lower the costs, allowing for higher income (Shi et al., 2023). For example, precision agriculture technologies can be used to increase production while lowering production costs, thereby increasing farmers' net income (Shofiyati et al., 2024). Furthermore, adaptive capacity assists farmers in dealing with climate and market risks and uncertainties, thereby protecting their income from natural disasters and market fluctuations. Technology adoption and adaptive capacity also contribute to the long-term viability of farm businesses, resulting in increased farm productivity over time.

Furthermore, the factors that influence technology adoption and adaptive capacity have an impact on equity and inclusion. Smallholders can close the gap with large-scale farmers by leveraging information and communication technologies, as well as flexible inputs and services (Harvey et al., 2018). Inclusionary policies and support systems for excluded groups are a good example of how to promote equitable rural development by improving their adaptive capacity and economic well-being. Technology adoption and adaptation capacity are viewed as critical in increasing farmer income in the context of climate change. These characteristics contribute to higher productivity, lower costs, and better risk management, which helps to raise income per head while also potentially increasing the economy's vulnerability by creating

greater dependence on external inputs, technologies, and market conditions. These are some of the factors that must be addressed in order to ensure that all farmers benefit from such improvements. Thus, climate change will have an impact on agriculture. By encouraging the use of technology and improving farmers' adaptive capacity, it will be critical for their economic well-being and agriculture's sustainability.

4.2 How does climate change sensitivity increase technology adoption?

To encourage farmers to adopt new technology during climate extremes, economic, political, cultural, and institutional sensitivity must first be established. All sensitivities influence farmers' adoption of technologies, supporting the concept of targeted strategies. These are some of the challenges that, if well addressed by policymakers and implementers, could lead to the development of good programs enabling farmers to adopt technology that improves their resilience to climate change.

4.2.1 Climate change's economic sensitivity and technology adoption

Economic sensitivity to climate change is defined as the extent to which climate variability affects farmers' economic condition, income, and stability. When farmers suffer significant economic losses as a result of natural disasters such as droughts, floods or heat waves, they face financial difficulties and look for ways to cope, which may include using new technologies. First, the economic consequences of climate extremes can encourage farmers to use technology to reduce potential damage and increase output. Those who have been affected by adverse weather and have suffered significant losses will be willing to invest more in technologies that can increase crop yields and/or reduce risk (Harvey et al., 2018). Drought-resistant crops, efficient irrigation methods, and improved weather forecasting methods are among the measures that could help prevent such losses (Frimpong et al., 2023; Khatun et al., 2021).

Furthermore, during times of economic stress, farmers are more likely to adopt technologies that promise short-term returns or cost savings, even if they require an investment. Similarly, financial incentives such as subsidies or grants may increase stakeholders' willingness to adopt new measures (Wu et al., 2022). Farmers who anticipate high returns from new technology are more likely to invest, particularly in areas where they have previously suffered economic losses due to climate change (Wang et al., 2019). As a result, the economic returns that can be realised from new technologies are very important in encouraging farmers to adopt them, especially after farmers experienced adverse economic impacts due to climate extremes.

4.2.2 Climate change's political sensitivity and technology adoption

Political sensitivity to climate change is another important factor in farmers' decision-making regarding technology ad

option. Government policies and laws can influence whether or not farmers embrace new technologies. Other policies, such as providing subsidies for climate-smart technologies or funding agricultural research, have been shown to improve farmers' ability to innovate. Climate-smart technologies may include tools that help farmers adapt to climate change, such as improved drainage systems to reduce flood risk. Political instability or adverse policy changes, for example, can create uncertainty and discourage investment in new technologies (Aisen & Veiga, 2013; Bertin et al., 2016).

The level of political sensitivity determines farmers' trust in the government and their willingness to accept new technologies. A positive perception of government climate change and agricultural modernisation plans can boost farmer confidence and technology adoption (Zakaria et al., 2020). On the contrary, if farmers believe that political leaders have abandoned them or are not providing the necessary support, they may be resistant to the adoption of new technologies (Crentsil et al., 2020). Furthermore, political sensitivity influences farmers' risk perception and willingness to use new technologies in their farming operations. Unfortunately, government policies and guidelines on climate change, which often provide farmers with guidance on how to approach climate change and technology as a viable means of managing and controlling it, are frequently met with political instability, making farmers hesitant to adopt new technologies (Hebsale Mallappa & Pathak, 2023; Wu et al., 2023). Such hesitation may arise from controversies among political

elites or from a disconnect between farmers and policymakers, especially when farmers perceive government projects as ineffective or potentially harmful to their livelihoods.

4.2.3 Climate change's cultural sensitivity and technology adoption

Climate extremes are known to have a wide range of effects on people's social relationships, cultural norms, and beliefs, so cultural sensitivity is essential in the analysis. Cultural beliefs and practices shape farmers' attitudes towards new technologies and have a significant impact on their attitudes towards the adoption of new technologies, considering that some new technologies disrupt cultural norms and beliefs. People in agricultural societies may be sceptical of innovations that differ from traditional approaches (Shen et al., 2023). For example, technologies that require changes in farming practices may be rejected if they are perceived to violate people's beliefs or knowledge systems (Mohan et al., 2021). While this can be seen as an impediment, some scholars argue for the revival of indigenous knowledge systems to address problems that may not be easily solved with modern technologies. Traditional knowledge remains valuable for challenges that communities have long experienced, but it can also limit adaptation when new problems arise that require different solutions. In the case of climate change, we are not facing an entirely new issue, but rather an intensification of existing variability, which now demands greater attention than in the past.

However, new technologies can be embraced when they complement or improve culture. Technologies that improve or replace traditional practices, or that incorporate indigenous knowledge in their implementation, are more likely to be adopted (Denashurya et al., 2023). As a result, cultural consideration in these technologies may aid in their adoption and use (Adade Williams et al., 2020). Furthermore, cultural factors influence how technology is communicated and marketed. For cultures with high levels of communality, community-based strategies such as demonstrations or peer teaching can be more effective than individualistic approaches (Dutta, 2007). Involving local leaders and incorporating culture into the design and implementation of technology interventions has the potential to increase adoption (Questa et al., 2020).

4.2.4 Climate change's institutional sensitivity and technology adoption

Institutional sensitivity refers to farmers' awareness and attitudes towards institutional capability in dealing with climate change. The efficiency and level of support provided by these institutions have a significant impact on farmers' willingness to adopt new technologies. Institutions are important for technology adoption because they provide resources, information, and support. An example are agricultural extension services that train farmers to use new technologies effectively (Makate, 2020). Similarly, institutional support through the dissemination of research and technologies can encourage farmers to adopt new technologies (Schut et al., 2016).

Institutional credibility and reliability also influence farmers' perceptions. Fan et al. (2023) found that positive experiences with credible and effective institutions increase the likelihood that promoted technologies will be adopted. Unfavourable attitudes towards institutions, on the other hand, may reduce their eagerness to adopt new technologies (Cafer & Rikoon, 2018). Institutional support in the form of loans and/or grants from financial institutions can help farmers invest in new technologies (Geng et al., 2024). Such institutional supports are critical in providing assistance to farmers and facilitating technology adoption.

4.3 How does climate change sensitivity enhance adaptive capacity?

Sensitivities in the economic, political, cultural, and institutional domains can activate the required adaptive capacities. It is critical to understand how these domains can be effectively used to support adaptation and mitigate the effects of climate change. This section investigates how economic, political, cultural, and institutional sensitivity each can enhance an individual's ability to cope with climate change.

4.3.1 Climate change's economic sensitivity and adaptive capacity

Economic sensitivity refers to the assessment of the economic consequences of climate extremes on an individual or collective basis. It boosts adaptive capacity by encouraging preventive measures and investments such as insurance, diversification of income sources, or the use of sustainable practices (Adger, 2000). Furthermore, evidence suggests that as economic risks become more widely recognised, climate bonds and green investments emerge (Henderson et al., 2016).

Furthermore, economic sensitivity promotes risk culture, resulting in the development of technologies and strategies that reduce vulnerability, such as drought-tolerant crops and energy-efficient buildings (Pelling & High, 2005). This emphasis on economic resilience enables individuals and institutions to prepare for, respond to, and recover from climate shocks (Tol et al., 2008). Similarly, economic sensitivity encourages collaboration among various interested parties, such as governments, businesses, and civil society, for resource sharing, which is critical in the development of effective adaptation strategies (Agrawal, 2010). Climate change mitigation and adaptation can be accomplished through public-private partnerships, which can aid in the construction of infrastructure that can shield communities and enhance their resilience (Sovacool et al., 2015).

4.3.2 Climate change's political sensitivity and adaptive capacity

Political sensitivity to climate change entails an understanding of how politics and policies can mitigate the effects of climate change and thus strengthen a community's ability to respond to those impacts. This consciousness increases political participation and support for interventions like community-based adaptation strategies and policies (O'Brien et al., 2010). This is especially true where people believe their leaders are concerned about climate change (Adger et al., 2005a, 2005b).

Political sensitivity also influences resource allocation and governance effectiveness in managing climate change risks, emphasising the importance of political intervention in climate adaptation and government coordination in climate risk management (Pelling, 2010). As a result, good leadership is required to implement policies that benefit vulnerable groups while also promoting long-term development. Political sensitivity increases the likelihood of governments being accountable and transparent in the climate governance process. People and communities who are aware of the issues can challenge their leaders and their decisions, forcing policy changes that will improve and accelerate adaptation (Bulkeley & Betsill, 2013). This contributes to the development of a more sensitive and equitable framework for climate adaptation, thereby improving society's overall adaptive capacity (Pelling, 2010).

4.3.3 Climate change's cultural sensitivity and adaptive capacity

Climate change's cultural sensitivity refers to the way extreme weather events affect cultural beliefs, practices, and attitudes. This sensitivity improves adaptive capacity by integrating traditional knowledge with adaptive procedural strategies (Adger et al., 2013a). Local farmers have a wealth of knowledge about their surroundings as well as lessons learnt from previous challenges, which will be useful for today's adjustment (Turner & Clifton, 2009).

Cultural sensitivity can lead to the social integration and cooperation needed for adaptation. Understanding the cultural aspects of climate change helps sectors work together to address these issues (Adger, 2006). Well-knit networks make resources more available and increase people's collective capacity to cope with climate change (Pelling & High, 2005; Tompkins & Adger, 2004). Furthermore, cultural consciousness plays an important role in the stewardship and transfer of cultural inheritances when faced with climate change. Thus, cultural assets help communities identify tangible steps that should be taken to protect their culture (Cruikshank, 2001). This not only preserves cultural assets, but also fosters cultural and psychological attachment to the place and motivates adaptive interventions (Adger et al., 2013b; O'Brien et al., 2009).

4.3.4 Climate change's institutional sensitivity and adaptive capacity

Institutional sensitivity to climate change refers to people's perceptions of institutions' preparedness and ability to manage climate risks (Adger et al., 2005a,b). Higher levels of institutional sensitivity build trust in institutions and encourage collaboration with related agencies, which in turn contributes to climate risk mitigation and increases adaptive capacity (Gupta et al., 2010). In the Malaysian context, agencies such as the Department of Agriculture (DOA) and the Muda Agricultural Development Authority (MADA) play a central role in providing technical guidance, irrigation management, subsidies, and training to farmers in the MRB. The extent to which farmers perceive these institutions as responsive and reliable shapes their willingness to adopt recommended practices and technologies.

Communities and organisations that comprehend the diverse sectors engaged in the climate change process are more effectively equipped to improve adaptive practices. They are typically involved in resource distribution, research funding, and the creation of environments conducive to learning and adaptive management (Agrawal, 2010; Eakin & Lemos, 2006). Furthermore, incorporating cultural diversity into planning improves the comprehensiveness and implementation of adaptation measures, which are more likely to consider the needs of all segments of society, particularly vulnerable groups, and to be sustainable long-term. This approach further improves the ability to deliver adaptation and the community's readiness and recovery from climate impacts (Folke et al., 2005; Adger et al., 2005a,b).

5 Methods

This section describes the study's location, the main and control variables used in the study, as well as the validity and reliability of the instrument. It also outlines the methods for data collection and analysis.

5.1 Study location

This study included farming communities in the Muda River Basin (MRB). The MRB is a major river system in northwest Peninsular Malaysia, covering an area of 4,210 km^2 (Luhaim et al., 2021) (Figure 2). The river marks the border between Kedah and Penang, beginning in the Kedah mountain ranges and flowing about 30 kilometres south. The basin spans 180 kilometres and includes five districts involved in the current study: Baling, Kuala Muda, Kulim (Kuala Ketil), Padang Terap, and Sik (Daud & Safiei, 2018; Ghani et al., 2010; Julien et al., 2006).

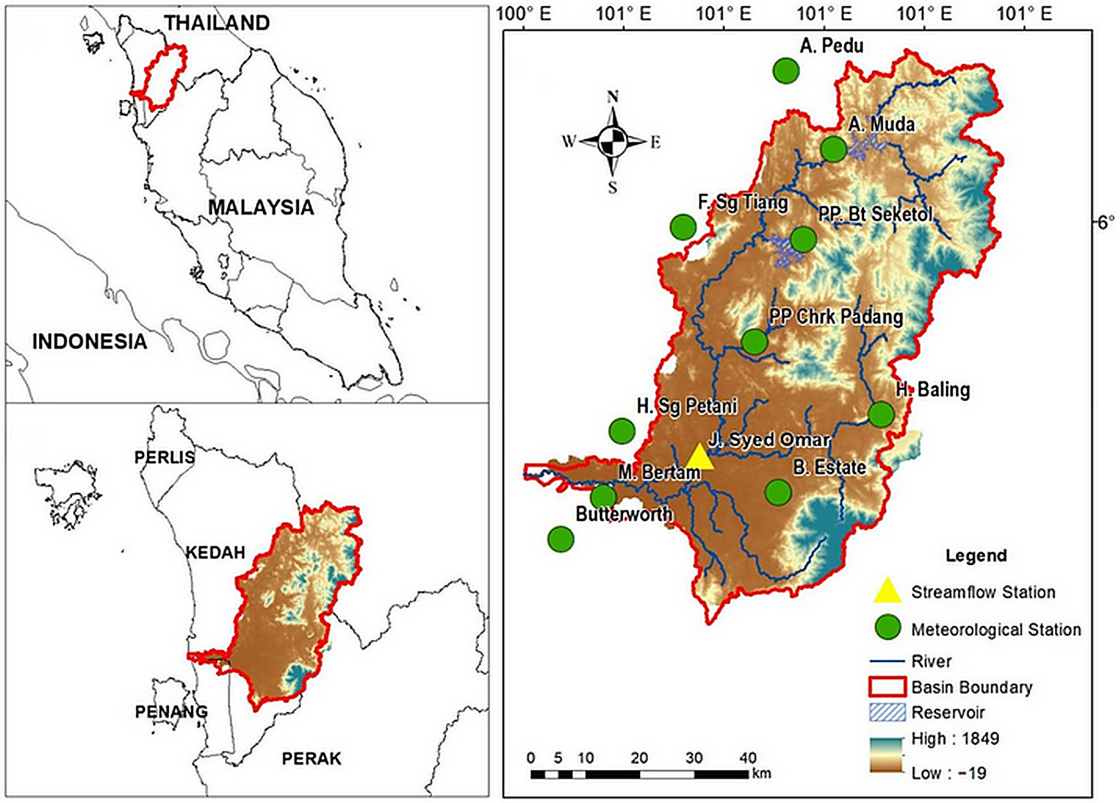

Figure 2: The Muda River Basin, situated in the northwest of Peninsular Malaysia. Map data sources: Malaysian Meteorological Department (MMD).

5.2 Survey instrument

This study took a survey approach, collecting data on the factors under investigation from respondents through questionnaires. The questionnaire was written in Malay. The instrument consisted of two primary components. The first section contains the respondents' basic demographic information. The instrument's second section includes a number of items used to assess the variables or study constructs. The construct-related items were developed by the researchers or adapted from earlier research to suit the rural and agricultural population being studied.

5.3 Variables and measures

The key variables or main constructs used in this study are: economic well-being, adaptive capacity, technology adoption, economic sensitivity, political sensitivity, cultural sensitivity, and institutional sensitivity. These constructs are created using a number of items, which are then rated on a Likert type scale of 1-5, with 1 representing 'strongly disagree' and 5 representing 'strongly agree'.

5.3.1 Economic wellbeing

Economic wellbeing was adapted from Yassin et al. (2015), who developed a scale of economic wellbeing and financial health that includes several aspects of an individual's economic status within the context of Malaysian society. The current study includes eight items that investigate how current or expected economic or financial stress affects the respondent's household income and savings, visionary spending, coping with emergency needs, living comfortably, spare expenditure for non-necessities such as travel, and security for

retirement and during joblessness. A higher score on the five-point Likert scale indicates better economic well-being for the respondent. Two examples are:

- "I am satisfied with the household income." (In Malay: *"Saya berpuas hati dengan pendapatan isi rumah."*)
- "I have enough savings to cover emergency expenses." (In Malay: *"Saya mempunyai simpanan yang mencukupi untuk menampung perbelanjaan kecemasan."*)

5.3.2 Adaptive capacity

This study adapted Shaffril et al.'s (2013, 2017) measure of the social system's adaptation to climate change, which was developed based on Marshall et al.'s (2010) sixteen domains of individual adaptive capacity. This resulted in the development of 36 items that cover the sixteen aspects of climate change social adaptation. A higher score on the five-point Likert scale indicates a respondent's greater adaptive capacity. This includes an individual respondent's ability to anticipate, plan for, and deal with the increasing severity of climate extremes by leveraging current knowledge, skills, community support, social network, financial stability, skills, and willingness to learn and adapt while seeking new opportunities for sustainable livelihoods in the face of climate change. The items used for the construct include the following three examples:

- Domain 2 – Ability to cope with change: "Extreme weather doesn't stop me from going out to work." (In Malay: *"Cuaca melampau tidak menghalang saya daripada keluar bekerja."*)
- Domain 9 – Business size and approach: "I seek advice from experts in making decisions about my business." (In Malay: *"Saya mendapatkan nasihat daripada pakar dalam membuat keputusan berkenaan bidang usaha saya."*)
- Domain 11 – Income diversity: "I also do additional work apart from my current business to cover family expenses." (In Malay: *"Saya juga melakukan kerja tambahan selain daripada bidang usaha sekarang untuk menampung perbelanjaan keluarga."*)

5.3.3 Technology adoption

Rogers's (2003) Innovation Diffusion Theory (IDT) inspired the creation of a set of twenty items for the technology adoption construct. This framework identifies the five perceived characteristics of how innovations spread in society: relative advantage, compatibility, complexity, trialability, and observability. In this study, four items for each of these domains were created. Many previous studies have used similar items to assess technology adoption (e.g., Atkinson, 2007; Emani et al., 2018; Sattler & Nagel, 2010; Sharifzadeh et al., 2017; Yuen et al., 2021). Higher scores on the five-point Likert scale indicate greater technology adoption. Three examples of items used for the construct are provided below:

- Domain 1 – Relative advantage: "The agriculture technology shortens my time required for farming chores." (In Malay: *"Teknologi pertanian memendekkan masa yang saya perlukan untuk kerja-kerja pertanian"*)
- Domain 3 – Complexity: "I find it easy to learn how to use agriculture technology" (In Malay: *"Saya rasa mudah untuk belajar menggunakan teknologi pertanian"*)
- Domain 5 – Observability: "I can see improvements in farm productivity due to the technology." (In Malay: *"Saya dapat melihat peningkatan dalam produktiviti pertanian disebabkan oleh teknologi"*)

5.3.4 Climate change sensitivity

Economic, cultural, political, and institutional sensitivities were assessed using conceptual frameworks developed by Fenton et al. (2007) and Marshall et al. (2010). In the current study, thirty items representing these four constructs were developed to measure the degree to which farmers perceive that climate change has impacted their economy (9 items) and sociocultural practices (7 items), as well as the capacity and responsiveness of the political system (7 items) and relevant institutions (7 items) in dealing with climate change. A higher score on the five-point Likert scale indicates a greater intensity of climate change sensitivity, implying that respondents believe they are more affected (economically and culturally) by extreme weather, and that politicians and relevant institutions are more responsive in addressing climate change impacts. Here are four examples of items used for the four categories of sensitivity:

- ***Economic sensitivity***: "Extreme weather has disrupted productivity in my agricultural work." (In Malay: *"Cuaca yang melampau telah mengganggu produktiviti dalam kerja pertanian saya."*)
- ***Political sensitivity***: "Extreme weather occurrences cause politicians or community representatives to respond quickly to provide aid to the affected people or farmers." (In Malay: *"Kejadian cuaca yang melampau menyebabkan ahli politik atau wakil masyarakat bertindak balas dengan cepat untuk memberikan bantuan kepada ahli komuniti atau petani yang terjejas."*)
- ***Cultural sensitivity***: "Due to extreme weather, I rarely leave the house to attend public events in the village or surrounding area." (In Malay: *"Oleh kerana cuaca melampau, saya jarang keluar rumah untuk menghadiri majlis keramaian di kampung atau sekitar."*)
- ***Institutional sensitivity***: "In the current extreme weather conditions, government agencies assist farmers and residents in increasing or diversifying their sources of income." (In Malay: *"Dalam keadaan cuaca yang melampau sekarang, agensi kerajaan membantu petani dan penduduk dalam meningkatkan atau mempelbagaikan sumber pendapatan mereka."*)

5.3.5 Control variables

This study used five control variables: respondents' income, gender, age, perceived climate severity, and health adversity.

- ***Income.*** The respondents' income was assessed by asking for the exact amount of monthly income (Malaysian Ringgit) they received. The results were then logarithmically transformed with a base of ten.
- ***Female.*** The variable 'female' denotes the respondent's gender. For inferential data analysis, males are coded 1 and females are coded 2.
- ***Age.*** Respondent's age in years.
- ***Climate severity.*** An individual's perception of 'climate severity' typically refers to their subjective assessment of the severity or intensity of climate-related changes in their immediate surroundings. This was measured on a 10-point Likert scale (1 - strongly disagree, 10 - strongly agree) for the following statement: "The weather patterns in my area are quite extreme, with erratic and alarming occurrences of both rainfall and heat events." (In Malay: *"Corak cuaca di kawasan saya agak melampau, dengan kejadian hujan dan panas yang tidak menentu dan membimbangkan."*). A higher score from a respondent indicates that this person is more concerned or alarmed about climate extremes in their area, which includes fluctuating and unpredictable weather patterns as well as rain and heat occurrences.

- ***Health adversity.*** This study used a 10-point Likert scale (1-strongly disagree to 10-strongly agree) to elicit respondents' perceptions of the negative effects of climate extremes on their health status: "The extreme weather has adversely affected my health." (In Malay: *"Cuaca yang melampau telah menjejaskan kesihatan saya."*). Respondents with higher scores indicate that the severe weather has a significant impact on their health.

5.4 Validity and reliability

This study used expert validation to evaluate the items used in measuring the components of the research instrument. Appointed experts in climate change, agricultural extension, and agricultural economics have specifically verified the research instrument used in this study. Furthermore, to ensure the validity of the questionnaire, this study pre-tested it on 100 respondents. Cronbach alpha values for all constructs in the pilot test exceeded 0.75, including economic well-being (0.82), adaptive capacity (0.87), technology adoption (0.91), economic sensitivity (0.90), political sensitivity (0.79), cultural sensitivity (0.87), and institutional sensitivity (0.89). This demonstrates that the items in this study are valid in their respective construct measurements because they produce nearly the same numerical or score value each time they are used, assuming that all other conditions are equal, as stated by Hays and Revicki (2005).

5.5 Sample and data collection

Data were collected using a non-probability sampling method known as homogeneous convenience sampling. This approach was chosen because it can identify sub-groups of people who share certain characteristics, cultures, or occupations and rely primarily on agriculture for their income. Homogenous convenience sampling selects a population under study based on specific sociodemographic characteristics. In a study by Jager et al. (2017), the authors stated that, while probability samples provide more generalisable data, there are specific benefits to using non-probability convenience samples, particularly homogeneous convenience sampling. They are inexpensive, time-saving, simple to use, and faster than probability sampling techniques. Jager et al. noted that selecting convenience samples based on specific criteria can improve generalisability. This study contends that the research context, which consists of agricultural communities in the MRB, broadens this homogeneity and thus increases generalisability of the results. Because all respondents are exposed to the same environmental factors that are typical for the basin, particularly the impact of climate change, one could argue that the discovered tendencies apply to the entire population of agriculture communities in the MRB.

This study employed convenience sampling, in which respondents, primarily farmers, were identified on their farms and in social settings in towns. This made it simple to identify and mobilise a diverse group of farmers in the MRB and its various districts where they farm. Participants were recruited between May 20 and August 7, 2024. The enumerators were responsible for administering questionnaires during the survey, and participation was entirely voluntary. All participants were at least 18 years of age. Informed written consent was obtained from all participants prior to their inclusion in the study. The participants were fully informed of the study's purpose and how the data would be used, and the data was only to be used for research purposes in order to protect the participants' identities. For data protection purposes, all collected data were de-identified, with sample identifying information stored and handled in accordance with institutional data protection guidelines.

The study's power analysis was performed using G-Power software version 3.1.9.4, with the sample size formula from Faul et al. (2007). The number of participants required under convenience sampling was determined accounting for the number of independent variables, the average estimated effect size of the predictors (f^2), the alpha probability error (α), and the power (1 - β error probability). Power analysis revealed that for the current study, a minimum of 178 participants would be required to achieve an effect size of $f^2 = 0.15$, with 11 predictor variables (including control variables), a statistical significance level of .05, and a statistical power of .95. To improve the sensitivity of the results, the alpha level of significance was increased from .05 to .01 and the statistical power from .95 to .99. As a result, the G-Power software recommended a new minimum sample size of 287 respondents to achieve statistical power of 99%.

6 Results

This section includes the results for both the measurement and structural models. The primary goal is to ensure the constructs and items in this study are reliable and valid. The structural model assessment determines the direct and indirect effects of the variables specified in the path model.

6.1 Descriptive analysis

The data for this study were collected from 382 farmer respondents, 346 males and 36 females, all of whom living in MRB's agricultural settlements. Table 1 shows the variables used in this study, along with the basic characteristics of the respondents. The mean age of these farmers is likely higher than the national average for the working population in Malaysia. However, it is not as high as what is often observed in other developing countries, where younger generations tend to leave agriculture and the nation becomes increasingly reliant on food imports.

Mean scores on the 1 to 5 Likert scale were 2.98 for economic wellbeing, 3.69 for technology adoption, and 3.28 for adaptive capacity. Economic sensitivity was the highest of the four measures of sensitivity, at 3.48, followed by political sensitivity (3.14), institutional sensitivity (2.54), and cultural sensitivity (2.01). Perceived climatic severity was very high (8.18 on a Likert scale of 1 to 10), whereas perceived health adversity was low (3.97).

Table 1: Descriptive statistics for all variables.

Measurement scale	Variable	Mean	Standard deviation
Likert Scale 1 – 5	Economic wellbeing	2.98	0.68
	Economic sensitivity	3.48	0.55
	Political sensitivity	3.14	0.63
	Cultural sensitivity	2.01	0.64
	Institutional sensitivity	2.54	0.60
	Adaptive capacity	3.28	0.56
	Technology adoption	3.69	0.73
Likert Scale 1 – 10	Climate severity	8.18	1.45
	Health adversity	3.97	2.22
Total income (RM per month)		2353	1984
Age (years)		48.94	14.64

6.2 Results for the measurement model

This study sought to identify the mediating roles of adaptive capacity and technology adoption in the relationship between climate change sensitivity and farmers' economic well-being. Hair et al. (2022), Ringle et al. (2024), and Henseler et al. (2015) recommended that the measurement model be evaluated using 1) convergent validity and reliability, and 2) discriminant validity using the HTMT ratio.

6.2.1 Convergent validity and reliability

Table 2 shows the average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha (CA) scores for all seven components examined in this study. The first step in evaluating reflective measurement models is to determine the reliability of the indicators. According to Hair et al. (2022) and Malhotra (2010), an outer loading or factor loading above .71 indicates that the construct explains more than 50% of the indicator's variance ($0.71^2 = 0.5$), indicating acceptable reliability. However, Hair et al. (2019, 2022) advised against eliminating items with outer loadings less than 0.70 but greater than 0.40, particularly if the deletion did not result in an increase in composite reliability (CR) and average variance extracted (AVE).

Table 2: Convergent validity, internal consistency, and variance inflation factor AVE = average variance extracted; CR = composite reliability.

Construct	Item	Factor loading	(AVE)	(CR)	Cronbach's α
Economic wellbeing	EW1	0.853	0.691	0.947	0.936
	EW2	0.846			
	EW3	0.849			
	EW4	0.865			
	EW5	0.829			
	EW6	0.708			
	EW7	0.841			
	EW8	0.850			
Economic sensitivity	ES1	0.837	0.576	0.915	0.895
	ES2	0.811			
	ES3	0.820			
	ES4	0.795			
	ES5	0.531			
	ES7	0.713			
	ES8	0.764			
	ES9	0.756			
Political sensitivity	PS1	0.834	0.555	0.896	0.869
	PS2	0.859			
	PS3	0.827			
	PS4	0.674			
	PS5	0.680			
	PS6	0.650			
	PS7	0.655			
Cultural sensitivity	CS1	0.892	0.775	0.96	0.951
	CS2	0.901			
	CS3	0.898			
	CS4	0.892			
	CS5	0.899			
	CS6	0.918			
	CS7	0.753			
Institutional sensitivity	IS1	0.778	0.718	0.947	0.935
	IS2	0.853			
	IS3	0.835			
	IS4	0.829			
	IS5	0.885			
	IS6	0.883			
	IS7	0.862			
Adaptive capacity	AC2	0.462	0.409	0.936	0.928
	AC3	0.781			
	AC4	0.693			
	AC5	0.525			
	AC6	0.658			
	AC7	0.785			
	AC8	0.773			
	AC9	0.550			
	AC10	0.488			

Table 2 (continued)

Construct	Item	Factor loading	(AVE)	(CR)	Cronbach's α
	AC11	0.619			
	AC12	0.491			
	AC19	0.678			
	AC20	0.475			
	AC21	0.827			
	AC22	0.634			
	AC23	0.728			
	AC24	0.547			
	AC27	0.673			
	AC30	0.571			
	AC32	0.723			
	AC34	0.479			
	AC35	0.682			
Technology adoption	TA1	0.769	0.567	0.962	0.958
	TA2	0.808			
	TA3	0.815			
	TA4	0.860			
	TA5	0.771			
	TA6	0.783			
	TA7	0.743			
	TA8	0.764			
	TA9	0.465			
	TA10	0.491			
	TA11	0.526			
	TA12	0.798			
	TA13	0.649			
	TA14	0.818			
	TA15	0.828			
	TA16	0.833			
	TA17	0.783			
	TA18	0.788			
	TA19	0.781			
	TA20	0.813			

Table 2 shows the results of the measurement model where all constructs have factor loadings greater than .4. This occurs after removing extremely low factor loading values below .4, particularly for economic sensitivity (ES6) and adaptive capacity (AC1, AC13, AC14, AC15, AC16, AC17, AC18, AC25, AC26, AC28, AC29, AC31, AC33, and AC36). As a result, in Table 2, all constructs have AVE scores greater than 0.5, the threshold value suggested by Hair et al. (2022), with the exception of adaptive capacity (AVE $= 0.41$). This occurs because many of its items have factor loading values less than 0.71. However, Fornell and Larcker (1981) stated that an AVE score of less than 0.5 is acceptable if the composite reliability (CR) value exceeds 0.6. Many other studies have used this principle, including Lam's (2012) study, which encountered the same problem. According to Table 2, the CR value for adaptive capacity is 0.94, which is significantly higher than 0.6, indicating that the construct's convergent validity remains acceptable. Table 2 shows that CR values for other constructs all are significantly higher than the minimum threshold of 0.6.

The constructs' internal consistency reliability is high for all constructs. As shown in Table 2, the Cronbach's alpha values for all constructs range from 0.87 to 0.96, all of which are significantly higher than 0.6, the minimum acceptable value according to Hair et al. (2022). Overall, the data on factor loading, AVE, CR, and Cronbach's alpha show convergent validity and reliability for all constructs used in this study.

6.2.2 Discriminant validity

The HTMT criterion is used to assess discriminant validity in this study. Henseler et al. (2015) found that the HTMT criterion outperforms both the Fornell and Larcker criterion and the assessment of (partial) cross-loadings when determining discriminant validity. According to Hair et al. (2022) and Ringle et al. (2024), all HTMT values must be less than 0.90 to meet the requirement. As shown in Table 3, the HTMT ratios for constructs (excluding control variables) range from 0.05 to 0.66, all of which are less than 0.9, indicating discriminant validity between two reflectively measured constructs. These findings can also help address potential concerns about acquiescent response bias, which refers to the tendency of respondents to agree with items regardless of their content. Since the survey did not include reverse-scored items, this could be seen as a possible limitation. However, the acceptable HTMT values suggest that the results are not primarily driven by uniform agreement across items.

Table 3: HTMT discriminant validity result with the inclusion of control variables in the analysis.

No.	Variable	1	2	3	4	5	6	7	8	9	10	11
1	Adaptive capacity											
2	Age	0.217										
3	Climate severity	0.295	0.097									
4	Cultural sensitivity	0.447	0.073	0.264								
5	Economic sensitivity	0.342	0.046	0.096	0.129							
6	Economic wellbeing	0.647	0.044	0.333	0.192	0.121						
7	Female	0.09	0.079	0.015	0.106	0.055	0.037					
8	Health adversity	0.199	0.110	0.071	0.075	0.111	0.082	0.009				
9	Income	0.288	0.195	0.020	0.138	0.092	0.253	0.182	0.001			
10	Institutional sensitivity	0.298	0.098	0.176	0.052	0.225	0.148	0.032	0.019	0.027		
11	Political sensitivity	0.430	0.085	0.107	0.294	0.365	0.124	0.035	0.242	0.124	0.290	
12	Technology adoption	0.656	0.252	0.213	0.379	0.228	0.506	0.134	0.131	0.194	0.145	0.175

6.3 Results for the structural model

This section presents the structural model results after verifying the measurement model results. Following Hair et al.'s (2022) recommendation, the multicollinearity issue was investigated before determining the significance and relevance of relationships. Table 4 displays the variance inflation factor (VIF) values for each independent variable and its corresponding dependent variable. The VIF values range from 1.054 to 2.205, indicating that no significant multicollinearity issues exist.

Table 4: Collinearity assessment of independent variables as predictors of adaptive capacity, economic well-being, and technology adoption.

	Variance Inflation Factor (VIF)		
Variable	Adaptive capacity	Technology adoption	Economic wellbeing
Female	1.056	1.056	1.076
Age	1.082	1.082	1.116
Income	1.112	1.112	1.257
Climate severity	1.123	1.123	1.232
Health adversity	1.054	1.054	1.128
Economic sensitivity	1.136	1.136	1.223
Political sensitivity	1.252	1.252	1.298
Cultural sensitivity	1.173	1.173	1.334
Institutional sensitivity	1.174	1.174	1.215
Adaptive capacity	NA	NA	2.205
Technology adoption	NA	NA	1.886

The results of the structural model are represented graphically in Figure 3. The R-square values are shown in the dependent variables' ovals, while beta coefficients and p-values (in parenthesis) for each independent variable are displayed next to their corresponding effect arrows.

Table 5 summarises the structural model's findings, including R^2 values for each dependent variable and path coefficients for the direct effects of all variables mentioned in the path model. As a result, economic well-being has the highest R^2 value (.537), followed by adaptive capacity (.391) and technology adoption (.288). R^2 values of 0.75, 0.50, and 0.25 are considered significant, moderate, and weak, respectively, in various social science disciplines (Hair et al., 2011). However, acceptable R^2 values differ depending on the research setting, and in some cases, an R^2 value as low as 0.10 is considered acceptable, particularly for previously unpublished research or when new independent variables are used, as in this study. Raithel et al. (2012), for example, claimed that R^2 values as low as 0.10 are sufficient, especially when predicting stock returns.

Beyond explanatory power (R^2), the model's predictive relevance was assessed using both the blindfolding and PLSpredict procedures. The blindfolding results indicated that all endogenous constructs had Q^2 values greater than zero: Adaptive Capacity ($Q^2 = 0.343$), Technology Adoption ($Q^2 = 0.241$), and Economic Wellbeing ($Q^2 = 0.180$), confirming medium to strong predictive relevance. The PLSpredict analysis further revealed moderate prediction errors, with RMSE values ranging from 0.813 to 0.911 and MAE values between 0.651 and 0.731, suggesting acceptable predictive accuracy for key constructs. However, the CVPAT comparison between the PLS-SEM and linear model (LM) benchmarks showed minimal average loss differences (0.007–0.020) and non-significant t-tests ($p > .46$), indicating that the predictive performance of the PLS-SEM model was statistically comparable to that of the LM benchmark. Finally, the SRMR values were 0.083 for the saturated model and 0.111 for the estimated model. The saturated model falls at the recommended threshold of 0.08 (Hu & Bentler, 1999), indicating an acceptable fit of the measurement model, while the higher estimated model SRMR reflects minor model complexity. Overall, the combination of strong explanatory power (R^2), adequate predictive relevance (Q^2), and acceptable model fit (SRMR) supports the robustness and quality of the proposed PLS-SEM model (Hair et al., 2022; Hu & Bentler, 1999).

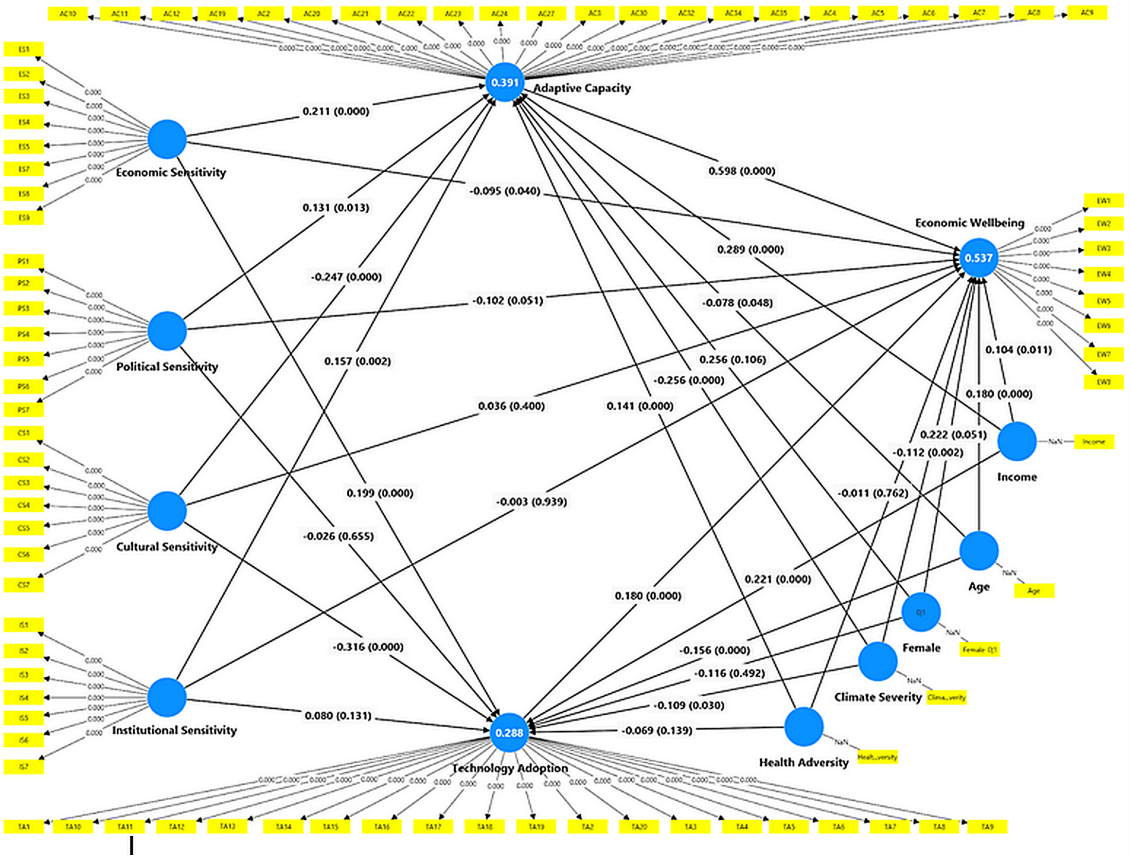

Figure 3: The finalized graphical output of path analysis for the interrelationships between all variables influencing the economic well-being of farmers in the Muda River Basin as a result of climate change sensitivities caused by climate extremes. Note: The constructs contain R-squares; p values are shown for the outer model, whilst standardised path coefficients (with p-values in brackets) are shown for the inner model. Items with low factor loadings were already removed from the analysis.

Table 5: Direct effects for all variables specified in the path model

Dependent variable	Direct effect	β coefficient	Standard deviation (STDEV)	t statistic (|O/STDEV|)	p value	R^2	Q^2 (Stone–Geisser)
Economic wellbeing	Adaptive capacity → Economic wellbeing	0.598	0.053	11.356	0.000	0.537	0.180
	Technology adoption → Economic wellbeing	0.180	0.052	3.498	0.000		
	Economic sensitivity → Economic wellbeing	-0.095	0.046	2.081	0.037		
	Political sensitivity → Economic wellbeing	-0.102	0.053	1.945	0.052		
	Cultural sensitivity → Economic wellbeing	0.036	0.043	0.844	0.398		
	Institutional sensitivity → Economic wellbeing	-0.003	0.044	0.077	0.939		
	Income → Economic wellbeing	0.104	0.041	2.557	0.011		

Table 5 (continued)

Dependent variable	Direct effect	β coefficient	Standard deviation (STDEV)	t statistic (|O/STDEV|)	p value	R^2	Q^2 (Stone–Geisser)
	Female → Economic wellbeing	0.222	0.114	1.947	0.052		
	Age → Economic wellbeing	0.180	0.037	4.901	0.000		
	Climate severity → Economic wellbeing	-0.112	0.035	3.171	0.002		
	Health adversity → Economic wellbeing	-0.011	0.036	0.300	0.765		
Adaptive capacity	Economic sensitivity → Adaptive capacity	0.211	0.046	4.637	0.000	0.391	0.343
	Political sensitivity → Adaptive capacity	0.131	0.053	2.481	0.013		
	Cultural sensitivity → Adaptive capacity	-0.247	0.043	5.741	0.000		
	Institutional sensitivity → Adaptive capacity	0.157	0.052	3.026	0.002		
	Income → Adaptive capacity	0.289	0.048	6.009	0.000		
	Female → Adaptive capacity	0.256	0.160	1.599	0.110		
	Age → Adaptive capacity	-0.078	0.040	1.957	0.050		
	Climate severity → Adaptive capacity	-0.256	0.045	5.740	0.000		
	Health adversity → Adaptive capacity	0.141	0.039	3.605	0.000		
Technology adoption	Economic sensitivity → Technology adoption	0.199	0.048	4.125	0.000	0.288	0.241
	Political sensitivity → Technology adoption	-0.026	0.057	0.454	0.650		
	Cultural sensitivity → Technology adoption	-0.316	0.055	5.760	0.000		
	Institutional sensitivity → Technology adoption	0.080	0.052	1.541	0.123		
	Income → Technology adoption	0.221	0.045	4.913	0.000		
	Female → Technology adoption	-0.116	0.172	0.675	0.500		
	Age → Technology adoption	-0.156	0.041	3.794	0.000		
	Climate severity → Technology adoption	-0.109	0.050	2.178	0.029		
	Health adversity → Technology adoption	-0.069	0.048	1.458	0.145		

Note: The direction of arrows indicates the direction of effects. The path coefficients and t-statistics were calculated using bootstrapping with 10,000 replications.

Table 5 shows that both adaptive capacity ($\beta = .6$, $p < .01$) and technology adoption ($\beta = .18$, $p < .01$) have a positive and significant impact on economic wellbeing. This demonstrates that increased adaptive capacity and the use of technology will improve farmers' economic status. Nonetheless, the coefficient

estimate of adaptable capacity was three times larger than that of technology adoption, highlighting the critical role of adaptive capacity in the economic well-being of MRB farmers. This study examined the effects of four different types of social sensitivity. Only economic sensitivity (β = -.10; $p < .05$) had a negative impact on the economic well-being of farmers after controlling for other factors. The direct effects of cultural, political, and institutional sensitivity were all non-significant, with p-values of more than 5%. The negative relationship between economic sensitivity and economic wellbeing is understandable, as farmers affected by climate change felt deprived of their economic well-being.

Furthermore, the effects of the control factors on the economic status were assessed. Economic well-being is positively influenced by age (β = .18, $p < .01$) and income (β = .10, $p < .05$), but negatively by climate severity (β = -.11, $p < .01$). At the 10% level, health adversity had no effect on economic wellbeing, as shown in Table 5. These findings revealed that the elderly and high-income earners had better economic well-being, whereas farmers who believed climate change had worsened had poorer economic well-being.

In this study, it is critical to determine whether farmers' sensitivity to climate change has led them to embrace technology and improve on adaptation in their work. Table 5 shows that economic sensitivity (β = .21; $p < .01$), institutional sensitivity (β = .16; $p < .01$), and political sensitivity (β = .13; $p < .05$) all have a positive and significant impact on adaptive capacity. Based on these findings, it is possible to conclude that farmers' adaptation levels increase when they believe climate change is affecting their economic activities. Furthermore, the findings on institutional and political sensitivity show that if institutions and political representatives are perceived to be more sensitive to climate change, farmers are more likely to adapt to it. Cultural sensitivity had a significant negative impact on adaptive capacity (β = -.25; $p < .01$), outweighing the effects of economic, institutional, and political sensitivity. This means that farmers who have been affected by extreme weather conditions, as well as the loss of physical socialisation and cultures, have become less adapted to the effects of climate change in their lives. This finding is significant because social capital in the form of strong networks and community relations helps to increase resource availability while also improving community resilience and adaptation to the effects of climate change (Pelling & High, 2005; Tompkins & Adger, 2004). As a result, it could be argued that the overall degradation of this function in the community is due to extreme weather, which has limited face-to-face information sharing and hampered farmers' learning processes, both of which are necessary for the enhancement of their adaptive capacity.

Certain control factors have a significant influence on adaptive capacity. Income has a strong positive relationship with adaptation (β = .29; $p < .01$), indicating that high-income earners are better able to adjust their life and work during climate change events. Finally, the researcher was unable to establish a significant relationship between gender and farmers' adaptive capacity in this study. However, age has a negative impact on adaptive capacity (β = -.08; $p < .05$), suggesting that young farmers adapt more easily than older ones. Surprisingly, analyses revealed that perceived climate severity was negatively associated with adaptive capacity (β = -.26, $p < .01$), whereas health adversity had a positive effect (β = .14, $p <$ .01). This suggests that farmers who believe their health has been affected by climatic extremes will try to strengthen their resilience and adaptability to the changes.

Those who perceive climate change as more severe tend to report lower adaptive capacity. This suggests that farmers who view extreme climatic events as highly threatening may experience heightened psychological stress, which can undermine their resilience. While the current study did not directly measure climate anxiety as a latent construct, perceived severity may capture elements of climate-related anxiety, reflecting farmers' worry about the impacts of climate change. Unlike in Western contexts, where "climate anxiety" is often discussed in terms of media exposure and general environmental concern, in the case of Malaysian farmers, these perceptions may be more accurately understood as immediate reactions to direct experiences with extreme climate events.

Stress, sadness, and helplessness can indicate mental health deterioration related to climate change. Mental disorders can impair an individual's cognitive function, limiting their ability to understand climate variation and change. The fear of the unknown and the future that climate change brings leads to a lack of innovation or to risk aversion. This study suggests that limited access to balanced information, along with limited critical thinking ability, especially in populations with limited recent formal education,

may contribute to confusion, anxiety, and irrational responses to climate change. Providing accurate and accessible information is crucial, but additional efforts may be needed to support cognitive engagement and adaptive decision-making across all segments of the farming population. Such an attitude may cause a community to ignore new technologies or approaches that would otherwise improve their flexibility, adaptive capacity, and thus productivity.

The term 'climate anxiety' refers to a condition in which people find it difficult to get up and do something to combat the negative effects of climate change. Climate anxiety may also cause self-centredness, leading to a decrease in community engagement in addressing climate change issues. Similarly, these factors can deteriorate relations and undermine the potential for community-based adaptation (Albrecht, 2011; Berry et al., 2010; Clayton et al., 2017; Cunsolo & Ellis, 2018; Hickman, 2020; Hickman et al., 2021).

Furthermore, the influence of sensitivity on technology adoption was investigated. According to Table 5, the study's findings indicate that political and institutional sensitivities had no influence on technology adoption. Farmers with higher economic sensitivity to extreme weather conditions are more likely to adopt technology in agriculture to increase production (β = .20; $p < .01$). This study found that cultural sensitivity has a negative impact on technology adoption (β = -.32; $p < .01$), similar to its negative impact on adaptive capacity (β = -.25; $p < .01$). However, the former has a larger effect size (β = -.32) than the latter (β = -.25). Based on these findings, it is possible to conclude that sociocultural activities are important in MRB communities, particularly for farmers who need to learn new agricultural practices in light of climate change and modern farming methods. Social interactions, such as social activities or cultural engagements, may have been the channels through which farmers obtained information and knowledge that protected them from the effects of climate events on their economic well-being.

The effects of the control variables on technology adoption were also investigated. Income was found to have a positive influence on technology adoption (β = .22; $p < .01$). As a result, farmers with higher incomes are more likely and capable of assessing technology and incorporating it into their economic activities. In Table 5, the gender of farmers and perceived health adversity did not significantly affect technology adoption. Although the relationship between age and adaptive capacity was not statistically significant at the 5% level of significance, this study found that older farmers are less likely to adopt technology than younger farmers (β = -.16; $p < .01$). This demonstrates that younger farmers are more capable of understanding and adopting new technologies to improve their economic activities. This could also be explained by a generational cognitive difference, where younger cohorts in this part of Malaysia are more familiar with technology use and digital tools, allowing them to integrate innovation more effectively into their farming practices.

Additionally, climatic severity had a significant negative impact (β = -.11; $p < .05$) on technology adoption. This finding is consistent with the concept of 'climate anxiety', which states that farmers who believe climate change is worse are less likely to choose the best strategy for dealing with climate extremes. This finding is consistent with the study's findings about the negative direct effects of 'climate anxiety' on adaptive capacity and economic well-being. Farmers who have experienced more serious 'climate anxiety' are more pessimistic about their economic well-being, and they are also less capable of dealing with climate change because they have adopted less technology and achieved less adaptive capacity. Although climate anxiety was not found to have a statistically significant direct effect on technology adoption, it is possible that this is due to indirect pathways through other variables. One plausible explanation is that brighter and better-informed farmers may be less likely to perceive climate change as an overwhelming or insurmountable threat. These farmers are also more open to understanding and adopting new technologies that help them manage risks and improve productivity.

In light of this, one of the most pressing questions raised in this study, as previously stated, is whether adaptive capacity and technology adoption can help to mediate the effects of sensitivity on economic well-being. According to Table 5, only economic sensitivity had a direct impact on economic wellbeing, with the effect being negative and significant at the 5% level. This suggests that farmers who report higher economic sensitivity to climate change, meaning they perceive greater economic risks and disruptions due to climate variability, also tend to report lower economic well-being. This interpretation aligns with the hypothesised direction of influence, where perceived vulnerability leads to economic strain, rather than

the other way around. Nonetheless, this relationship should be interpreted with caution, as subjective perceptions can reflect both actual exposure and subjective evaluation. In contrast, political, institutional, and cultural sensitivities were found to have no significant direct impact on economic well-being. Table 6 shows the indirect effect analysis, in which adaptive capacity and technology adoption mediated the effects of climate change sensitivities on economic wellbeing.

Table 6: Specific indirect effects for all variables specified in the path model.

Mediator	Specific indirect effect	β coefficient	Standard deviation (STDEV)	t statistic ($\|O/ST$
Adaptive capacity	Economic sensitivity → Adaptive capacity → Economic wellbeing	0.126	0.030	4.148
	Political sensitivity → Adaptive capacity → Economic wellbeing	0.078	0.032	2.460
	Cultural sensitivity → Adaptive capacity → Economic wellbeing	-0.148	0.030	4.968
	Institutional sensitivity → Adaptive capacity → Economic wellbeing	0.094	0.033	2.820
	Income → Adaptive capacity → Economic wellbeing	0.173	0.030	5.708
	Female → Adaptive capacity → Economic wellbeing	0.153	0.098	1.568
	Age → Adaptive capacity → Economic wellbeing	-0.046	0.025	1.872
	Climate severity → Adaptive capacity → Economic wellbeing	-0.153	0.029	5.251
	Health adversity → Adaptive capacity → Economic wellbeing	0.085	0.025	3.438
Technology adoption	Economic sensitivity → Technology adoption → Economic wellbeing	0.036	0.014	2.608
	Political sensitivity → Technology adoption → Economic wellbeing	-0.005	0.011	0.439
	Cultural sensitivity → Technology adoption → Economic wellbeing	-0.057	0.019	2.971
	Institutional sensitivity → Technology adoption → Economic wellbeing	0.014	0.011	1.353
	Income → Technology adoption → Economic wellbeing	0.040	0.015	2.649
	Female → Technology adoption → Economic wellbeing	-0.021	0.033	0.636
	Age → Technology adoption → Economic wellbeing	-0.028	0.011	2.573
	Climate severity → Technology adoption → Economic wellbeing	-0.020	0.011	1.808
	Health adversity → Technology adoption → Economic wellbeing	-0.012	0.009	1.344

Note: The direction of arrows indicates the direction of effects. The path coefficients and t-statistics were calculated using bootstrapping with 10,000 replications.

Table 6 shows that adaptive capacity significantly mediates the impact of cultural sensitivity (β = -.15; $p < .01$), economic sensitivity ($\beta = .13$; $p < .01$), institutional sensitivity ($\beta = .09$; $p < 0.01$), and political sensitivity ($\beta = .08$; $p < .05$) on economic well-being. The indirect effect of cultural sensitivity was the most significant, and it was negative. Adaptive capacity mediated the effects of control factors, with income ($\beta = .17$; $p < .01$), climate severity (β = -.15; $p < .01$), and health adversity ($\beta = .09$; $p <$ .01) having the largest and smallest indirect significant effect sizes on economic well-being, respectively. Adaptive capacity did not play a significant role in mediating the impact of age and gender on economic well-being.

Furthermore, Table 6 shows that cultural (β = -.06; $p < .01$) and economic (β = .04; $p < .01$) sensitivities have an indirect effect on economic well-being through technology adoption. Nonetheless, technology adoption did not channel the impacts of political and institutional sensitivities to economic well-being. Technology adoption mediated the effect of income on economic well-being (β = .04; $p <$ .01). The impacts of age, gender, climate severity, and health adversity on economic well-being were not significantly mediated by technology adoption.

7 Discussion

Climate change is impacting agricultural communities in the MRB. This study focuses on farmers' perceptions of climate variability and extreme weather events, which they experience as disruptions to their agricultural livelihoods. While climate change is widely understood to increase the frequency and intensity of such events globally, this study does not provide meteorological data to demonstrate that such changes have occurred specifically in this part of Malaysia. Rather, it relies on farmers' reported experiences and perceived sensitivity to climate extremes to explore how these perceptions influence their adaptive capacity and technology adoption. The current study, which was inspired by rational choice theory (RCT), sought to investigate how climate change sensitivity, specifically economic, political, cultural, and institutional sensitivities, had a statistical impact on farmers' adaptive capacity to climate extremes and technology adoption in agricultural activities. This study also used path analysis to investigate how adaptive capacity and technology adoption mediate the relationships between climate change sensitivity and economic wellbeing. Overall, farmers in MRB farming communities perceived themselves to be more sensitive economically (3.48), followed by political (3.14), institutional (2.54), and cultural (2.01) sensitivity, all measured on a Likert scale from 1 to 5.

This study used Rational Choice Theory (RCT), which states that farmers must consider available options based on their knowledge and understanding of climate extremes. The farmers' ultimate goal is to achieve the best possible outcome in their agricultural activities. This includes high productivity and sustainability, which can be achieved through increased adaptive capacity and technology adoption, as hypothesised in the current study. Farmers are unlikely to change or improve unless confronted with external forces, such as climate extremes, because they must invest effort and pay a price to improve their adaptive capacity and adopt new technologies. As a result, it is critical to recognise that their own initiative or sense of thought in adjusting to climate extremes is determined by the trigger factor, which refers to the vulnerability or sensitivity they experienced during extreme climate events, specifically the economic, political, cultural, and institutional sensitivities outlined by Fenton et al. (2007) and Marshall et al. (2010). In this study, farmers' perceived trigger factors (i.e., sensitivities) are viewed as sources of awareness, information, or knowledge of uncertainties that may prompt them to develop strategies based on available options, such as whether or not to put more effort into becoming more adaptive or adopt technology for dealing with climate extremes, with the ultimate goal of achieving the best outcome in their agricultural or business activities.

In summary, this study found that both technology adoption and adaptive capacity directly improved farmers' economic wellbeing. Climate change sensitivity variables, such as economic, political, and institutional sensitivity, had a positive effect on adaptive capacity, while cultural sensitivity had a negative impact. Cultural and economic sensitivity had the greatest impact among these. Farmers who believe they have been economically impacted and that the political and institutional environments are effective in assisting the community in dealing with climate extremes are more likely to develop the ability to adapt to changes in their environment. Furthermore, the current study suggests that sociocultural activities have served as a means of knowledge dissemination among farmers, which is an important source of adaptation and technology adoption. As a result, it is worth noting that disengagement or disruption in sociocultural aspects has hampered farmers' ability to adapt to climate change. Furthermore, path analysis revealed that adaptive capacity played an important role in mitigating the impact of these four sensitivities on economic wellbeing.

Only economic and cultural sensitivity had significant positive and negative effects on technology adoption, respectively. This finding is consistent with previous findings that of the four sensitivities, cultural (-) and economic (+) sensitivity had the greatest effects on adaptive capacity. Furthermore, technology adoption mediated the impact of cultural and economic sensitivity on economic well-being. These findings are significant for this study because political and institutional sensitivities had a strong positive impact on adaptive capacity but not on technology adoption. As a result, one could argue that farmers' perceptions of government effectiveness (i.e., political and institutional features) are important for the development of adaptive capacity but did not lead to technology adoption among MRB farmers. Similarly, it is possible that agricultural technology is expensive to acquire, and as a result, when farmers perceive serious efforts from the institutional and political sides, they tend to develop their adaptive capacity rather than incorporating technology into their economic activity in order to achieve higher economic well-being in the long run. In this case, it is worth noting that political and institutional sensitivities are based on what farmers see of what others (politicians, institutions, or government) are doing, whereas economic and cultural sensitivities are based on what farmers have personally experienced or suffered (economically or culturally) as a result of climate change events. However, it should be noted that being more adaptive can take many forms, including the sixteen dimensions identified by Marshall et al. and used in this study. However, the current study did not go into detail about each dimension and its relationship to sensitivity.

Given that adaptive capacity has a threefold greater positive effect than technology adoption on economic well-being, it is worthwhile to emphasise the development of adaptive capacity among farmers in order to ensure the sustainability of agricultural communities. The development of adaptive capacity is consistent with the farming community's empowerment concept, which is motivated by political, institutional, cultural, and economic sensitivity to climate change. To empower the area's farming communities and protect them from current and future climate change vulnerabilities, it is critical to support long-term approaches to adaptation and coping mechanisms. To address these challenges, governments, research institutions, and other stakeholders must work together across sectors to define a future of sustainable wellbeing for MRB farmers. At the same time, the findings should be interpreted in light of certain limitations, which point to avenues for future research.

8 Limitations and Future Research

This study is based on cross-sectional, self-reported data drawn from a homogeneous convenience sample of MRB farmers, predominantly male. Consequently, the findings should be interpreted as associative rather than causal. Measurement limitations include the use of single-item indicators for perceived climate severity and health adversity, as well as a technology adoption construct reflecting perceived innovation attributes rather than observed behaviors. Although diagnostic tests indicated acceptable levels of common method variance, the potential for residual bias cannot be ruled out.

Future research should employ longitudinal (panel or cohort) designs to better capture temporal dynamics and causal relationships. Incorporating objective exposure metrics, such as meteorological or flood records, would enhance validity. Using validated scales to assess climate-related anxiety is also recommended. Moreover, examining actual behavioral adoption and capital constraints (for example, credit access, subsidy participation, and farm size) would offer deeper insights into adaptation processes. Finally, testing moderated mediation pathways (such as income, age, and extension contact) could clarify the conditions under which sensitivity influences adaptation and well-being outcomes.

Competing interests: The authors declare no competing interests.

Ethical approval: This project received ethical approval from the Universiti Putra Malaysia's Ethics Committee for Research Involving Human Subjects. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

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A New, Free to Use Danish Vocabulary Test with Norms

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Abstract

We constructed a new multiple choice measure of Danish vocabulary, with an initial item pool of 101 items based on a 2-out-of-5 choice design. We gathered data from 622 subjects from an internet survey provider to ascertain the test properties and construct norms. The resulting complete test had excellent overall reliability, $r_{xx} = .95$,[1] and maintained high reliability ($> .90$) for test scores within a z-score range of approximately -3.2 to $+1.2$. Predictive validity was examined using questions about education, income, and number of books read in the previous year. Abbreviated scales were created with 5 to 50 items. Finally, norms were calculated for all scale variants.

Keywords: Vocabulary, IRT, Predictive validity, Reliability, Test optimization, Online testing

1 Introduction

Most cognitive tests available free of charge online are of dubious quality and with undocumented norms. Researchers instead tend to use a small set of proprietary and quite expensive tests, as these have known properties 6available from the test developers (e.g., Raven's matrices, Wechsler's, Cattell's). The test developers protect their tests using copyright law, and for this reason, almost none of these are available online for those wishing to measure their own or someone else's cognitive abilities. To meet this need for quality cognitive testing, we sought to develop a new public domain Danish vocabulary test. While there exist a number of Danish vocabulary tests such as those in the Wechsler's batteries (https://www.pearsonclinical.dk/wais-iv) or the Danish military test (Teasdale, 2009), these are all proprietary or protected. As far as we know, the present test is the only such free-to-use test in existence.

Vocabulary tests are among the most *g*-loaded, around $\lambda = .80$ without adjustment for reliability (Kirkegaard, 2022). The essential direction of causality is concept to word rather than word to concept. This means, according to Jensen (2001), that "Vocabulary is acquired when words fill conceptual "slots" that form in the course of mental development and seek to be filled. The wide range of individual differences in vocabulary reflects differences in the number of "slots" much more than differences in the amount of exposure to words. The causes of the available number of "slots" are still largely unknown but are certainly related to chronological age and Spearman's *g* factor."[2] Of particular interest is that some vocabulary tasks are more strongly related to reasoning such as multiple-choice synonyms, as opposed to, e.g., producing the definition (Bowles & Salthouse, 2008; Kave, 2024).

The present vocabulary test employs a select-2-of-5 response format, where participants identify two synonymous words among five options. The 2-of-5 design reduces random guessing (10%) compared to single-answer items (20%). This format is somewhat unusual and not covered in introductory books such as Kline (2015). Several recent studies however investigated the psychometric properties of such online vocabulary tests using this format and determined that these tests display a strong construct validity (Kirkegaard, 2021; Kirkegaard et al., 2024; Kirkegaard & Hu, 2025).

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1 This reliability is calculated using the **mirt** package from the latent scores obtained in the fitted IRT model.

2 This also implies that the unimportance of the exposure to words becomes more pronounced once the age effect is statistically controlled for.

Extending prior work on test properties of the select-2-of-5 response format in an online setting, the purpose of this study was to document this test and examine its properties, provide evidence of its validity, and provide norms. Item Response Theory (IRT) was used for this purpose due to its desirable features, such as the capacity of modeling the probability of a correct response as a function of both the test taker's latent ability (θ) and item parameters (difficulty, discrimination, and guessing) (Hambleton et al., 1991) and providing information about standard errors across ability levels (Embretson & Reise, 2000, p. 185). In the IRT framework, items that are more informative for a subject are given more weight in the scoring.

2 Data and methods

We collected data from an internet survey provider (https://www.dynata.com/) that allowed us to sample Danish subjects. Only native speakers of Danish were included. The data quality from the online provider was suspect, as evidenced by the removal of 64% of the initial sample (1,746 to 623 subjects) based on simple validity checks, which were ascertained by two attention checks as well as noting the time to take the test. The purpose of an attention check item is to distinguish between attentive and inattentive participants, by instructing the participant to pick a target word among a list of words (e.g., "Pick the word Tree"). Participants who did not select the target word were deemed ineligible for data analysis. Data from subjects not passing these requirements was otherwise not analyzed.

The test was developed using various online dictionaries and thesauruses were presented, and the subject was asked to identify which two were synonyms or had similar meanings. Figure 1 shows an example item from our survey.

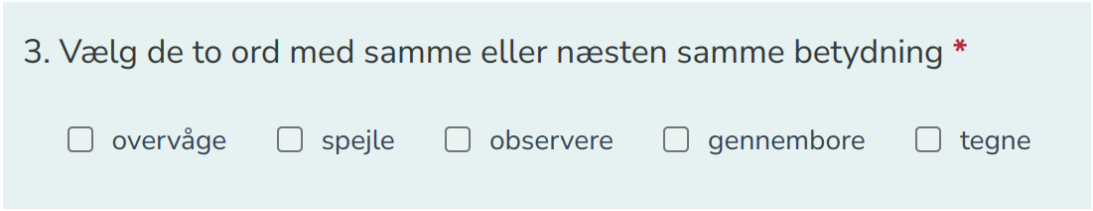

Figure 1: Example item. The correct choices are overvåge (to monitor) and observere (to observe).

The structure of the survey was as follows:

1. Consent and ID
2. Vocabulary questions (101 items + 2 attention checks)
3. Auxiliary questions (age, sex, education, income, fertility etc.)
4. Political ideology (30 questions) and party vote

The questions concerning fertility and politics were not used in this study, but will be used in future research. The vocabulary questions were scored into correct/incorrect format.

3 Results

First, the sum scores were calculated. This is the sum of correct scores for each subject, and thus theoretically ranges from 0 to 101. Figure 2 shows the distribution.

The scores are clustered towards the ceiling though only one subject reached it. The test was thus too easy overall, as the desired distribution would be more gaussian (normal) in shape. To examine this further, an item response theory (IRT) model was fitted to the data using the 2-parameter logistic model (2PL). This was done using the **mirt** package (Chalmers et al., 2020). The model converged and all items had positive loadings as expected. The mean factor loading was .61 with a standard deviation (SD) of 0.16.

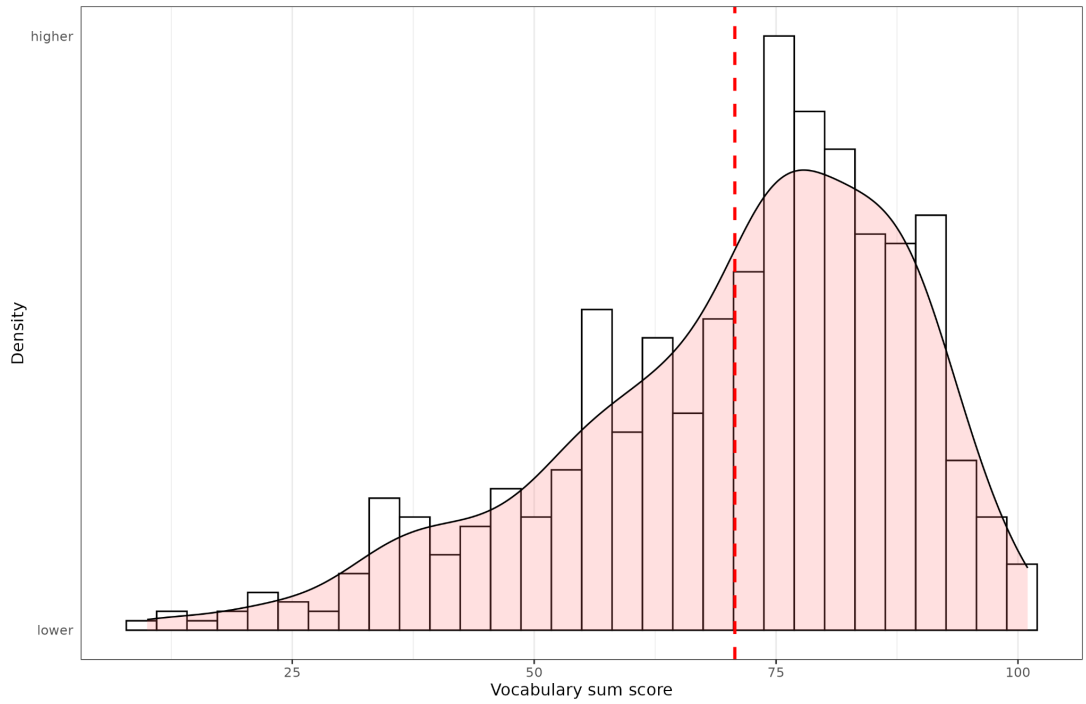

Figure 2: Distribution of sum scores for vocabulary

The mean pass rate was .70 with a SD of 0.20. The item factor loading was correlated at .41 with the item pass rate, as shown in Figure 3 ($r = -.37$ with the difficulty parameter). One possible reason for this positive correlation is that participants resort to guessing more often when solving the harder items. This means the probability of a correct answer depends more on this nuisance factor, and therefore less on cognitive ability.[3]

It is because of the high average item pass rate that the test scores are clustered near the top. Given the 2-out-of-5 choice design, the guessing chance is 10%. We additionally fit a model with the guessing parameter of the 3-parameter model fixed to 0.10, but this did not impact results much, and the results are not reported here. Figure 4 shows the distribution of IRT-based scores.

The distribution of IRT scores was markedly more Gaussian than the sum scores, which can also be seen in the distributional statistics (skew -0.86 vs. 0.08 for sum scores, and kurtosis 0.32 vs. 0.00 for IRT). This change of distributional properties happens despite the sum scores and IRT scores correlating .96. The relationship was nonlinear to allow this to happen.

While these scores work fine as a measure of current Danish vocabulary knowledge, they do not work as age-standardized scores, that is, as IQ scores (performance relative to the expectation based on age). Most cognitive tests show a marked relationship to age (Bowles & Salthouse, 2008; Kave, 2024; Salthouse, 2019; Verhaeghen, 2003), and this was also true for the present scores, shown in Figure 5.

As can be seen, the relationship between raw score and age was linear ($r = .55$), but the scatterplot revealed heteroscedasticity, with variance increasing as a function of age. To produce accurate IQ scores, it is necessary to account for age-related changes not only in the mean score but also in the score dispersion. Failure to do so would result in IQ scores with unequal measurement precision across the age range. We employed the same method used in a prior study in the design of an English vocabulary test (Kirkegaard et al., 2024). This is a multi-step process:

[3] One reviewer suggested that this relationship could also be explained by lower quality data among those with low scores. In this case however, the impact of such a nuisance factor (e.g., guessing, carelessness, misunderstanding of instructions) will permeate across many items, attenuating the correlation rather than amplifying it. Furthermore, the reliability curve derived from the IRT model shows only a slight decline in reliability for the very low scores, but a greater decline for the very high scores, which is consistent with the ceiling effect observed in the data.

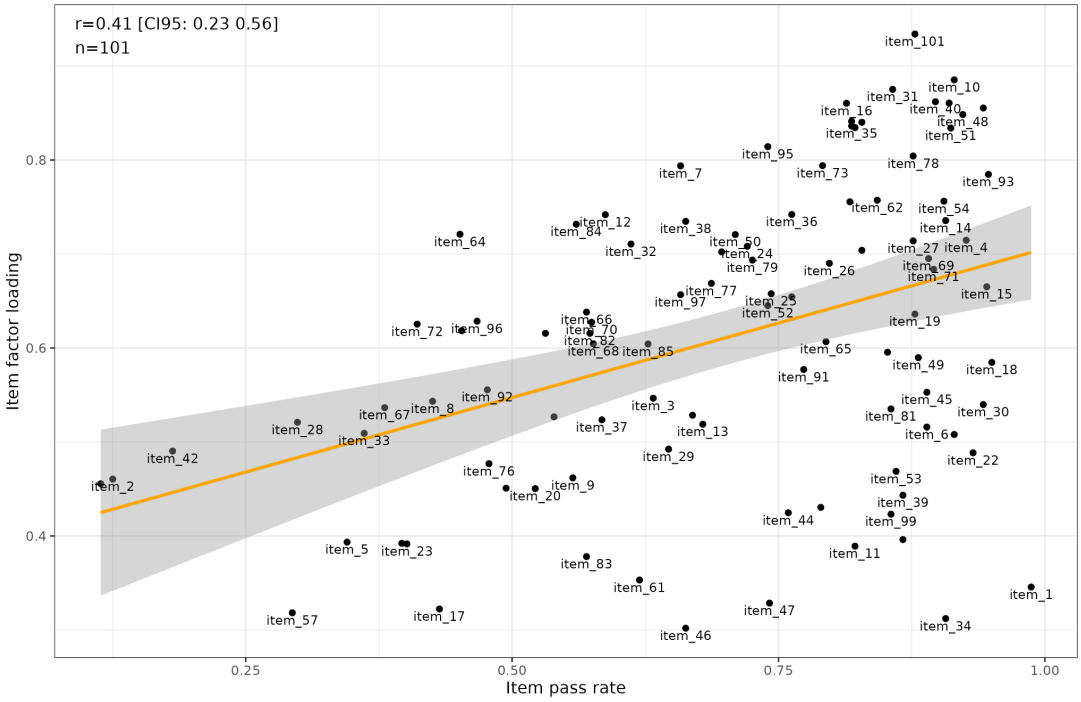

Figure 3: Scatterplot of item pass rates and item factor loadings.

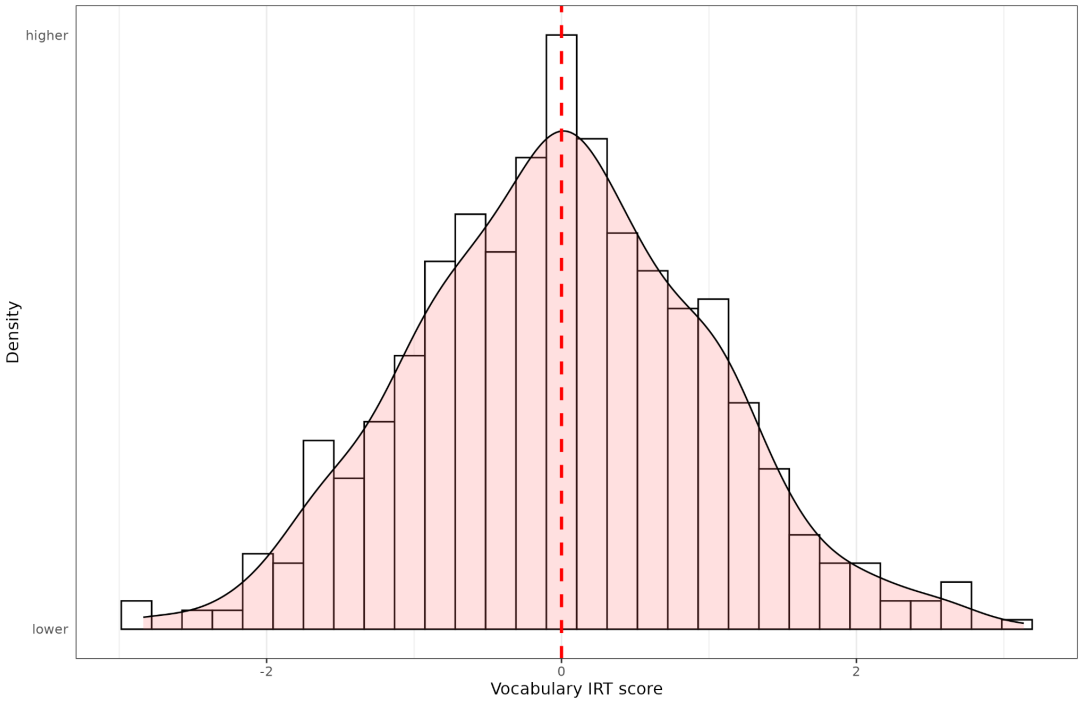

Figure 4: Item response theory scores for vocabulary

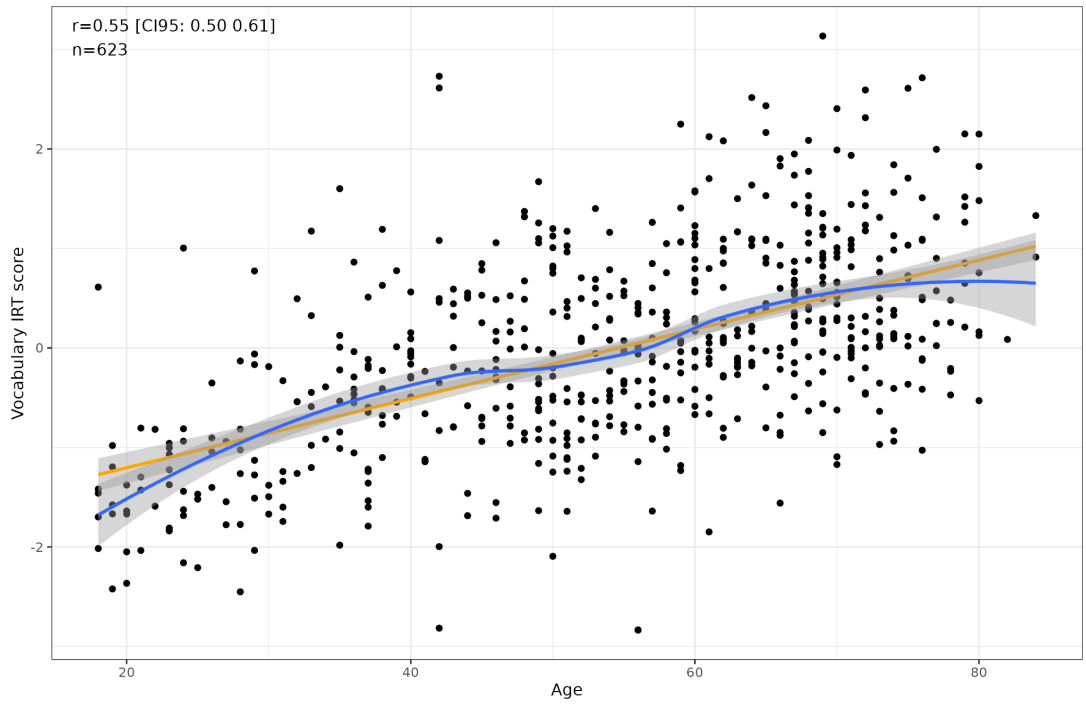

Figure 5: Relationship between age and Danish vocabulary ability score. Linear curve in orange and Loess curve in blue.

1. Using linear regression, predict vocabulary score from age. Save the residuals.
2. Using linear regression, predict the absolute value of the residuals from step (1). Save the residuals.
3. Standardize the residuals so that the sample mean is 100, and with an SD of 15.

The details of the models are saved so that any raw IRT (or sum) score can be converted into an IQ score. For the IRT scores, no heteroscedasticity was detected ($p = .23$), while it was detected for the sum scores ($p < .001$). As such, for the IRT scores, there was no need for step (2) above. The resulting IQ distribution is shown in Figure 6. The full information needed to calculate IQ scores from raw data is available in the supplementary information. The appendix gives further instructions.

The distribution was approximately normal, though less so than the unadjusted IRT scores (skew = 0.32, kurtosis = 0.64). There were some implausibly low scores on the tails. 5 subjects scored below 65 IQ, and 3 people above 145 IQ. Possibly, these reflect additional subjects who either did not try their best, or cheated by using a dictionary or asking an AI agent to help. These were excluded from further analysis.

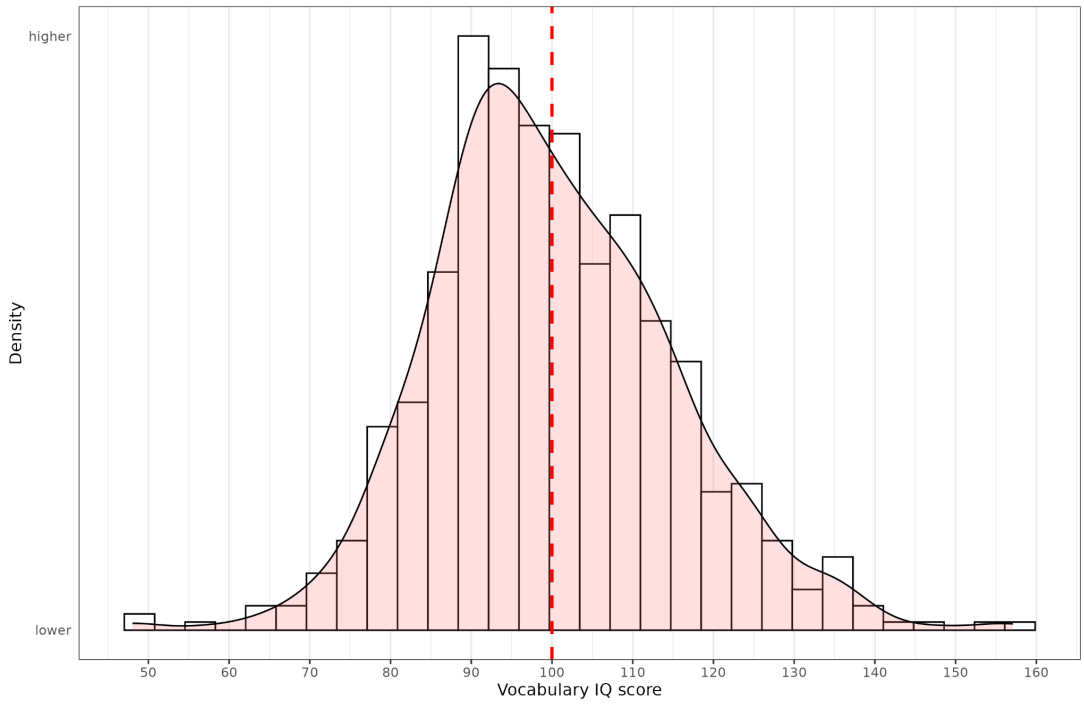

Figure 6: Vocabulary IQ (age-standardized) distribution.

4 Validation

We included a number of questions concerning other facts about the subjects that should relate to intelligence and thus vocabulary. Primarily, a medium strength association with educational attainment is expected. Figure 7 shows the average IQ by educational attainment.[4]

Vocabulary IQ and educational attainment were positively related; the regression of vocabulary on education displayed an adjusted R^2 of .115, which is equivalent to $r = .34$. Strangely, high school graduates with no further completed education attained higher IQs than those with higher education, and this was neither due to age-confounding nor due to the number of books read.[5] The 4 subjects with doctorates achieved a mean IQ of 116 in line with other recent Danish results (Akcigit et al., 2020).

Subjects were asked how many books they read last year (no limitations on type).[6] Some subjects claimed to have read or listened to hundreds of books (maximum value = 300), while the median was only 6. The correlation with IQ was .14. If values above 100 are winsorised to 100, the correlation was .18. If instead, a log transformation was applied (log(1+book read)), the correlation was .21, shown in Figure 8.

Pre-tax income for last year was reported by subjects, however, some seemingly reported it in thousands and some in ones.[7] The distribution of incomes shows a clearly bimodal distribution with peaks around 320k Danish Kroner (DKK) and 216. Usually, Danes will report their incomes in thousands in conversations, which would explain this pattern. However, we explicitly asked them not to do so. If values below 1000 are multiplied by 1000, then the resulting correlation is r = .11 (r = .12 before). It also appears that some reported their monthly income, though this was more difficult to adjust for. Log transformation alone preserves the correlation (r = .10), whereas additional filtering of zero-income responses increases the correlation (r = .17). The data did not seem to be entirely unreliable because in a regression model

[4] The question text was "What is your highest completed education?" with 8 options.

[5] A comparison of means shows that age and number of books were not noticeably higher for the high school group.

[6] The question was "How many books did you read last year? Including audiobooks." Subjects could input any non-negative integer.

[7] The question text was "How much money did you earn last year before taxes? Include all sources of income, such as social security and pensions. Best guess.", with the label for the input being "Danish kroner (NOT thousands)".

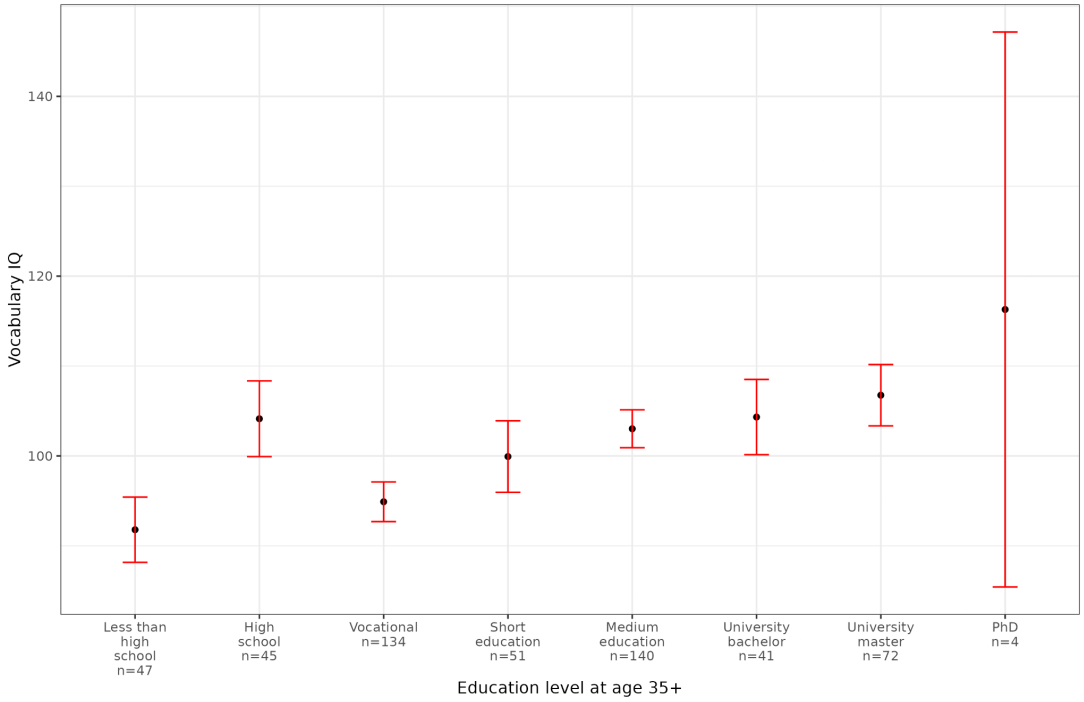

Figure 7: Average IQ by educational attainment. Data only for the subjects aged 35 and above.

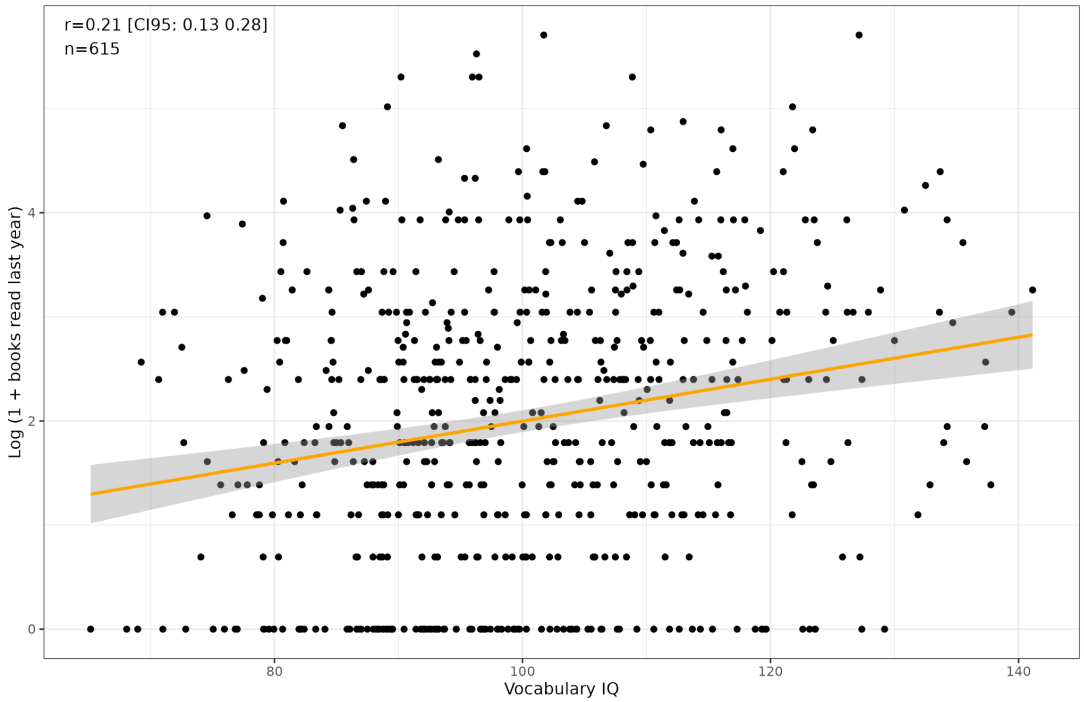

Figure 8: Vocabulary IQ and number of books read or listened to last year (log transformed).

including sex and age as predictors, men had an income 88k DKK above women, which is not far from publicly reported gaps (101k DKK in 2023 (Rossau, 2023)). In relative terms, men in our sample made 27% more than women, and the publicly reported value is 31%.

5 Scale abbreviation

The full scale of 101 items is too long for many practical purposes (median time for completion was approximately 30 minutes). For this reason, we constructed abbreviated versions of the scale for those uses. Since each use case may be different, we constructed abbreviated scales with 5-50 items in increments of 5. The scale abbreviation was done using the same approach as in a prior study (Kirkegaard et al., 2024). We excluded items that were too hard or too easy, keeping those with pass rates between 5% and 95%. This left 99 items out of the 101 initial. We used 3 algorithms with variations to optimally reduce the item count while retaining desirable test properties insofar as was possible. These were:

1. A maximum factor loading approach. *In the default setting, the k items with the highest factor loadings are chosen. In the balanced difficulty setting, the k items with the highest factor loadings are chosen subject to the constraint that they come from different intervals of item difficulty (these can be changed, but in this case, the 5 groups were used). Finally, alternatively, the factor loadings are residualized for item difficulty, and the k items with the highest residualized factor loading are chosen.*

2. A step-wise model selection approach. *This begins either forwards or backwards. In the backwards setting, the algorithm begins with the full test and each possible test with k-1 item is fit, and its properties saved. The best model is chosen based on its correlation with the full test and its overall reliability (the average of the scaled values is used). This process continues until the test reaches its desired length (e.g., 10 items). Since the process saves all the intermediate information, only a single run through is required to abbreviate the test to any length. In the forwards setting, the test begins with the 3 items with the highest factor loadings, since an IRT model cannot be fit using less than 3 items. After this, each possible k+1 test is fit, and the best is chosen as before. This process continues until the desired length is reached. The backwards approach is probably better at finding optimal test compositions, but it requires much more time.*

3. A genetic algorithm. *In this approach, the test begins with a random selection of k items equal to the desired length. The algorithm then randomly changes some of the items for other items and model fits are calculated. If an improved model is found, this becomes the new parent and the process repeats. The process stops once no improvement has been made after a number of generations (default is 10).*

The results of applying the algorithms are shown in Figure 9. They show that the stepwise selection algorithms did best (backwards slightly superior to forwards), though the advantage relative to the much faster loading maximization variants was small. The genetic algorithm was very slow and was only applied to the 50 item length, where it obtained roughly equal results with the stepwise algorithm. The maximum loading method performed much worse, probably because it selects items solely based on factor loadings, with complete disregard of difficulty levels. This is crucial, because a mismatch between test difficulty and an individual's true ability causes loss of measurement precision.

6 Discussion

This study introduced a new, freely available Danish vocabulary test developed using Item Response Theory (IRT). The full 101-item test demonstrated excellent reliability ($r_{xx} = .95$) and covered a broad range of ability levels (reliability $>$ .90 for ~90% of the sample). Predictive validity was supported by expected

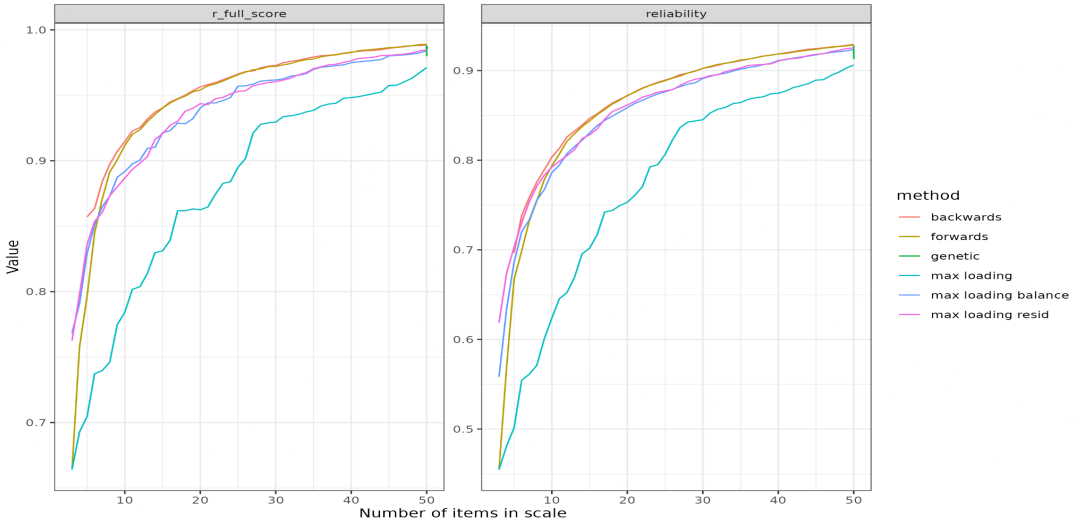

Figure 9: Results of test abbreviation using multiple algorithms

correlations with education level ($r \approx .55$), age ($r = .55$), and self-reported reading habits ($r = .21$), though the latter was modest.

Some findings are worth discussing. First, vocabulary scores increased nearly linearly with education, consistent with prior research (Bowles & Salthouse, 2008; Kave, 2024; Salthouse, 2019; Verhaeghen, 2003). Second, the relationship between vocabulary and income is small ($r = .11$). Given that the income variable is a self-report measure, the correlation may be biased downward due to the simultaneous effect of random measurement error and mean-reverting bias, a situation in which persons with low earnings overstate their earnings and persons with high earnings understate their earnings (Bollinger et al., 2019; Bound et al., 2001; Gottschalk & Huynh, 2010). Third, an unexpected anomaly emerged whereby participants with only high school education (gymnasie, N = 45) scored as highly as those with bachelor's degrees (N = 41). Why this happens is unclear. Perhaps some high-IQ individuals have chosen not to pursue higher education despite academic ability (e.g., entrepreneurial paths, creative careers, or early entry into high-paying jobs). Assuming it is not the result of sampling error, such an anomaly warrants further investigation.

The IRT framework allowed for detailed item analysis, revealing a moderate correlation ($r = .41$) between item difficulty (pass rates) and discrimination (factor loadings). As anticipated, very rare words exhibited lower discrimination, likely due to increased guessing. While the test was slightly too easy for the sample, this reflects a common challenge in vocabulary test design: balancing difficulty without resorting to obscure words that compromise item quality (i.e., item loading), as illustrated in a previous study (Kirkegaard et al., 2024). Increasing the difficulty level by incorporating rare words may be sub-optimal because specialized words depend more on prior knowledge. Jensen (1980, p. 234) once noted that "verbal analogies based on highly familiar words, but demanding a high level of relation eduction, are loaded on gf, whereas analogies based on abstruse or specialized words and terms rarely encountered outside the context of formal education are loaded on gc".

Limitations of the present study include the following. First, the dataset was an online convenience sample. The initial data quality was poor, as very simple validity checks removed 64% of the data, and we cannot be certain that all bad responders were removed. If bad quality responders are present, the norms may be slightly inaccurate since random responding leads to lower scores. On the other hand, if cheating was present, scores may be too high. Finally, sample selection bias is possible which may bias results in either direction depending on the direction of sampling bias.

Second, the abbreviation methods will overfit the data to some extent. Thus, the abbreviations made based on the present dataset will probably not be the best one can do, but will underperform slightly. This could be investigated using internal cross-validation, however, the bias was deemed to be slight. Instead, future research should ascertain the test properties on unrelated samples.

Third, the overall test was somewhat too easy for our subjects. This reflects the fact that inventing difficult items that also seem reasonable to subjects is difficult as they will necessarily involve quite rare words. Usage of very rare words will probably result in depressed factor loadings for items (in this study, $r = .41$).

Fourth, the sample size may have been too small to detect heteroscedasticity with regards to the age adjustment needed to calculate IQ scores. In a related study on an English vocabulary test, such heteroscedasticity was identified and corrected (Kirkegaard et al., 2024). Visual inspection of Figure 5 suggests heteroscedasticity, especially with the lower dispersion at younger ages, but this was not beyond chance. It is plausible that the tests used to detect heteroscedasticity had limited statistical power.

Fifth, the validation questions chosen were somewhat suboptimal and for education there was an unexpected result for the high school (gymnasie) group. Gymnasie is a 3-year general academically-oriented upper secondary program (e.g., grades 10-12). This degree is only useful for admission into university/other education. It is possible these participants are simply university drop outs, although we cannot confirm it yet. All in all, we were unable to determine what caused this anomalous result, although we could rule out age.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Supplementary material

The full data, R analysis code, and R notebook is available in the supplementary materials at: https://osf.io/3wzq5/. The R notebook furthermore contains other results mentioned but not shown in this paper. The interested reader is invited to further examine them.

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Appendix - Using the tests with norms

There are two main ways one can use the test. One can either use the item response theory (IRT) based scoring, or the classical test theory (CTT) scoring. In the former, items are scored in complex ways to allow

for their different factor loadings. In the second approach, each item is scored as 1 or 0 (i.e., equal loadings are assumed). To use the test, first select the desired version in terms of length, either the full version or one of the abbreviated scales. Second, choose whether to use the IRT or CTT version. Suppose we want to use the 20 item version using CTT scoring (reliability = .872, correlation with full scale = .956). First, look at the files for the abbreviated scales (*abbrev_backwards_CTT.rds*, *abbrev_norms_CTT.rds*). Find the item identifiers used in this scale (items 7, 12, 16, 31, 32, 35, 38, 40, 41, 50, 64, 73, 75, 77, 84, 86, 87, 89, 95, 101). We can see the questions in *vocab_items.csv* (e.g., item 7 is: glacis, molok, **rænkespil**, melbærris, **maskepi**, the bold words both meaning a conspiracy). Suppose a 30 year old gets a score of 17/20, what does this mean? First, we look up the raw centile, which is 61st. Second, we apply age adjustments to get the IQ estimate. We could do this manually using the saved models and descriptive statistics in the norms, however, it is easier to use the function *apply_norms()*. Doing so yields an IQ score of 120, or 91st centile. Using the same function, one can also output approximate tables for ease of scoring. For instance, a score of 10 corresponds to 101 IQ, while a score of 20 corresponds to 128 IQ. The exact R code needed to make these calculations can be found in the R notebook.

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Meta-Analysis of American Race Differences in Intelligence

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Abstract

We present a meta-analysis of 139 U.S. studies (1918–2017; N = 400,000) examining racial differences in intelligence averages and distributions. Studies were included if they used representative U.S. samples, IQ tests with at least 3 subtests, reported White reference groups, and provided sufficient statistics to compute Cohen's *d*. Studies were excluded if samples were unrepresentative (e.g., elites, college-only, selective cities), duplicated, lacked general ability differences, lacked within-group SDs, lacked a White comparison group, or relied on scholastic achievement tests. Random- and mixed-effects meta-analytic models were used to estimate racial means. With the White mean set to 100, averages were 82 (Black), 89 (Hispanic/American Indian), 105 (Asian), and 109 (Jewish). Evidence indicates small study effects inflated Black mean IQs. Variances and distributions were similar across races, and there is strong evidence against convergence in intelligence between Blacks and Whites in cohorts born after 1960.

Keywords: Race, IQ, Race differences, Meta-analysis

1 Introduction

The existence of differences in intelligence between racial groups is a topic of profound societal importance, as it touches on education, economic opportunity, and social policy. Understanding whether and how such differences manifest can influence decisions in resource allocation, educational interventions, and workforce planning. The concepts of "race" and "intelligence" themselves are nebulous and there is no agreement on what they exactly constitute. In this article 'intelligence' will be used as a synonym for *g*, the first principal component of measured mental abilities; race refers to the socially constructed categories people use to conceptualize the genetic, cultural, and ethnic diversity that exists in the world.

Race differences in characteristics such as intelligence and personality have been believed to exist for a long time (Aristotle, n.d.; Nietzsche, 1886), although the denial of the existence of these differences or at least their genetic origin is not rare (Blumenbach & Bendyshe, 1865; Sherwood & Nataupsky, 1968; Sussman, 2014). With the passage of time, evidence began to support the existence of ethnic differences in cognitive ability, notable contributions being the Coleman (1972) report and Jensen's (1969) work on how much IQ and scholastic achievement could be boosted. While the causes of these differences are fiercely debated (Horowitz et al., 2019), their existence is accepted by most intelligence researchers (Rindermann et al., 2020).

There is strong interest in race differences in the United States, both from a scientific perspective and from a social perspective (Cofnas, 2020; Turkheimer et al., 2017; Weiss & Saklofske, 2020; Winegard et al., 2020). Over many decades there have been scholarly and public debates about the size and causes of race differences in socially valued metrics, whether these concern housing, income, wealth, crime, or education. A notable point of contention has been secular changes in the Black-White IQ gap as well as the exact magnitude of it (Dickens & Flynn, 2006; Herrnstein & Murray, 1994; Murray, 2007; Nisbett et al., 2012;

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Rushton & Jensen, 2006). Some researchers believe that some gaps have substantially reduced over time, while others have not found support for this conclusion.

Because it has been a number of years since the last meta-analysis, and newer data have been published, we sought to update existing meta-analyses. This includes adding more groups not previously included due to small sample sizes, mainly Jewish samples. Furthermore, there has been consistent interest in possible variability of differences in intelligence between groups. Differences in variance between groups have been a point of contention in the literature on sex differences in intelligence (Arden & Plomin, 2006; Lehre et al., 2008), and this applies to race differences as well. Some have argued that Asians may have a lower standard deviation in intelligence, though this does not seem to be corroborated by statistical evidence (Hsu, 2008). Jensen advocated that the Black standard deviation in IQ was a few points lower than the White one (Jensen, 1969), and this observation has not since been contested. Thus we sought to meta-analyze race differences in skewness, kurtosis and variance in addition to mean values.

As of now, our hypotheses are that the race differences in intelligence are the same as the ones that have been found in prior studies: a Black IQ of 85 (Lynn, 2006b), a Hispanic IQ of 89 (Roth et al., 2001), Asian IQ of 105 (Lynn, 2006a), and a Jewish IQ of 110-115 (Cochran et al., 2005; Cremieux, 2023a). Due to the lack of high quality literature surrounding the differences in variance and distribution in intelligence between races, the null hypothesis of no differences was used, though we acknowledge that previous academics have claimed that there are differences in standard deviations between races.

2 Data and methods

Effect sizes were gathered from studies included in prior meta-analyses (Dickens & Flynn, 2006; Fuerst, 2013; Gottfredson, 2005; Osborne & McGurk, 1982; Roth et al., 2001; Shuey, 1966), from Google Scholar searches, and from large datasets, including both cohorts of the National Longitudinal Study of Youth (NLSY), the Program for the International Assessment of Adult Competencies (PIAAC), the Midlife in the United States (MIDUS) series , the Adolescent Brain Cognitive Development (ABCD) study, the Philadelphia Neurodevelopmental Cohort (PNC), and Project Talent. This ended in the collection of 139 effect sizes with a total of 400,120 individuals. All data is from the United States.

To ensure that the estimates are based on representative samples with good measures of intelligence, 73 studies were excluded for six different reasons:

1. The test involved did not have at least 3 subtests,
2. The sample in question was already included,
3. No difference in general ability was reported,
4. No standard deviations within groups were reported so that Cohen's *d* could not be computed,
5. There was no White reference group,
6. The sample was not sufficiently representative in its procedure.

Examples of samples deemed unrepresentative include studies that deliberately sampled lower-class individuals, higher-class individuals, college students, college applicants, samples of veterans, or samples of cities that are highly selected for cognitive ability (e.g. Boston, San Francisco). Samples of students within high school or below, WW1 enlistees, and employees were deemed sufficiently representative of the general population. IQ tests here were defined as tests that intend to measure cognitive ability. Data from scholastic achievement tests was also excluded, as scholastic ability and general intelligence are conceptually and empirically distinct, despite being highly correlated (Deary et al., 2007; Kaufman et al., 2012). A flowchart which charts the entire selection process is available in Figure 1.

To calculate race difference in intelligence, the White mean and standard deviation was used as a reference, so the mathematical formula to calculate the difference would be 100 - 15 $*$ $(w_m$ - $g_m)/w_{sd}$, where w_m is the White mean, g_m is the mean of the racial group, and w_{sd} is the standard deviation of the White sample.

When analyses were conducted by the authors, IQ was calculated using factor scores that were computed using the R package *psych* (Revelle, 2024). When appropriate, age corrections were made to the scores to avoid age confounding from biasing the results. Distribution data, such as the skewness

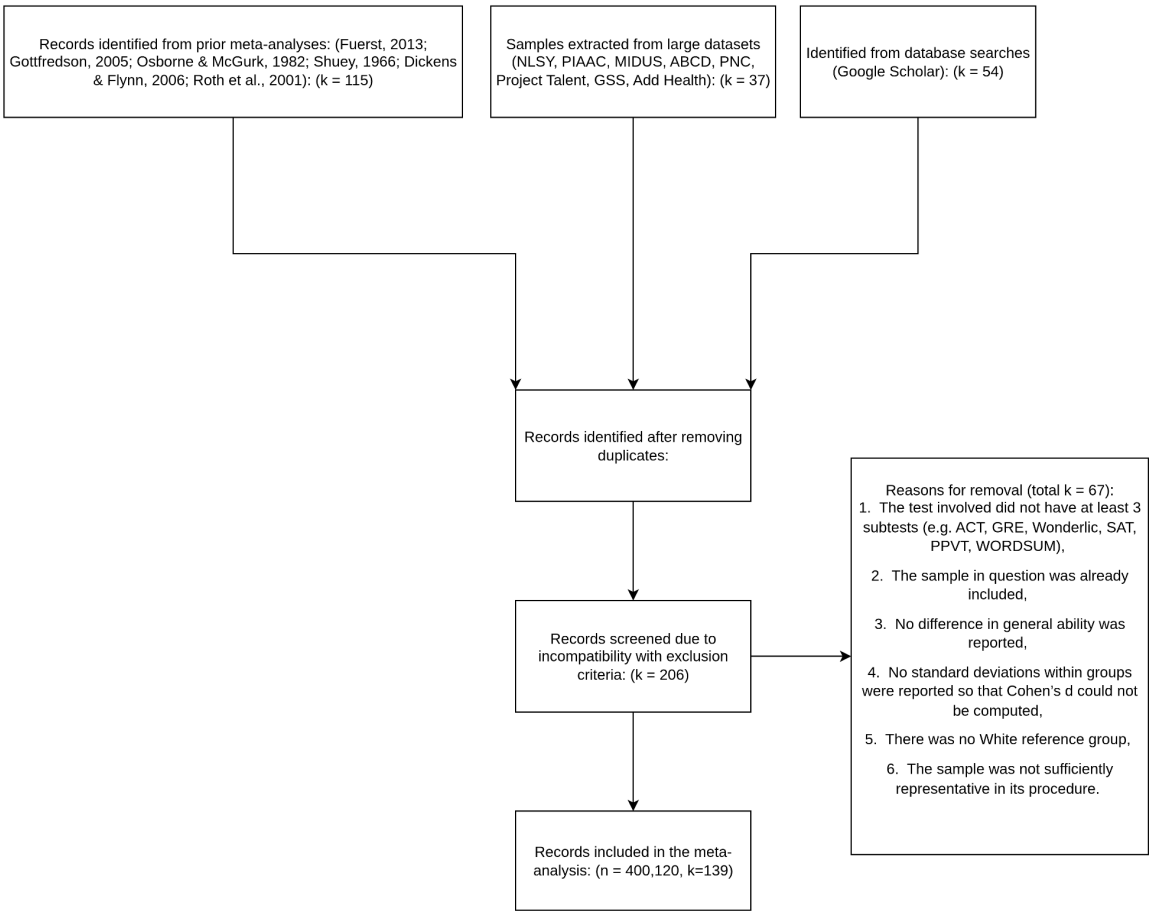

Figure 1: Flowchart of the study selection process.

and kurtosis of individual distributions were calculated as well. When assessing racial identification, Black and Hispanic Jews were classified as Black or Hispanic, as it was Ashkenazi Jews that were the group hypothesised to have higher intelligence. When possible, sampling weights were used to compute race differences in cognitive ability to avoid sampling procedures from biasing the results (e.g. some samples oversampled low social status subjects). A random effects meta-analytic model was used for meta-analytic models when no moderators were used, and a mixed effects model was used when moderators were included. The *metafor* R package (Viechtbauer, 2010) was used to fit the meta-analytic models when appropriate.

To facilitate interpretation, meta-analyses of means were conducted within individual race groups. For the distribution data, race differences in the distribution of intelligence were tested by testing whether race was a statistically significant moderator. While this makes the results more difficult to understand, it makes the statistical test less biased, as the p-values are based on only one test instead of five.

The influence of several different moderators was tested, including the number of subtests, cohort, the age at which the respondents were tested, and the standard error of the mean. Based on priors different moderators were chosen for different meta-analyses, for example, due to previous debate over whether the race difference in intelligence has diminished over time, discussed in the introduction, cohort effects were considered when analyzing race differences in intelligence. Publication bias was assessed with a visual inspection of funnel plots as well as a regression test.

3 Results

According to the random-effects meta-analysis, the average IQ of Black people in the United States is 85 (95% CI: [83.9, 86.1], $I^2 = 98.45\%$). A moderator analysis found that cohort, age at testing, and number of subtests had no association with the size of the difference. There was strong evidence of small-study effects ($p < .001$), as evidenced by the regression test and the funnel plot shown in Figure 2. This held ($p = .002$) even after removing the outliers. Corrected for the small study effects, the average Black IQ was 81.5 (95% CI: [79.7, 83.3]). The results of the meta-analytic regression models are available in Table 1.

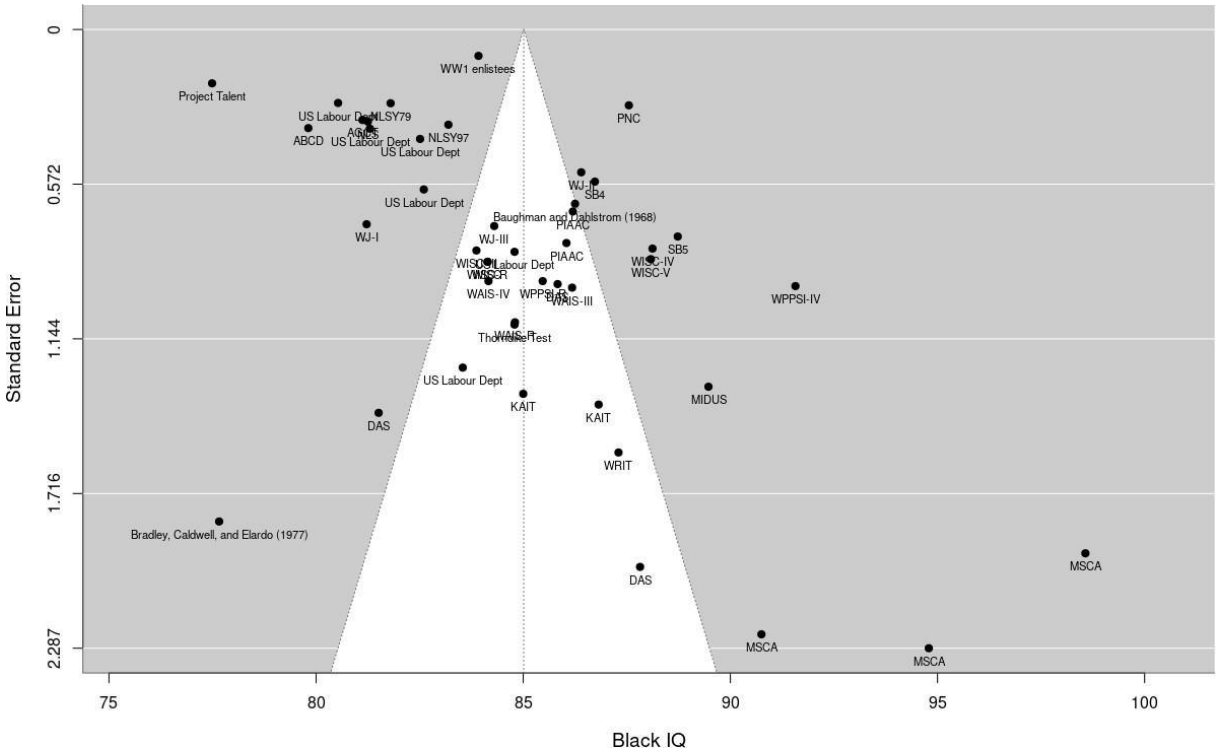

Figure 2: Funnel plot of the estimates of the mean Black IQ.

Table 1: Moderator analysis of mean Black IQs. *** $p < .001$, ** $p < .01$, * $p < .05$.

Parameter	Model 1	Model 2	Model 3
Intercept	8.116 (47.211)	-7.05 (56.25)	85.012 (0.565)***
Number of subtests	-0.034 (0.056)	-0.04 (0.067)	
Age at testing	0.023 (0.041)	0.003 (0.048)	
Cohort	0.037 (0.024)	0.047 (0.028)	
Standard error	3.858 (0.945)***		
Heterogeneity (I^2)	96.45	97.53	98.45
Test of moderators	p = 0	p = 0.245	p = 0
R^2 (%)	33.81	3.97	

To test whether this was a result of publication bias, studies were restricted to standardization samples (where differences are likely to be reported regardless of results) or the studies where the differences were calculated by the authors. A sample of WW1 enlistees was kept, as it was likely to be reported regardless of results. In these samples, American Blacks scored at an average of 85.7 (95% CI: [84.4, 87], $I^2 = 98.41\%$),

but there were still small study effects, according to the regression test ($p < .0001$), suggesting that these small study effects are not due to publication bias.

Of note was that the studies with lower Black means were usually large, national samples with high quality IQ testing: the NLS datasets, the ABCD dataset, a large sample of WW1 enlistees, the Project Talent dataset, and a sample of employees who were tested by the US Labour Department. The average Black IQ within these datasets was 81.8 (95% CI: [80.7, 82.9], $I^2 = 97.84\%$), almost identical to the average corrected for publication bias. It is worth mentioning that the two samples (WW1 enlistees and employees) where the representativeness is somewhat in question both have sample means that are somewhat larger than the other datasets: the sample of employees has a mean of 82.5 and the sample of enlistees has a mean of 83.9.

For the other four races, the average of Hispanics was estimated to be 88.9 (95% CI: [88, 89.9], $I^2 = 88.22\%$); for Jews 107.4 (95% CI: [106.1, 108.7], $I^2 = 75.65\%$); for Asians 103 (95% CI: [101, 105], $I^2 = 73.85\%$); and for Amerindians 89.1 (95% CI: [86.4, 91.7], $I^2 = 35.07\%$). There was no evidence for publication bias within any of these groups according to the regression test (all $p > .05$).

There were no race differences in the distribution of intelligence. Differences between races in variance, kurtosis, and skewness did not reach statistical significance as shown in Table 2.

Table 2: Moderator analysis of race differences in the distribution of intelligence for three different dependent variables (DV). *** $p < .001$, ** $p < .01$, * $p < .05$.

Parameter	DV: Skewness	DV: Standard Deviation	DV: Kurtosis
Intercept	-0.314 (0.114)**	15 (0.128)***	0.325 (0.264)
Jewish	-0.007 (0.311)	-0.539 (0.485)	-0.099 (0.612)
Asian	-0.006 (0.491)	0.319 (0.562)	-0.355 (0.723)
Hispanic	0.338 (0.259)	-0.291 (0.272)	-0.393 (0.469)
Black	0.416 (0.2)*	-0.485 (0.204)*	-0.250 (0.414)
Amerindian	0.306 (0.899)	0.369 (0.992)	-0.810 (1.062)
Heterogeneity (I^2)	42.89	84.91	86.13
Test of moderators	p = 0.366	p = 0.184	p = 0.937
R^2	16.48	4.58	0

The percentiles of IQ within races were also measured to test whether certain races were likely to have a large amount of outliers in any direction. These were meta-analyzed, and then predictions of the percentiles within races were made based on the means and standard deviations within these samples. The averages generated from the real distributions corresponded almost perfectly to those generated by simulated ones that assumed normality, as shown in Table 3.

Table 3: Comparison of the observed IQ percentiles within races with simulated ones based on the means and standard deviations within groups. The simulated results are in parentheses.

P.	Black	Hispanic	Amerindian	White	Asian	Jewish
5th	59.3 (58.4)	62.4 (62.2)	62.5 (63.7)	74.1 (75.3)	78.4 (77.6)	83.1 (83.2)
10th	64.3 (64.0)	68.0 (67.9)	73.2 (69.4)	80.4 (80.8)	85.1 (83.2)	88.1 (88.6)
25th	73.1 (73.4)	77.3 (77.4)	81.4 (79.0)	90.3 (89.9)	95.1 (92.4)	97.5 (97.3)
50th	83.8 (83.8)	87.3 (88.0)	89.8 (89.5)	100.7 (100.0)	104.7 (102.6)	107.7 (107.0)
75th	94.2 (94.2)	97.8 (98.5)	100.6 (100.1)	110.5 (110.2)	112.6 (112.7)	116.4 (116.8)
90th	103.9 (103.7)	108.0 (108.0)	108.8 (109.5)	118.8 (119.2)	119.9 (121.8)	124.1 (125.5)
95th	110.2 (109.3)	113.8 (113.7)	111.5 (115.2)	123.2 (124.6)	124.9 (127.3)	128.1 (130.7)

4 Discussion

While the IQ of Black people in the United States is conventionally estimated to be 85, this figure is likely to be affected by sampling error and other artefacts. The most likely sources of bias in estimating this figure are measurement error in intelligence and non-representative sampling; publication bias is not likely to be relevant when calculating such a large difference and most of the sources of data are likely to be reported regardless of results. Given that both of these biases underestimate the difference, it is likely based on priors that the true Black IQ is lower than 85. Of note is that the largest national samples which test ability the best tend to have larger differences: the ABCD, NLSY79, NLSY97, NLS, Project Talent datasets, US DOL's sample of employees, and the sample of WW1 enlistees have differences of 20, 18, 17, 19, 22, 17, and 16 points respectively. This is lower than the conventional estimate given (85), though not by a large amount.

The average IQ of US Jews has been estimated to be 107.5. This is a little lower than most estimates suggest — Cochran et al. (2005) estimate it to be between 112 and 115 and Cremieux (2023a) estimated it to be 110 in their meta-analysis. There is also the issue of using religious identification as a measurement of Jewish ancestry; Jews do not consider being Jewish to be religious, rather they conceive of their identity as ethnic or cultural (Pew Research Center, 2013). Religious people tend to be less intelligent than non-religious ones (Dutton et al., 2019), so using religious identification as a proxy for ethnicity may underestimate the true Jewish IQ. Given using religiosity as an indicator possibly deflates the difference, and this estimate is a bit lower than previous ones, the true average IQ of an American Jew lies somewhere between 107 and 112.

The average IQ of Asians in the United States has been estimated to be 103. Sampling different portions of the Asian population may also affect this score, as the average IQ of Asians varies considerably by country of origin (Fuerst, 2023a). To avoid this problem, average IQs of sub-populations of Asians were calculated based on IQ scores in the ABCD dataset (Fuerst, 2023a) as well as scholastic test results (Fuerst, 2023b) which are shown in Table 4. When these estimates were averaged with weighting by population size (Wikipedia, 2024), this resulted in an estimate of 105.6. Of note is that the Asian IQ has risen over time, as their average used to be close to the White mean, but gradually grew to a mean of roughly 105 (Lynn, 2006a).

Table 4: Average IQ and population size by Asian subgroup

Group	Average ABCD IQ	Average SAT IQ	Average	Population size
Chinese	111.3 (n = 81)	110.2 (n = 24,620)	110.8	5,143,982
Korean and Japanese	110.1 (n = 33)	108.55 (n = 11,810)	109.3	3,436,326
Filipino	103.5 (n = 51)	98.8 (n = 8100)	101.2	4,089,570
Other	102.5 (n = 52)	102.47 (n = 13,120)	102.5	3,034,102
Asian Indian	102.4 (n = 53)	110.3 (n = 32,750)	106.4	4,506,308
Vietnamese	98.7 (n = 24)	100.5 (n = 9,090)	99.6	2,162,610
Malaysia		107.6 (n = 240)	107.6	38,277
Cambodia		95.4 (n = 700)	95.4	300,360

The average IQ of American Indians has been estimated to be 89. This is in line with prior research on the average IQs of Native Americans (Lynn, 2006b). This score of 89 is also close to the average IQ-metric

score of Native Americans on the SAT, which is 91.3 (Fuerst, 2023b). One should note that these are self-identified Native Americans, who may only have partial ancestry.

No race differences in variance of intelligence were found. This is not consistent with opinions of some prior researchers (Hsu, 2008; Jensen, 1969); Jensen wrote that he thought the Black standard deviation was lower than the White one, and Hsu notes that some have argued the Asian standard deviation is lower than the White one. Although the Black standard deviation in intelligence was below 15, there was massive heterogeneity in standard deviations which suggested that test or sample specific factors drive differences in variance between Whites and Blacks on cognitive tests. Concretely, this could come in the form of minor violations in measurement invariance between races or the presence of floor/ceiling effects.

There is currently no consensus on whether the average IQ of the Black population within the United States has changed in the last 100 years. Some comparisons of standardization samples have suggested that the Black IQ rose between the 80s and 00s (Dickens & Flynn, 2006), though this increase is not observed in some tests, such as the Woodcock Johnson (Murray, 2007), where the gap stopped closing after cohorts born in the 60s. An ignored caveat is that reported declines in the racial gaps do not appear to have been caused by changes in general intelligence (Cremieux, 2023b). Between the subtests of the WAIS-R and WAIS-III, test gains in Blacks and g-loadings correlated negatively (r = -.28), which holds for the WISC as well (r = -.38). The closing in the gap also reduces by 46% when latent methods instead of composite scores are used to calculate race differences in intelligence.

The difference between Black and White children on the NAEP achievement tests narrowed between the 80s and the 90s (Vanneman et al., 2009). However, the same did not hold for race differences in the SAT (Dalliard, 2023), where the difference has stayed constant at about 1 standard deviation ever since 1987; race differences in ACT scores have remained at about 1 standard deviation ever since 1995 (National Center for Education Statistics, 2024), though these observations aren't necessarily contradictory as the tests were not tracked at the same time. Yet the very low score of American Blacks (80) in the recently collected ABCD dataset is still at odds with the perspective that the gap has shrunk.

Trends in scores on the WORDSUM test in the General Social Survey were studied by Huang and Hauser (1998), who found convergence in the Black-White WORDSUM gap. Hu (2017) responded that this convergence was inflated by assuming that age and cohort effects are additive. He showed that when using multilevel models that dispense with this assumption, the extent to which the Black-White gap declined is reduced by 85%. Modeling issues aside, the WORDSUM is only a 10-item vocabulary test; strong conclusions should not be drawn from this survey. A summary of the results of the meta-analysis is presented in Table 5.

Table 5: Summary of the meta-analysis

	Black	**Hispanic**	**Amerindian**	**Asian**	**Jewish**
Meta-analytic mean	85	89	89	103	107
Prior meta-analyses	83.5	89	89.5 (Lynn)	105 (Lynn)	110 (Cremieux)
Conventional estimate	85	88–92	85–90	103–106	107–115
Empirical standard deviation	14.5	14.7	15.4	15.3	14.5
Likely standard deviation	15	15	15	15	15
Kurtosis/skewness differences	No evidence	No evidence	No evidence	No evidence	No evidence
Best estimate of the mean	82 (79–84)	89 (88–90)	89 (86–92)	105 (104–106)	109 (107–112)

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Appendix

Table A1: Number of Americans in each category of IQ by race. Raw number is in the cell, the percentage (within group) is in parentheses. Means are assumed to be the best estimates from the final table, standard deviations are assumed to be 15 within all groups.

IQ bracket	Black	Hispanic	Amerindian	White	Asian	Jewish
<70	9,617,661 (21.2%)	5,683,431 (10.3%)	449,330 (10.3%)	4,463,718 (2.27%)	206,137 (0.983%)	35,338 (0.465%)
70-85	16,680,745 (36.7%)	16,184,386 (29.2%)	1,281,770 (29.3%)	26,669,438 (13.59%)	1,704,915 (8.14%)	381,341 (5.02%)
85-100	13,878,756 (30.6%)	20,674,540 (37.3%)	1,634,907 (37.3%)	66,981,122 (34.13%)	5,828,232 (27.8%)	1,668,331 (21.9%)
100-115	4,591,593 (10.1%)	10,535,865 (19.0%)	834,424 (19.0%)	66,981,019 (34.13%)	7,923,589 (38.1%)	2,895,060 (38.1%)
115-130	600,192 (1.32%)	2,124,003 (3.84%)	167,898 (3.83%)	26,663,919 (13.59%)	4,291,216 (20.5%)	2,004,999 (26.4%)
130-145	30,447 (0.0671%)	168,400 (0.304%)	13,259 (0.303%)	4,201,786 (2.14%)	919,653 (4.39%)	551,734 (7.26%)
145-160	602 (0.00133%)	5,314 (0.00960%)	407 (0.00929%)	258,786 (0.132%)	77,624 (0.37%)	59,644 (0.785%)
>160	4 (0.00000880%)	61 (0.000110%)	5 (0.000114%)	6,212 (0.00317%)	2,634 (0.0126%)	2,573 (0.0339%)

Table A2: Racial demographics by IQ category (%).

IQ bracket	Black	Hispanic	Amerindian	White	Asian	Jewish
<70	47.02	27.78	2.20	21.82	1.01	0.17
70-85	26.52	25.73	2.04	42.40	2.71	0.61
85-100	12.54	18.68	1.48	60.53	5.27	1.51
100-115	4.90	11.24	0.89	71.44	8.45	3.09
115-130	1.67	5.92	0.47	74.37	11.97	5.59
130-145	0.52	2.86	0.23	71.39	15.63	9.37
145-160	0.15	1.32	0.10	64.31	19.29	14.82
>160	0.03	0.53	0.04	54.07	22.93	22.40

Table A3: Moderator analysis of Hispanic IQs. *** $p < .001$, ** $p < .01$, * $p < .05$.

Parameter	Model 1	Model 2
Intercept	88.934 (0.477)***	55.96 (53.237)
Number of subtests		-0.104 (0.041)*
Age at testing		-0.042 (0.046)
Cohort		0.018 (0.027)
Heterogeneity	88.22	81.19
Test of moderators		p = 0.008
R^2 (%)		38.18

Table A4: Moderator analysis of small study effects on Black IQs. *** $p < .001$, ** $p < .01$, * $p < .05$.

Parameter	Model 1	Model 2
Intercept	82.03 (1.04)***	82.7 (1.16)***
Number of effect sizes reported	-0.27 (0.27)	-0.25 (0.30)
Standard error	4.11 (0.92)***	
Inverse standard error		-0.85 (0.31)**
R^2	33.48%	14.13%
Moderator test p-value	$p < .0001$	$p = .018$

Table A5: Table of the means, standard deviations, and sample sizes by data source.

Source	Race	Test date	Test age	Sample size	Mean	SD
PIAAC	White	2017	35	1955	100	15
PIAAC	Hispanic	2017	35	320	91.17	16.13
PIAAC	Black	2017	35	361	86.04	15.85
ABCD	White	2017	10	5784	100	15
ABCD	Jewish	2017	10	175	106.57	15.77
ABCD	Amerindian	2017	10	38	86.29	20.84
ABCD	Asian	2017	10	13	95.12	12.67
ABCD	Asian	2017	10	50	101.85	16.44
ABCD	Asian	2017	10	109	109.82	14.09
ABCD	Asian	2017	10	64	101.85	14.66
ABCD	Black	2017	10	1692	79.81	17.90
ABCD	Hispanic	2017	10	1692	89.07	16.92
PNC	White	2017	13.74	4989	100	15
PNC	Black	2017	13.74	2861	87.55	16.94
WISC-V	White	2014	11	1228	100	15
WISC-V	Black	2014	11	312	88.08	13.66
WISC-V	Hispanic	2014	11	458	90.65	13.25
WISC-V	Asian	2014	11	89	105.2	14.79
PIAAC	White	2012	35	2903	100	15
PIAAC	Hispanic	2012	35	382	87.83	15.75
PIAAC	Black	2012	35	497	86.20	15.08
WPPSI-IV	Asian	2012	5	52	102.84	14.6
WPPSI-IV	White	2012	5	908	100	15
WPPSI-IV	Hispanic	2012	5	413	92.25	12.33
WPPSI-IV	Black	2012	5	250	91.57	13.72
WAIS-IV	White	2009	35	1540	100	15
WAIS-IV	Black	2009	35	260	84.16	15.1
WAIS-IV	Hispanic	2009	35	289	87.36	15.7
WAIS-IV	Asian	2009	35	71	103.12	16.46
MIDUS	White	2005	55.8	3432	100	15
MIDUS	Jewish	2005	55.8	98	104.48	15.63
MIDUS	Black	2005	55.8	129	89.4	14.94
MIDUS	Amerindian	2005	55.8	18	96.09	13.92

MIDUS	Asian	2005	55.8	23	101.76	11.83
WISC-IV	White	2002	11	1402	100	15
WISC-IV	Black	2002	11	343	88.12	16.12
WISC-IV	Hispanic	2002	11	335	89.57	13.03
SB5	White	2000	35	2070	100	15
SB5	Black	2000	35	384	88.73	13.53
NLSY97	White	1999	15	3587	100	15
NLSY97	Black	1999	15	1814	83.19	14.92
NLSY97	Hispanic	1999	15	1300	89.38	14.63
NLSY97	Amerindian	1999	15	20	91.32	10.24
NLSY97	Jewish	1999	15	99	107.12	14.33
WJ-III	White	1998	35	2592	100	15
WJ-III	Black	1998	35	426	84.3	14.32
WAIS-III	White	1995	35	1523	100	15
WAIS-III	Black	1995	35	247	86.18	13.48
KAIT	White	1993	16.2	575	100	15
KAIT	Hispanic	1993	16.2	76	87.36	14.57
KAIT	Black	1993	15.8	117	86.82	15.54
KAIT	White	1993	52.5	972	100	15
KAIT	Hispanic	1993	46.5	64	84.2	16.62
KAIT	Black	1993	46	124	85	16.83
WRIT	White	1993	26.68	559	100	15
WRIT	Black	1993	26.68	92	87.3	14.9
WRIT	Hispanic	1993	26.68	73	92.3	14.7
WISC-III	White	1989	11	1543	100	15
WISC-III	Black	1989	11	337	83.87	13.89
WJ-II	White	1987	35	3573	100	15
WJ-II	Black	1987	35	807	86.4	16.11
DAS	White	1986	11.5	1692	100	15
DAS	Hispanic	1986	11.5	226	90.74	14.07
DAS	Black	1986	11.5	254	85.83	14.8
DAS	Asian	1986	11.5	48	104.76	14.8
DAS	White	1986	3	247	100	15
DAS	Hispanic	1986	3	39	92.53	15.53
DAS	Black	1986	3	57	87.82	14.3
DAS	White	1986	4.25	505	100	15
DAS	Hispanic	1986	4.25	78	89.07	13.18
DAS	Black	1986	4.25	112	81.51	14.52
WPPSI-R	Asian	1986	5	23	100.25	19.37
WPPSI-R	White	1986	5	1192	100	15
WPPSI-R	Hispanic	1986	5	181	87.07	15.03
WPPSI-R	Amerindian	1986	5	18	88.66	12.31
WPPSI-R	Black	1986	5	260	85.47	15.51
SB4	White	1985	35	3691	100	15
SB4	Black	1985	35	711	86.73	13.53
WISC	Black	1982	11	305	84.14	13.58
WISC	White	1982	11	1868	100	15

NLSY79	White	1980	20	6932	100	15
NLSY79	Black	1980	20	3026	81.80	13.11
NLSY79	Hispanic	1980	20	1839	86.72	15.87
NLSY79	Jewish	1980	20	109	110.09	12.75
WAIS-R	White	1978	35	1664	100	15
WAIS-R	Black	1978	35	192	84.8	12.95
US Labor Dept	White	1977	18	983	100	15
US Labor Dept	White	1977	22	3369	100	15
US Labor Dept	White	1977	29	4601	100	15
US Labor Dept	White	1977	39	2571	100	15
US Labor Dept	White	1977	49	2011	100	15
US Labor Dept	White	1977	60	968	100	15
US Labor Dept	Black	1977	18	333	84.79	15.1
US Labor Dept	Black	1977	22	1672	81.3	13.33
US Labor Dept	Black	1977	29	3048	80.53	13.77
US Labor Dept	Black	1977	39	1374	82.51	13.03
US Labor Dept	Black	1977	49	643	82.6	12.68
US Labor Dept	Black	1977	60	144	83.54	11.25
US Labor Dept	Hispanic	1977	18	98	89.14	15.62
US Labor Dept	Hispanic	1977	22	376	88.61	12.31
US Labor Dept	Hispanic	1977	29	680	87.81	15.18
US Labor Dept	Hispanic	1977	39	360	90.31	14.66
US Labor Dept	Hispanic	1977	49	171	87.77	14.73
US Labor Dept	Hispanic	1977	60	49	90.12	15.09
Bradley et al. (1977)	White	1977	2	37	100	15
Bradley et al. (1977)	Black	1977	2	68	77.66	15.62
WJ-I	White	1976	35	3329	100	15
WJ-I	Black	1976	35	434	81.22	17
Thorndike Test	White	1973	11	237	100	15
Thorndike Test	Hispanic	1973	11	239	91.8	13.62
Thorndike Test	Black	1973	11	189	84.79	13.27
WISC-R	Black	1972	11	305	84.14	13.58
WISC-R	White	1972	11	1868	100	15
NLS	White	1972	17	12275	100	15
NLS	Black	1972	17	1938	81.25	13.49
MSCA	White	1970	3	43	100	15
MSCA	Black	1970	3	43	94.79	15.18
MSCA	White	1970	4.75	60	100	15
MSCA	Black	1970	4.75	60	98.57	14.43
MSCA	White	1970	7.5	45	100	15
MSCA	Black	1970	7.5	45	90.75	13.73
Baughman & Dahlstrom (1968)	White	1968	10.5	464	100	15
Baughman & Dahlstrom (1968)	Black	1968	10.5	542	86.25	13.54
Project Talent	Amerindian	1960	15	222	87.89	15.27
Project Talent	White	1960	15	129344	100	15
Project Talent	Hispanic	1960	15	328	82.96	13.89
Project Talent	Black	1960	15	5679	77.49	15.01

Project Talent	Jewish	1960	15	6944	106.83	13.99
Project Talent	Asian	1960	15	949	100.62	15.80
WLS	White	1955	16	4244	100	15
AGCT	White	1942	25	2147	100	15
AGCT	Black	1942	25	2010	81.12	14.65
WW1 enlistees	White	1918	25	93955	100	15
WW1 enlistees	Black	1918	25	23596	83.92	14.33
SEAQO AND KOLDIN	Jewish	1936	12	800	108.73	14.78
SEAQO AND KOLDIN	White	1936	12	452	100	15

Table A6: Mean Black IQ by cohort.

Cohort	Mean Black IQ
1890-1939	82.7
1940-1959	83.8
1960-1979	86.5
post 1980	85.9

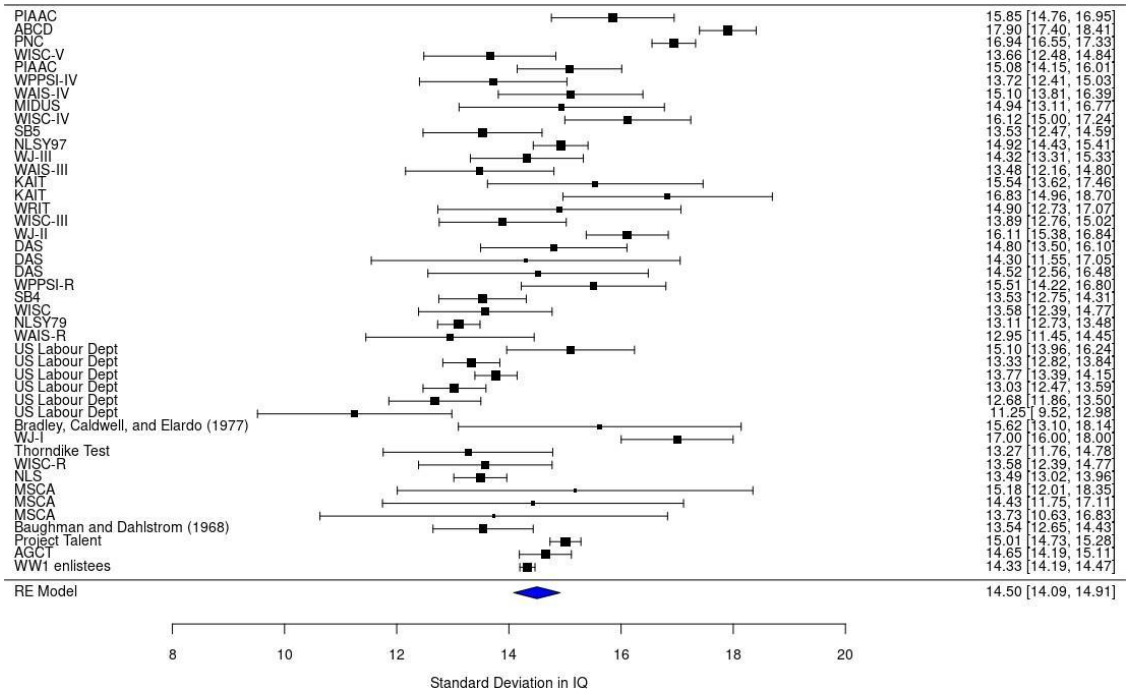

Figure A1: Forest plot of standard deviations in IQ within Blacks.

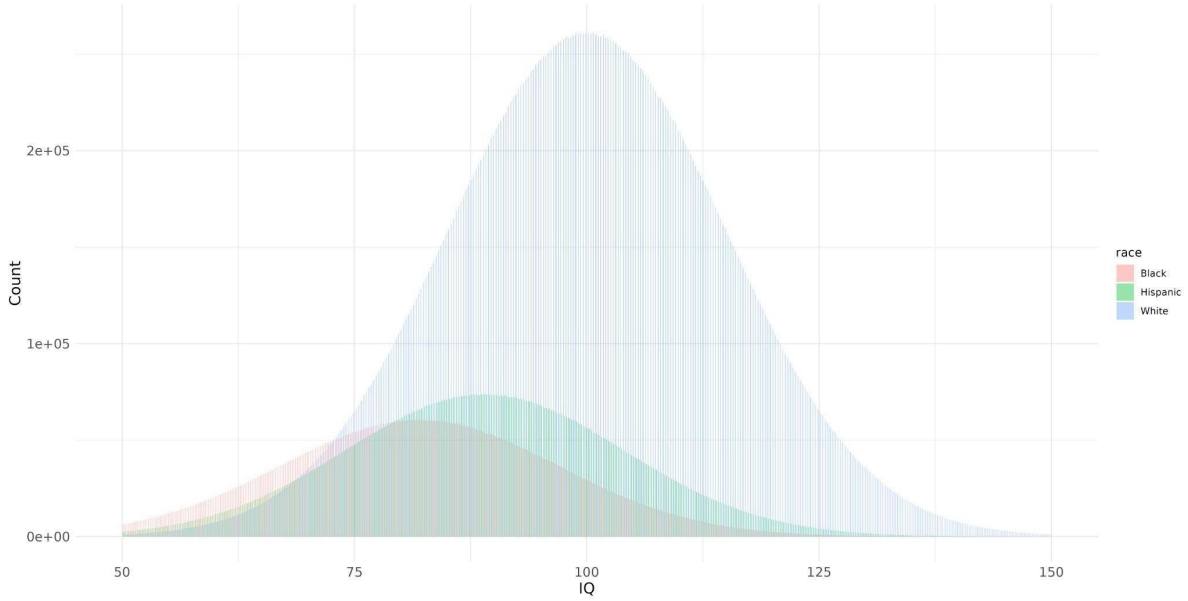

Figure A2: IQ distribution by race, taking into consideration population sizes

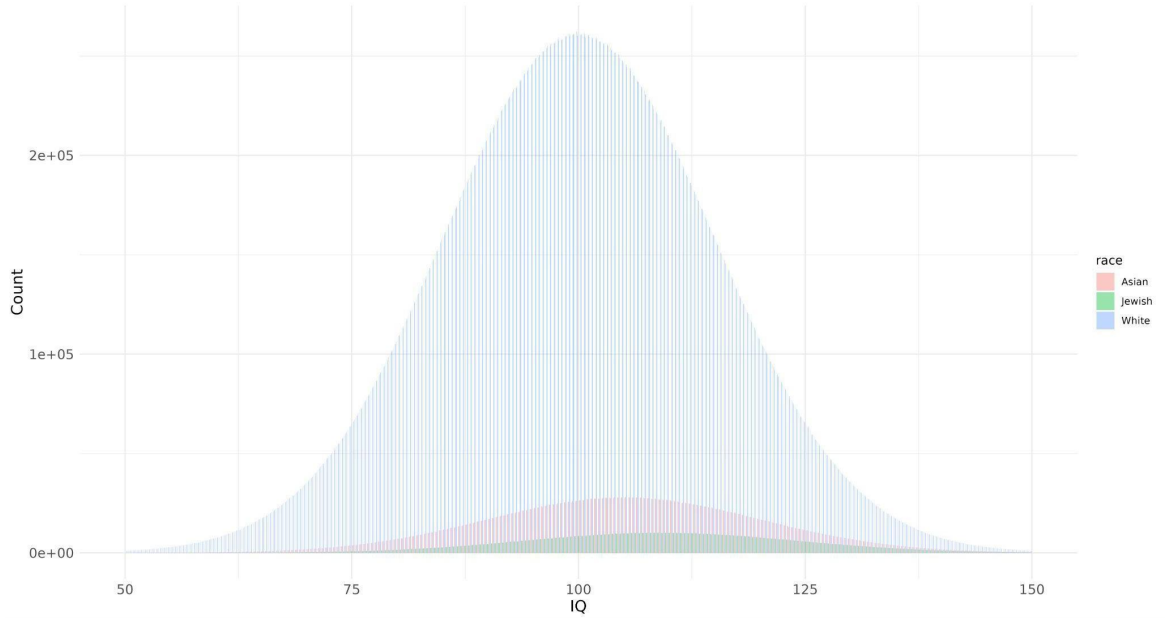

Figure A3: IQ distribution by race (version 2).

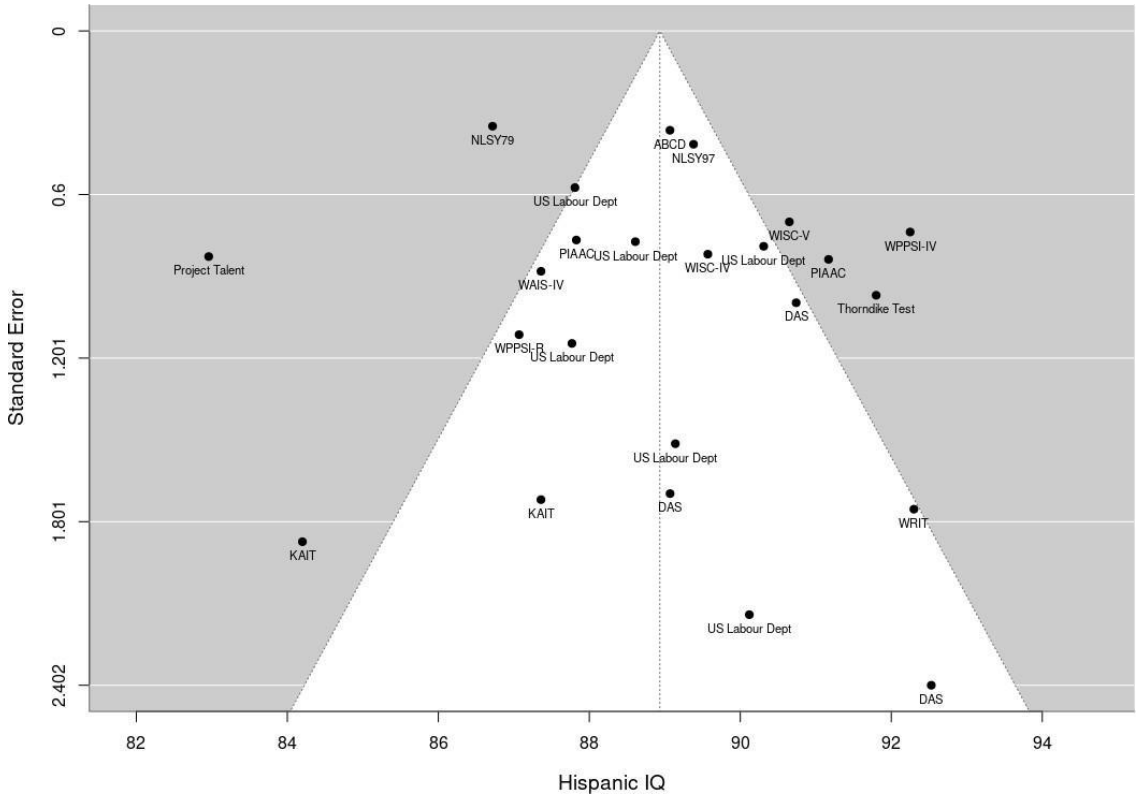

Figure A4: Funnel plot of the average Hispanic IQ

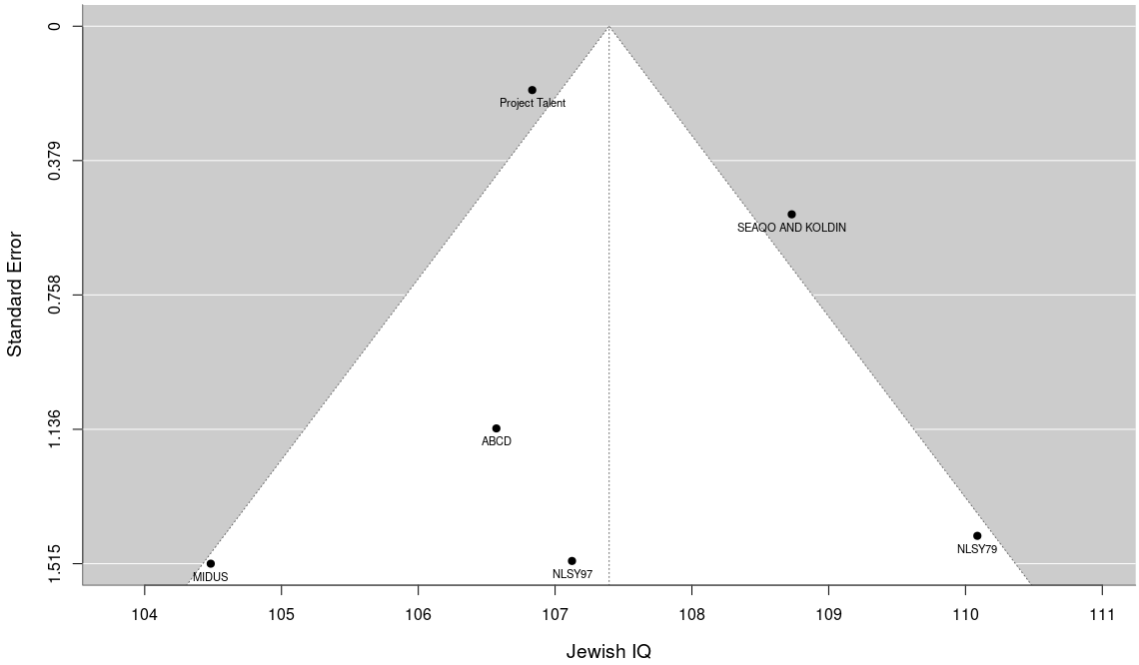

Figure A5: Funnel plot of the average Jewish IQ

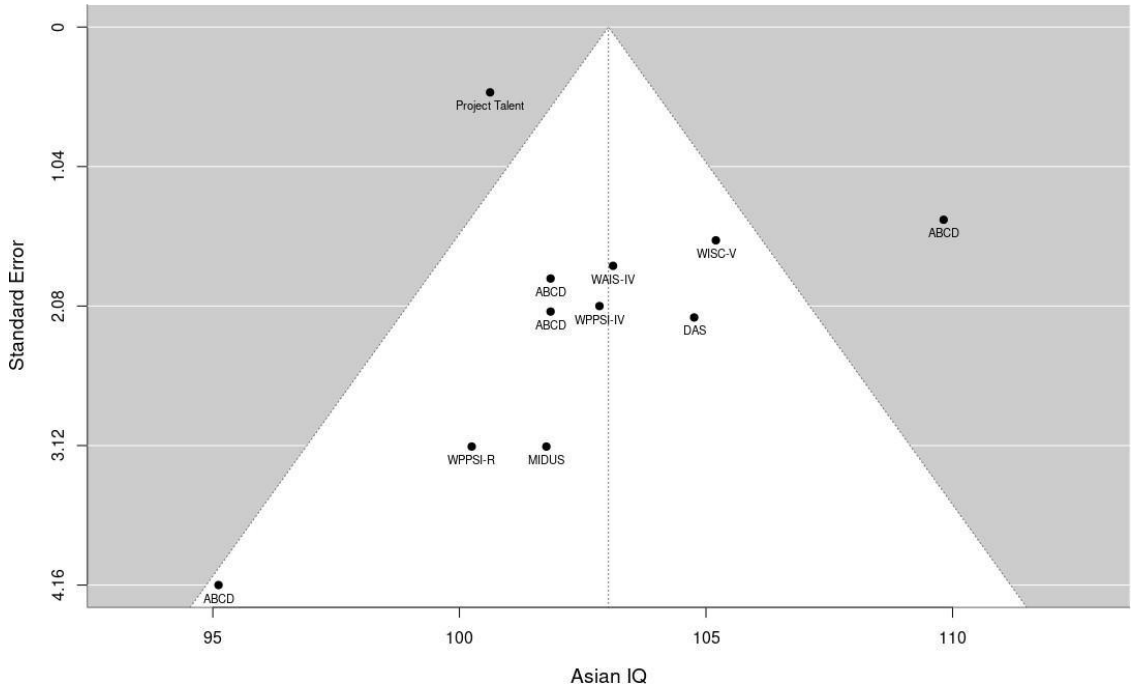

Figure A6: Funnel plot of average Asian IQ

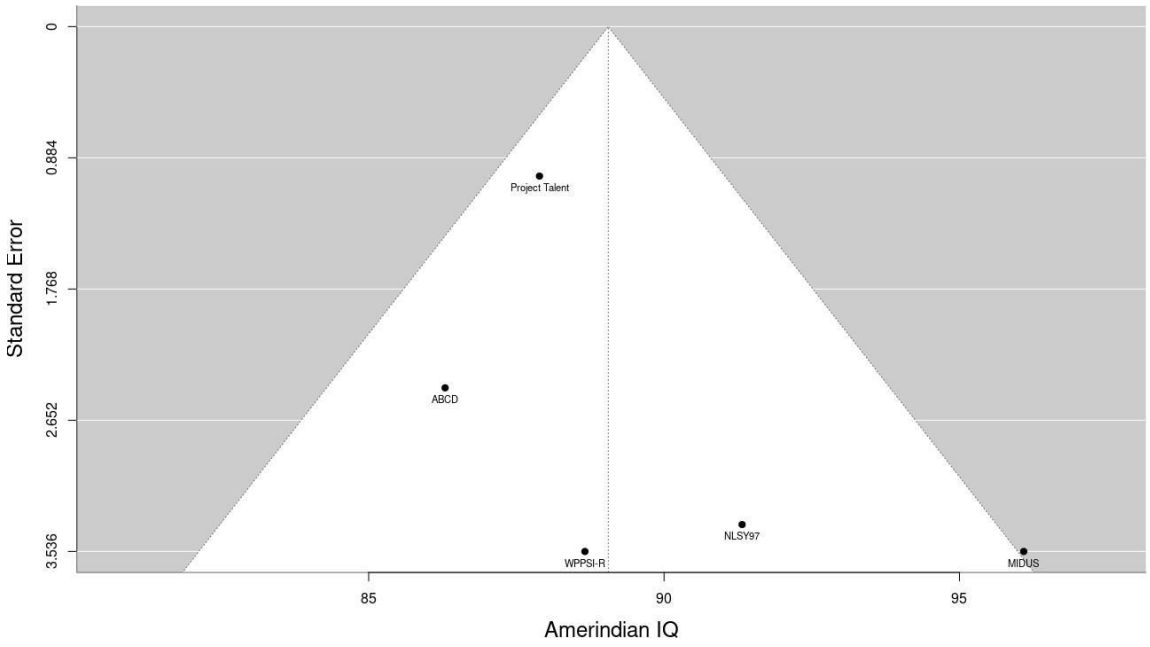

Figure A7: Funnel plot of the average Amerindian IQ

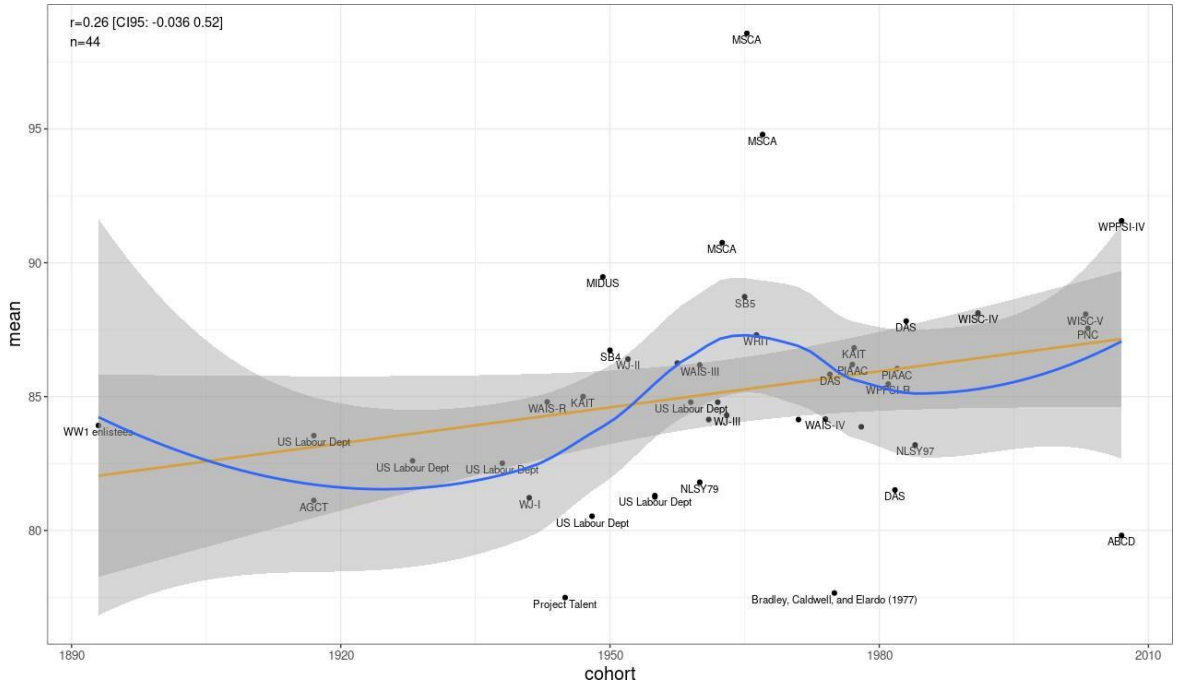

Figure A8: Scatterplot of Black samples by cohort and average. Blue trendline is plotted using locally estimated scatterplot smoothing.

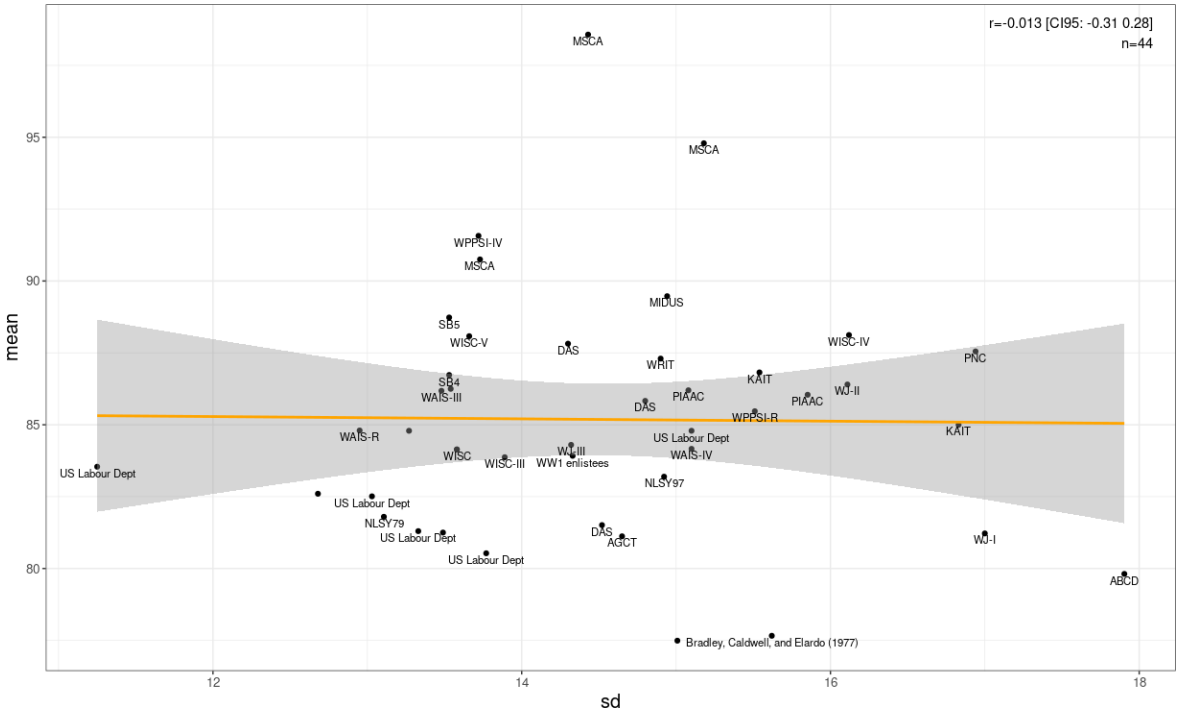

Figure A9: Scatterplot of sample means and standard deviations within the Black samples

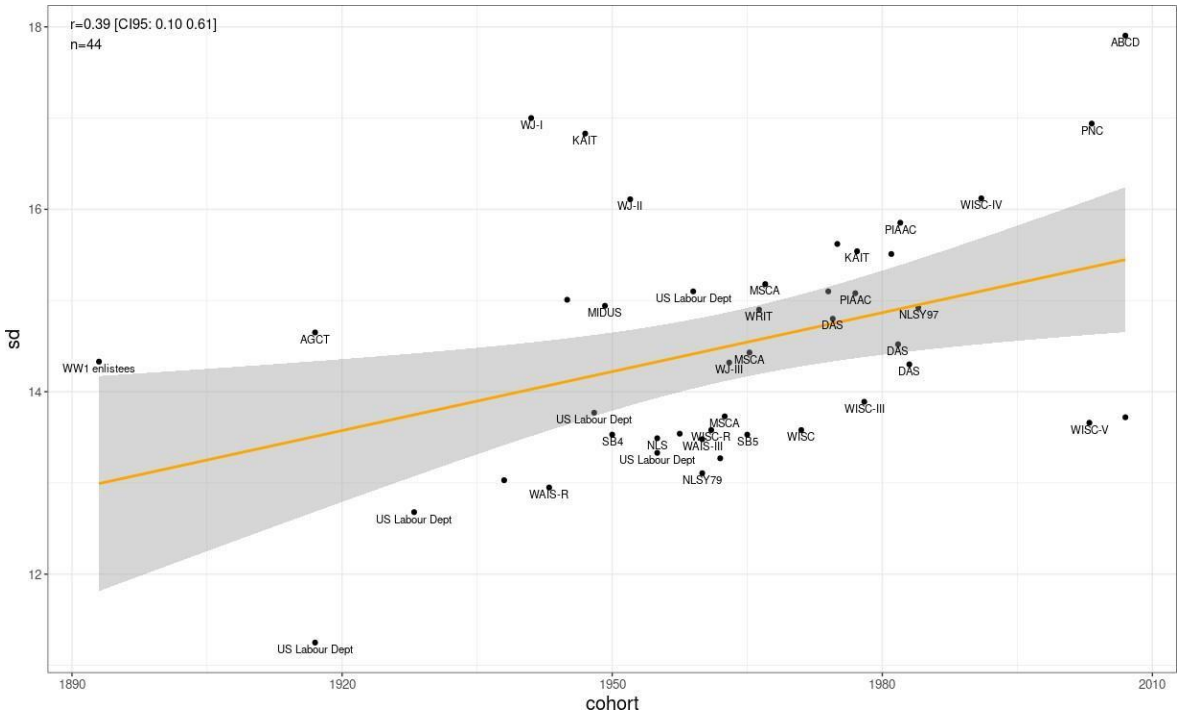

Figure A10: Scatterplot of sample standard deviations and birth cohort within Black samples. The p-value is .009.

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Evolution and Race Differences in Views on and Prevalence of Fellatio: Did Bill Clinton "Have Sex with That Woman, Miss Lewinsky"?

Edward Dutton*

Abstract

A number of studies have implied that fellatio may reflect aspects of a slow Life History Strategy. Specifically, it involves bonding with the partner, and if the semen is swallowed, the woman's immune system may become used to one specific male, aiding pregnancy by that male. We surveyed the small number of available studies on race differences in the prevalence of fellatio. Consistent with Life History Theory, it is less prevalent among blacks than among whites and is considered, by blacks, to be far more serious and intimate. However, fellatio is also less prevalent among Northeast Asians than among whites, implying that the difference might partly reflect issues such as race differences in curiosity and Openness, specifically in relation to sexual matters.

Keywords: Race, Life history strategy, Fellatio, Sex

1 Introduction

President Bill Clinton famously told the world in 1998 that, "I did not have sex with that woman, Miss Lewinsky." However, Miss Lewinsky did fellate President Clinton; that is, engage in oral sex with him. According to a 1999 study, 44% of men and 37% of women believed that "oral sex" counted as "having sex" (Worthen, 2021, p. 133).

Interestingly, there are also race differences in this view. A meta-analysis of the views of young American adults found that "a majority believe oral sex to be less intimate compared to intercourse and that oral sex does not spoil virgin status." However: "African Americans may view oral sex as more 'intimate, involved, and serious' and hence would be more likely to agree that oral sex is sex. . . European Americans being statistically more likely than African Americans to agree that oral sex is not sex" (Dotson-Blake et al., 2012). In other words, from an African American viewpoint, Clinton lied to the nation. He had indeed "had sex with that woman," because she had fellated him. Why would there exist such stark differences in racial attitudes towards oral sex? Indeed, are there race differences in the extent to which oral sex is engaged in at all? If so, why is this the case?

2 What Is fellatio?

As was explained in Dutton (2018a), "Fellatio" is defined as the oral stimulation of the penis, especially to orgasm. The word derives from the Latin "*fellatus*," meaning "to suck" and is commonly referred to as a "blow job," "giving head" or "noshing." Fellatio is a form of foreplay in sexual relationships as well as a sexual act in itself. The practice has been found in animals, ancient societies, and also in contemporary tribal societies. This may imply that fellatio involves some form of evolutionary benefit. However, it could be a side effect of the way sexual functions are wired that manifests repeatedly because it is not selected against. It could also be a "side effect" of some other adaptive trait.

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Flying foxes and fruit bats have been found to engage in oral sex, with coitus lasting longer between fruit bats if the male is first orally pleasured (Tan et al., 2009). The *Kama Sutra*, written in the 1st century AD in India, explores the subject of fellatio in some depth. Oral sex is portrayed on the Greek Attic red figure Kylix, dated to approximately 510 BC. Anthropologists have documented homosexual fellatio among assorted tribal groups. The initiation rite of passage of the Simbari of Papua New Guinea involves boys, aged between 7 and 10, daily fellating older males and swallowing their semen. This is, supposedly, the only way they can attain their own semen (Soble, 1997, p. 124).

3 The evolution of fellatio

A number of studies have indicated direct benefits to fellatio in terms of fertility and health. The first is that oral sex makes fertilization more likely. Tan et al. (2009) suggest that fellatio increases the extent to which the penis is lubricated, it increases the size of the erection, and it increases the length of sexual intercourse. This was demonstrated based on research with fruit bats. All of these factors, they maintain, increase the likelihood of fertilization. The researchers aver that saliva reduces the risk of transmitting certain sexually transmitted diseases, meaning a healthier partner and offspring. Such behaviour may, however, also risk disease transmission in humans.

Further, when a woman regularly swallows her partner's semen, the woman's immune system becomes used to it, making it more likely that her immune system will accept the proteins in this specific man's semen. It has been documented that many miscarriages, or preterm births, occur because the mother's immune system treats these proteins, also found in the foetus, as foreign invaders. One study documented that 82% of women without preeclampsia — high blood pressure during pregnancy which can cause miscarriages and premature births — regularly practiced fellatio and swallowed, but only 44% of those with preeclampsia regularly fellated their husbands and swallowed (Koelman et al., 2000). Consistent with this exposure model, a number of studies have found that women with greater vaginal exposure to their partner's semen were less likely to suffer from pre-eclampisia (Saftlas et al., 2014; Di Mascio et al., 2020, meta-analysis) and increased exposure to a specific mouse's semen means that female mice better tolerate pregnancies (Robertson et al., 2009). Sperm donor pregnancies, where there has been no exposure to the partner's semen, also have a higher preeclampsia risk (Kho et al., 2009). Accordingly, fellatio aids pregnancy and aids offspring survival. One can legitimately imagine a situation where a couple presents to a doctor because they are struggling to become pregnant or stay pregnant and the doctor inquires of the wife: "Well, are you regularly fellating your husband and swallowing?" It should be stressed, however, that no attempt appears to have been made to replicate Koelman et al. (2000). Nevertheless, it is clear that other studies are indirectly congruous with it.

These results indicate that fellatio appears to have evolved, in part, because it is associated with fertility and health. However, parallel dimensions to its evolution have been explored. Pham and Shackelford (2013) have argued that infidelity detection or, perhaps more likely, infidelity prevention may be one reason why women may wish to orally pleasure their partners. Perhaps cues of infidelity could be unconsciously picked up via tasting the penis. Pham et al. (2015) found that both men and women reported being more satisfied with their relationships the more oral sex they received. Moreover, length of relationship was moderately positively correlated with frequency of and length of oral sex. Thus, one aspect of the purpose of oral sex would appear to simply be bonding. This is most obviously evidenced in the so-called "Sixty-Niner", when a male-female couple perform oral sex on each other simultaneously. Giving oral sex within a relationship has been shown to be positively associated with the personality trait Agreeableness; that is altruism and empathy (Pham et al., 2015), which is itself associated with the capacity to foster strong bonds.

4 Fellatio, group differences, and Life History Strategy

A number of studies have found race differences in the extent to which fellatio is performed. If an important dimension to fellatio is bonding, then this is to be expected. Rushton (2000) showed that different racial groups vary in their Life History Speed, in a model known as Differential-*K*. Fast Life History (LH)

Table 1: Relative ranking on a set of life history variables across three major races: Northeast Asians ("Asian"), Caucasians ("European"), and Sub-Saharan African ("African"). Adapted from Rushton, 1995, Table 1.1.

	Asian	European	African
Maturation Rate			
Gestation time	Longer	Intermediate	Shorter
Skeletal development	Later	Intermediate	Earlier
Motor development	Later	Intermediate	Earlier
Dental development	Later	Intermediate	Earlier
Age of first intercourse	Later	Intermediate	Earlier
Age of first pregnancy	Later	Intermediate	Earlier
Life span	Longer	Intermediate	Shorter
Personality			
Activity level	Lower	Intermediate	Higher
Aggressiveness	Lower	Intermediate	Higher
Cautiousness	Higher	Intermediate	Lower
Dominance	Lower	Intermediate	Higher
Impulsivity	Lower	Intermediate	Higher
Self-Concept	Lower	Intermediate	Higher
Sociability	Lower	Intermediate	Higher
Social Organization			
Marital Stability	Higher	Intermediate	Lower
Law abidingness	Higher	Intermediate	Lower
Mental health	Higher	Intermediate	Lower
Administrative capacity	Higher	Higher	Lower
Reproductive Effort			
2 egg twinning (per 1000 births)	4	8	16
Hormone levels	Lower	Intermediate	Higher
Size of genitalia	Smaller	Intermediate	Larger
Secondary sexual characteristics	Smaller	Intermediate	Larger
Intercourse frequency	Lower	Intermediate	Higher
Permissive attitudes	Lower	Intermediate	Higher
Sexually transmitted diseases	Lower	Intermediate	Higher

strategists, evolved to an easy but unstable ecology, invest bio-energetic resources in reproduction. As life is unpredictable, they are adapted to copulate with as many fertile, healthy people as they can, investing little in the partners and hoping some offspring survive. Slow LH strategists are adapted to a harsh yet predictable ecology, where the group has reached the carrying capacity of the ecosystem. Thus, they start competing with each other. This selects for "quality over quantity". When a fast life history strategist has lots of offspring by lots of partners and invests nothing in them then, in such an ecology, the offspring could all perish. As such, they invest more energy in the nurture of their (smaller number of) offspring and energy in their (smaller number of) sexual partners, to ensure their offspring's survival. To this end, they also create strongly bonded units. Accordingly, to the extent that fellatio is a matter of bonding, there should be racial differences in its extent and in attitudes towards it.

Rushton argues that Sub-Saharan Africans are, on numerous measures, faster life history strategists than are Caucasians, as would be predicted from the highly divergent nature of their ancestral environments. The most salient differences are set out in Table 1. For a more detailed exploration of these differences, which examines more of them, see Dutton (2020).

Pham et al. (2015) have shown that Agreeableness (an aspect of a slow LH) positively predicts

Table 2: Race differences from D'Souza et al. (2014), Table 3.

	White	Black	Mexican	Hispanic	Other	*p*
Males						
N. performed oral sex on	12.6	5.2	4.2	6.2	3.1	<.001
Age first performed oral sex	19	20.4	21	19.1	22.3	<.001
Ever performed oral sex	90.8%	76.5%	72%	84.6%	62.9%	
More oral than vaginal sex partners	12.2%	7.9%	11.3%	8.3%	7%	<.001
First sexual exp. <18	55.7%	75.4%	56.8%	72.3%	25.6%	<.001
First oral sex exp. < 18	37.5%	23%	22.4%	27.2%	13%	<.001
Oral sex at sexual debut	43.5%	17.6%	25.9%	26.5%	32%	<.001
Oral sex after sexual debut	49.5%	60.7%	48.2%	59.4%	33.4%	-
Never oral sex	7%	21.7%	25.8%	14.1%	34.6%	-
Females						
N. performed oral sex on	4.5	2.5	2.1	2.7	2.6	<.001
Age first performed oral sex	19.6	21.9	21.2	21.9	21.5	<.001
Ever performed oral sex	90.7%	63.2%	63.1%	75.5%	73.9%	<.001
More oral than vaginal sex partners	11.1%	8.9%	6.2%	7.2%	8.1%	<.001
First sexual exp. <18	53.8%	66.6%	48%	46%	30.2%	<.001
First oral sex exp. < 18	32.8%	14.4%	14.7%	16.2%	19.2%	<.001
Oral sex at sexual debut	40.5%	12.7%	23.1%	21.2%	31.7%	<.001
Oral sex after sexual debut	52.5%	54.6%	42.1%	56.5%	44.3%	-
Never oral sex	7%	32.7%	34.7%	22.3%	23.9%	-

performing oral sex. The available studies on fellatio are congruous with this. They all find that African Americans, compared to whites, are significantly more likely to have never been fellated or to have never fellated and to have experienced or performed fellatio in a relationship only after the performance of penetrative sex. This ordering is reversed in whites (D'Souza et al., 2014). So, let us look at these data. They can be seen in Table 2.

Unfortunately, studies comparing white and Northeast Asian people are confounded by the fact that relatively youthful samples were employed (e.g. Meston et al., 1996). Northeast Asians appear to become sexually active later than white people (Rushton, 2000). Moreover, there is evidence that Northeast Asians are extremely sexually restricted, and this includes oral sex (Meston et al., 1996). Indeed, even among adult samples, 50% of white Americans had engaged in oral sex in the last year compared to only 7% of Chinese (Parish et al., 2007). Consistent with the idea that fellatio is associated with slow LH, some research has found evidence that lower socioeconomic status (SES) people are less likely to engage in fellatio than higher SES people (e.g. Schofield, 1965). Black people in the US, on average, are of lower SES than white people (Lynn, 2002), so SES may be the mediating factor.

It can be seen from Table 2 that oral sex is more prevalent among whites than blacks, in the case of both men and women. Whites, on average, have more oral sex partners, perform oral sex at a younger age, perform oral sex more, are more likely to have more oral than vaginal sex partners, are more likely to have oral sex as their first sexual experience, are more likely to have experienced oral sex during their sexual debut, and are less likely to have never had oral sex. This is despite the fact that, as noted in Table 1, Blacks are, in general, more sexually promiscuous and experimental. Moreover, the authors found white adolescents progressed through a predictable pattern of kissing, above the waist touching and then below the waist touching before engaging in coitus. Black adolescents engaged in very little behaviour of this kind and quickly advanced to sex. It can be seen in Table 2 that "Hispanics" — usually a blend between whites and Native Americans (see Dutton, 2020) — are between whites and blacks in terms of oral sex performance. Based on various measures, we would expect Hispanics to follow a faster LH strategy than

whites but slower than blacks (see Lynn, 2002), and the results are consistent with this.

5 What do these results tell us?

These results, it should be noted, are consistent with a number of other published studies. A literature review (3 studies in the US) on this subject found that one study noted that 87% of white American but only 70% of African American women reported having ever received cunnilingus, implicitly from partners of the same race. However, 93% of white American women reported that they had, at some point, fellated a man compared to only 65% of African American women. Another study in the US found that 81% of white men had performed cunnilingus on a female compared to 51% of African American men. Further, 75% of white women had fellated a male compared to 34% of black women who had done so. However, only 10% of black women had themselves experienced cunnilingus (Jemmott et al., 1995). A study of teenagers aged 15 to 19 in the US found that 45% of white males had given oral sex whereas 50% of white girls had given oral sex. Among blacks, around 30% of males and females had given oral sex (Shapiro & Maras, 2015, p. 42). Auslander et al. (2009) conducted a study of 202 American girls aged between 14 and 21 (26% white, 43% black and 31% Hispanic) and found that black girls were significantly less likely than white or Hispanic girls to have ever given or received oral sex and, if they had, they were significantly older than whites or Hispanics when they had it for the first time.

The race differences we have noted can be neatly understood in terms of Life History Theory. As we have seen, one possible reason to perform oral sex is as part of a mate retention strategy. Fast LH strategists should be inclined to invest more energy in reproduction and far less energy in maintaining their relationship or bonding with their partner; as their strategy would be inherently promiscuous. Accordingly, if oral sex is primarily a matter of partner retention, then fast LH strategists should be less inclined to perform it on their partner. This is indirectly evidenced by the way in which black couples in the US have less oral sex than do white couples. As we have discussed, slow LH strategists have longer, more faithful, more stable and happier marriages and so it seems that, implicitly, oral sex is an aspect of ensuring this.

An alternative possibility is that heightened oral sex among European people reflects some underlying European personality trait relating to curiosity; exploring your partner and exploring ways in which you can pleasure each other. In this regard, it has been found that Europeans are higher than East Asians in a series of polymorphisms that relate to Openness and curiosity (Kura et al., 2015). In the US, whites score higher in Openness even than acculturated East Asian Americans (Benet-Martínez & Karakitapoglu-Aygun, 2003; Eap et al., 2008). Consistent with this, a survey of sex workers found that white clients were particularly interested in "kinky sex" and also in kissing compared to blacks. The Northeast Asian sample was not big enough for statistically significant comparisons, but they liked kissing less than did whites (Francis & Kirkegaard, 2023). This explanation would also be congruous with the social class differences in fellatio noted above (Schofield, 1965). Openness is associated with socioeconomic status (Sutin et al., 2015).

It is interesting, with regard to the racial differences in fellatio, that kissing appears to have developed as a learned behaviour. Anthropological studies find that only 46% of societies engage in kissing and that it is not practiced at all in primitive Central American or Sub-Saharan African societies or in Melanesia. It has been argued that the practice started in Ancient Mesopotamia in about 2500 BC and spread as a learned behaviour, possibly because it aided bonding or reflected a desire to bond (Arboll & Rasmussen, 2023). It has been suggested that mouth-to-mouth kissing stems from primate grooming behaviour, but that it has only expressed itself in certain societies and especially more developed ones (Lameira, 2024), though this would imbricate with Life History Strategy. The oldest depiction we have of female-on-male fellatio in Europe is on a 5th century BC Greek Kylix (drinking cup) at the Louvre in Paris, this society being relatively developed. Thus, it may be that oral sex is an expression of a desire for sexual exploration and bonding occasioned by being a developed, and, thus, relatively "open" and "curious" society.

We have seen that another proposed reason for oral sex is infidelity detection. From the perspective of a fast LH strategist, partner infidelity would not be an especially significant concern because they would be investing relatively few resources in either the sexual partner or any resultant offspring. As such, we would expect — for this reason as well — lower levels of oral sex among blacks than whites and this is what

we find. The pattern of sexual intercourse noted among blacks — very little petting and moving straight to penetrative sex — seems to imply less of an interest in exploring the partner and even in discerning factors that might be germane to the future relationship, such as genetic similarity, and this may be another relevant issue in terms of the function of oral sex. It has been argued that we mate assortatively to optimize the extent to which we pass on our genes, and we unconsciously pick up clues of "genetic similarity" (Rushton, 2005). Oral sex, tasting the bodily fluids of one's potential partner before committing to sex, may be a means of doing this, as may be tongue kissing. Fast LH strategists are simply less sexually selective and select more for physical health than for compatibility, so oral sex at an early stage would be less necessary.

The next proposed reason is that in order to become pregnant, and stay pregnant, by a specific male. In this sense, fellatio involves investing energy in a specific male in order to become pregnant by that specific male, who is attractive for whatever reason. Alternatively, from the male perspective, receiving oral sex relates to impregnating a specific female. We would expect this to be anathema to a fast LH strategist, who would be better off investing his time and energy in sexual intercourse with a variety of partners. By contrast, for the slow LH strategist, penetrative sex is a serious risk because you only want to get pregnant by the "right man", one who is strongly adapted to the specific ecology and who will invest in you and your offspring, promoting offspring survival (see Dutton, 2018b). If you're a slow LH man, and you will invest in the partner and offspring, you want to ensure that she will not cuckold you, that she is genetically healthy and that she will be a good mother. Thus, from your perspective, penetrative sex is more intimate than oral sex. However, it seems likely that cunnilingus is more relevant as a means of avoiding cuckoldry, as it pleasures the female and causes her to bond with the male.

In summary, fellatio appears to combine a number of inter-related factors: it appears to ensure that the female gets pregnant by a particular male and bonds with him (implying a slow life history strategy), but race differences in its prevalence are complicated by race differences in Openness and general curiosity. This helps to explain why fellatio is so low among slow Life History Strategy North East Asians.

6 Future research

In order to test the hypotheses advanced here, it would be useful to explore, at the individual level, whether life history strategy is correlated with oral sex prevalence or preference. In this regard, it would also be very useful if general sociosexuality could be controlled for, as this is a component of a fast life history strategy.

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Technology-Based Interventions for Intimate Partner Violence: A Systematic Review

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Abstract

Intimate partner violence (IPV) affects mental health around the world. In light of the fact that victims of IPV are more likely than others to suffer from depression, anxiety and post-traumatic stress disorder (PTSD), this systematic review focuses on the outcomes of technology-based interventions for IPV survivors suffering from depression, anxiety, and PTSD. We searched databases including Pubmed, Scopus, PsychInfo and Google Scholar from 2000 to 2022 for studies examining the effectiveness of technology-based interventions in reducing depression, anxiety, and PTSD among IPV victims. Using a Cochrane quality assessment checklist, an independent researcher extracted the data and assessed its quality. In accordance with the PRISMA diagram, 16 articles were included. With regard to the varied content used in technological interventions and different types of interventions, including internet-based, computer-based and application-based, and taking account of methodological factors such as length of follow-up and sample size, technology-based interventions can significantly reduce depression, anxiety, and post-traumatic stress disorder.

Keywords: Intimate partner violence, Technology-based, Online intervention

1 Introduction

1.1 Prevalence and impact of intimate partner violence (IPV)

Globally, intimate partner violence (IPV), which the WHO (2012) defines as physical, sexual, emotional, or financial abuse and controlling behaviours by an intimate partner, is a widespread problem. One in three women worldwide experience physical or sexual violence from intimate partners (WHO, 2024). According to global estimates, about 30% of women worldwide have experienced physical and/or sexual intimate partner violence or non-partner sexual violence in their lifetime (WHO, 2021). Furthermore, approximately 38% of all murders of women are committed by an intimate partner.

Violence and abuse can have adverse effects on the victim's physical, mental, emotional, sexual, reproductive, and social health (Bramhankar & Reshmi, 2021; Costello & Greenwald, 2022; Lacey et al., 2021; Potter et al., 2021). Injuries to the head, neck and face, and chronic diseases and pain are commonly documented and are reported by a significant percentage, ranging from 35% to 94%, of survivors of IPV (Zieman et al., 2017). While secondary physical injury to IPV is common, the psychiatric consequences are substantial as well. Most victims of IPV experience long-term mental health disorders and maladjustments in their daily lives. According to a study conducted in Spain, 73% of IPV survivors had depressive symptoms, 77% showed elevated scores on trait anxiety, and 87% on state anxiety (Cirici Amell et al., 2023). Prevalence of post-traumatic stress disorder (PTSD) was also high (87%) and IPV significantly interfered with all

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aspects of 92% of survivors' lives (Cirici Amell et al., 2023). Also risk-taking behaviors such as abuse of drugs and alcohol are elevated (Stubbs & Szoeke, 2021).

Acutely, IPV, particularly physical and sexual violence, can result in fractures, traumatic brain injuries, skin lacerations, burns and, in severe cases, death (Raskin et al., 2024; Saenz & Tallman, 2024; Sun et al., 2023). Also, IPV experiences are associated with the development of PTSD, anxiety, depression, and suicidal ideation (Chandan et al., 2020; White et al., 2024). IPV survivors are three to five times more likely to report depression and anxiety than those who have not experienced IPV or experienced other traumatic events (Hind et al., 2012; Lagdon et al., 2014). Between 30 and 80 percent of individuals who have experienced IPV fulfill the criteria for PTSD (Nathanson et al., 2012). These mental health problems can have long-term and debilitating effects on IPV survivors' lives, affecting their overall functioning and quality of life. Therefore, it is important to address these common outcomes among IPV survivors and identify effective interventions considering the challenges and barriers to accessing services discussed below.

1.2 Barriers to seeking help

Despite IPV's multiple damages, many people do not report it or delay counseling. Survivors of IPV face a number of barriers to intervention including lack of knowledge about support and healthcare resources available in the community, embarrassment, fear of the perpetrator, fear of invasion of their privacy, and a fear of trusting individuals to reveal their experiences in private (Bridges et al., 2018; Heron & Eisma, 2021; Rohn & Tenkorang, 2022; Shaheen et al., 2020; Vranda et al., 2018). For individuals with financial, linguistic, cultural, and accessibility barriers, access to traditional services (such as primary care screening, shelters for battered women, safe houses, or counseling hotlines and helplines) may be limited (Henry et al., 2022). Shame and misconceptions exacerbate all of these factors (Balice et al., 2019; Heron & Eisma, 2021). Victims of violent abuse are often isolated by their perpetrators, have limited social support networks, and lack access to community services as a consequence (Balice et al., 2019; Sabri et al., 2016).

In recent years, the emergence of online psychological interventions has provided new avenues for support. A technology-based intervention can address these risk factors by providing global access to information, reporting of violent experiences, and seeking treatment for associated disorders. It is also possible to significantly reduce the costs of programs and traditional interventions by using these kinds of interventions (Fleming et al., 2018; Mehta et al., 2019). The emerging literature suggests that digital and technology-based interventions can complement traditional methods or be proposed alongside them to provide survivors with support (Bloom et al., 2016; Debnam & Kumodzi, 2021; Koziol-McLain et al., 2018; Young et al., 2018). Digital interventions address coverage gaps, challenges, and inequalities in the healthcare system more effectively than traditional interventions. There are many limitations to traditional interventions, such as the cost of care, confidentiality, privacy, geographical accessibility, and stigma. There are limitations for victims in underserved areas, especially in areas with limited healthcare services. However, digital interventions are easily accessible to victims in underserved areas. In addition, interventions can be tailored to individual needs without incurring extensive costs. It is true that digital interventions can help cover existing gaps and therapeutic challenges, but they can also create new challenges and gaps. For example, these interventions may be less effective or impossible when victims have no access to the Internet or do not feel comfortable using technology. These issues can aggravate inequalities and decrease the effectiveness of interventions.

1.3 Aims of the current review

The advent of digital technology, with the development of online psychological interventions, has shown promise in positively impacting mental health outcomes, including reducing symptoms of anxiety, depression, and PTSD. However, information about the effectiveness of these interventions in women who have experienced IPV is ambiguous in the literature.

Compared to traditional interventions, this category of intervention has shown limited effectiveness in systematic reviews. El Morr and Layal's (2020) systematic review identified information and communication technologies as suitable for disclosure and IPV prevention. Interventions based on information and

communication technologies were effective mainly in screening, disclosure, and prevention of IPV (El Morr & Layal, 2020). Linde et al. (2020) examined the effect of eHealth interventions versus standard care on reducing IPV, depression, and PTSD among women exposed to IPV until 2019 (Linde et al., 2020). There was no evidence of beneficial effects of eHealth interventions on IPV. Another study focused on feasibility and acceptability of web-based and mobile health interventions for IPV victimization prevention. Mobile health tools for IPV prevention were especially acceptable in health-care settings, on mobile phone platforms, or when connecting victims to health care. Despite evidence for efficacy compared to conventional IPV prevention approaches, benefits were limited (Anderson et al., 2019).

The Rempel et al. (2019) review concentrated on what are the online interventions available to women who have experienced IPV and potential benefits and barriers to access to information and services for women's health and safety. Findings of the study suggest that online interventions focus on the act of leaving with less emphasis on the experiences that occur after a woman leaves the relationship. They focus on the survivor's individual capacity to escape an abusive relationship. Information gaps for support after leaving an abusive relationship still need to be addressed. The Rempel et al. (2019) systematic review specifically focused on the outcomes of technology-based interventions for IPV survivors suffering from depression, anxiety, and PTSD.

Our goal is to expand our understanding of current study results with a comprehensive overview of interventions that have been used to improve symptoms of depression, anxiety, and PTSD in victims of IPV. What are the results of these interventions? Finally, we highlight gaps in the current literature and areas where further research is needed.

2 Methods

2.1 Study selection criteria

We reviewed all experimental and quasi-experimental trials that examined whether technology-based interventions improved depression, anxiety, and PTSD outcomes among IPV samples between 2000 and 2022, without language restrictions. We excluded studies for which access to the full text was not possible and participants were under 18 years.

2.2 Search strategy

The keywords were selected based on the terminologies in MESH, EMTREE, and TERM databases, as well as the keywords used in similar studies. The following keywords were used in combination and separately: ("domestic violence" OR "intimate partner violence") AND (depression OR anxiety OR PTSD OR "post-traumatic stress disorder" OR "Posttraumatic Stress Disorders") AND ("mobile platform" OR smartphone OR "web-based intervention" OR mHealth OR eHealth OR "eHealth technology" OR online OR virtual OR "telehealth service" OR "text message" OR technology OR "technology related intervention"). Pubmed and Scopus, PsychInfo and Google Scholar were used as databases. After determining the search syntax, a manual search of articles from key journals with the highest number of relevant primary studies was conducted in addition to the electronic search, as well as a review of the reference lists of retrieved articles from the electronic search. In our study, Google Scholar returned 17,500 results based on publications between 2000 and 2022. For the purpose of capturing the most relevant studies, we focused on results sorted by "relevance". As a result, we reviewed approximately the first 2,000 Google Scholar articles, rather than the first 200 to 300 mentioned in literature (Haddaway et al., 2015), due to irrelevant results after 2000 when evaluating the whole of the results.

2.3 Study selection

Using the EndNote software, the results of a search in the data management databases were merged. Following that, similar studies were reviewed and eliminated. Two reviewers independently selected articles

based on title and abstract and classified into three categories: 'included', 'probable', and 'excluded'. All articles classified as 'excluded' by both reviewers were excluded from the study. Each reviewer then reviewed the full texts of the articles classified as 'probable' and created a list. Any discrepancies were resolved using the consensus strategy after comparing the generated list.

2.4 Data extraction

Two reviewers independently extracted data from the primary studies into an Excel spreadsheet. Whenever needed, correspondence was made with the authors if the required information was not reported in the article. Among the items included in the Excel form for data extraction were the author's name, publication year, study year, country, study design, diagnostic criteria, sample size, mean age, type of intervention, duration and number of sessions of the intervention, follow-ups, primary and secondary outcomes, and measurement tools.

2.5 Quality assessment of studies

Two independent reviewers assessed the quality of studies using the Cochrane Quality Assessment Checklist for Intervention Studies. The reviewers used a consensus strategy when there were discrepancies between them. The following criteria are evaluated in this checklist to assess the quality of clinical trial studies: Random sequence generation, Allocation concealment, Blinding of participants and personnel, Blinding of outcome assessment, Incomplete outcome data, Selective outcome reporting.

3 Results

3.1 Procedure

The initial search phase yielded 39,470 studies, of which 18 duplicate studies were excluded. The titles and abstracts of the remaining 39,452 studies were screened for relevance to the research topic, but 39,409 articles were excluded. The full text of the remaining 43 studies was reviewed. A total of 27 studies were excluded because they were study protocols, did not focus on intimate partner violence, or did not focus on adults. As a result, 16 studies were included in the systematic review. Figure 1 illustrates the stages of study inclusion in the systematic review.

Overall, the studies included a total of 3320 participants. Table 1 provides more information about the presented studies. As a means of presenting the findings in more detail, the articles will be examined in terms of Sample size and location, Type of intervention, Quality of intervention, Outcomes, and User experience.

Table 1: Summary of studies included in the systematic review

Authors	Outcome	Follow-up	Frequency & duration of intervention	Type of intervention	Design*	Sample size/ type	Location	Year
Braithwaite & Fincham, 2009	Couples' satisfaction, depression, anxiety, conflict tactics, physical assault, psychological aggression, negotiation, conflict patterns (constructive communication)	8 weeks and approximately 10 months (44 weeks) post baseline	7 weeks	Computer Based Preventive Intervention/relationship focused preventive intervention (ePREP: skills training in effective communication and problem solving).	RCT	77 psychology students in romantic relationships lasting 4 months or longer.	America	2009
Braithwaite & Fincham, 2007	Anxiety, depression, positive & negative affect, conflict tactics, perceived relationship quality (mutual discussion, mutual expression, mutual negotiation), trust (predictability, dependability, faith in one's partner).	8 weeks	7 weeks	Computer-based relationship focused preventive intervention (ePREP) relative to a depression and anxiety focused computer-based preventive intervention (CBASP): Cognitive Behavioral Analysis, changing patterns of maladaptive thinking and behavior, analyzing problematic situations in their lives.	RCT	91 psychology students at a large public university.	America	2007
Constantino et al., 2015	IPV experience, anxiety, depression, anger, personal support, social support.	–	Once a week for 6 weeks.	Free-of-charge online HELPP Intervention, 6 modules in 6 weeks: (1) personal thoughts, emotions, behavior; (2) interpersonal relationships and healing in telling; (3) health in HELPP; (4) education on safety in HELPP; (5) legal matters in HELPP; (6) community and the A-B-Cs of empowerment.	RCT	32 adult females who experienced IPV during the past 18 months, now separated from perpetrator as required by law, who had obtained protection from abuse (PFA) in court prior to participating.	America	2015
Fiorillo et al., 2017	PTSD symptoms, depression, anxiety, psychological flexibility.	After six weeks intervention.	6 sessions in 6 weeks.	Six-session web-based ACT self-help for trauma: introduction and psychoeducation on interpersonal trauma and ACT, willingness and acceptance, mindfulness, defusion and self-as-context, clarifying values, committed action consistent with values.	Before and after study.	25 adult women with a history of interpersonal trauma: childhood sexual and/or physical abuse, adolescent or adult sexual assault, or partner violence.	America	2017

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Table 1: Summary of studies included in the systematic review (Continued)

Authors	Outcome	Follow-up	Frequency & duration of intervention	Type of intervention	Design*	Sample size/ type	Location	Year
Glass et al., 2022	Primary outcomes: use of 34 safety strategies, decisional conflict. Secondary outcomes: past 6-months IPV and reproductive coercion, past-week depression and suicide risk, substance misuse, preparation for decision-making.	After 6 and 12 months.	–	myPlan intervention: (1) protection, focus on increasing safety; (2) enhanced decision-making around safety; (3) reducing IPV to facilitate healing. Considers IPV survivor priorities and designs a safety plan tailored to their needs and priorities.	RCT	353 women aged 18–24 screened positive for IPV.	America	2022
Glass et al., 2017	Primary outcomes: decisional conflict, safety behaviours, repeat IPV; secondary outcomes: depression, PTSD.	After intervention, 6 and 12 months.	–	Emergency safety plans through a secure website, tailored safety action plans with recommended strategies based on participant demographics, relationship characteristics, previous safety behaviours, priorities and DA/DA-R score.	RCT	720 adult women reporting physical, sexual or emotional abuse or threats of violence by a current intimate partner in past 6 months.	America	2017
Hassija & Gray, 2011	PTSD, depression symptoms, client satisfaction.	–	Weekly sessions lasting 60–90 minutes (at least 4 sessions).	Videoconferencing trauma-focused psychotherapy services. Individual sessions of trauma-focused, evidence-based therapy based on treatment manuals for prolonged exposure therapy for PTSD or cognitive processing therapy for rape victims, plus motivational interviewing techniques to facilitate decision making regarding relationship termination.	Uncontrolled trial.	15 female clients who had experienced domestic violence ($n = 12$) and sexual assault ($n = 3$).	America	2011
Hegarty et al., 2019	Primary outcomes: self-efficacy, depression. Secondary outcomes: fear of partner, number of helpful behaviours for safety and wellbeing, cost-effectiveness, harm, social support, health service use, life events.	After 6 and 12 months.	12 months.	Safety decision aid (healthy relationships, abuse and safety, relationship priority setting, tailored action plan).	RCT	422 women screened positive for any form of intimate partner violence in the last 6 months.	Australia	2019

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Table 1: Summary of studies included in the systematic review (Continued)

Authors	Outcome	Follow-up	Frequency & duration of intervention	Type of intervention	Design*	Sample size/ type	Location	Year
Hesser et al., 2017	Interpersonal violence, aggression, relationship quality and satisfaction, anxiety & depression; process measures: emotion regulation & anger rumination, adverse events, treatment seeking.	1-year follow-up.	8 weeks.	Internet-delivered cognitive-behaviour self-help intervention incorporating self-help techniques. Homework exercises focus on building effective conflict-management skills and increasing adaptive emotion-regulation ability; psychoeducation about violence; strategies to enhance motivation to change violent behaviour; crisis strategies.	RCT	65 participants (18+ years) in a close and stable relationship (partner, marriage), recruited from the community, who had experienced aggression or interpersonal violence or abuse.	–	2017
van Rosmalen-Nooijens et al., 2013	Primary outcomes: symptoms of PTSD, depression, anxiety. Secondary outcomes: direct effects of visiting the website, increased knowledge of sexual, reproductive & relational health, decreased sexual risk taking.	–	FtV + usual care (UC); control group with minimally enhanced UC, 12 weeks.	"Feel the Vibe", an internet-based intervention consisting of: (1) providing information about family violence on the FtV website; (2) offering peer support; (3) lowering the threshold to regular health-care services.	RCT	50 adolescents (age 12–17) and young adults (age 18–25) exposed to family violence at home, who registered themselves on feel-the-vibe.nl.	Netherlands	2013
Koziol-McLain et al., 2018	Primary outcomes: depression, IPV exposure. Secondary outcomes: depression, PTSD, alcohol & drug abuse, decisional conflict, safety-seeking behaviour.	After 3, 6, and 12 months.	One year.	Web-based safety decision aid with safety priority setting, danger assessment, and an interactive process to help women develop an individually tailored action plan.	Web-based two-arm parallel RCT.	412 women who had experienced IPV in the last 6 months.	New Zealand	2018
Ford-Gilboe et al., 2020	Primary outcomes: depression, PTSD. Secondary outcomes: helpfulness of safety actions, confidence in safety planning, mastery, social support, coercive control, decisional conflict.	After intervention and after 3, 6, and 12 months.	6 weeks.	Tailored, interactive online safety and health intervention (iCAN Plan 4 Safety): interactive priorities exercise, relationship planning, danger assessment with personalised feedback, stress management.	Double-blind RCT.	462 adults (19+ years or older) who had experienced IPV in the previous 6 months.	Canada	2020
Decker et al., 2020	Primary outcomes: safety preparedness, decisional conflict, safety strategies, IPV experience. Secondary outcomes: resilience, depression, self-blame, recognition of abuse, self-efficacy, risk for severe/lethal violence, relationship quality, support service use.	After intervention and 3 months later.	–	MyPlan Kenya: educational program helping women define healthy and unhealthy relationships, develop tailored safety strategies, recognise warning signs, and access information about violence, harmful beliefs, and relevant resources.	RCT	352 women who had experienced physical or sexual IPV, or reported being afraid of their partner in the previous 3 months.	Kenya	2020

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Table 1: Summary of studies included in the systematic review (Continued)

Authors	Outcome	Follow-up	Frequency & duration of intervention	Type of intervention	Design*	Sample size/ type	Location	Year
Creech et al., 2022	Primary outcome: number of health risks. Secondary outcome: treatment use.	Two months and four months.	Day of residential or inpatient psychiatric care.	SHE, a brief computerized intervention: psychoeducation resource handouts, motivational interviewing, stages-of-change model; compared with a screen-and-referral-only control condition.	RCT	153 females aged 24–65 with history of sexual assault.	United States of America	2022
Bloom et al., 2014	Exposure to reproductive coercion, depression, PTSD, birth & infant feeding outcomes.	–	Four online sessions (early & late pregnancy, 3 and 6 months postpartum).	Internet-based individualized safety decision aid giving options about unsafe relationships impacting health in pregnancy: depression & stress during or after pregnancy, drugs, alcohol & medicines during pregnancy, breastfeeding, etc.	RCT	46 pregnant and postpartum women who experienced IPV, recruited from the community (not IPV shelters).	America	2014
Özümerzifon et al., 2022	Pre- and post-intervention surveys self-administered electronically, PTSD checklist–DSM IV, heart rate variability measurements.	–	Six weeks, 12 sessions.	Move to Move Beyond (MTMB™): virtual creative dance/movement program using movement and creativity to foster reflection and self-awareness, encouraging choice & decision-making.	RCT	45 women aged 23–48, recruited from Sanctuary for Families (SFF), a non-profit IPV service organisation.	New York City	2022

Note: * RCT, Randomised controlled trial

3.2 Sample size and location

A wide range of populations was covered in these articles, including pregnant women, university students, trauma survivors, and IPV survivors (Bloom et al., 2014, 2016; Fiorillo et al., 2017; Glass et al., 2022; Hassija & Gray, 2011). Despite the fact that the included studies were located in different countries, including Canada (Ford-Gilboe et al., 2020), USA (Bloom et al., 2014; Braithwaite & Fincham, 2007, 2009; Constantino et al., 2015; Creech et al., 2022; Fiorillo et al., 2017; Glass et al., 2017, 2022; Hassija & Gray, 2011; Özümerzifon et al., 2022), Kenya (Decker et al., 2020), Australia (Hegarty et al., 2019), New Zealand (Koziol-McLain et al., 2018) and Netherlands (van Rosmalen-Nooijens et al., 2013), the largest number of studies (10 out of 16) were conducted in the USA, reflecting the country's central role in this field. Additionally, Nairobi (Decker et al., 2020), British Columbia (Ford-Gilboe et al., 2020), Pittsburgh (Constantino et al., 2015), Arizona, Maryland, Missouri, Oregon (Constantino et al., 2015), Florida (Braithwaite & Fincham, 2009), and Wyoming (Hassija & Gray, 2011) were specific places where studies were conducted while no specifics were mentioned in the other studies. Therefore, North America has contributed most of the research in this field, with 11 articles, and Europe has contributed two articles.

Also, There was a significant variation in sample size, ranging from 15 to 720 (Glass et al., 2017; Hassija & Gray, 2011). The age range of the samples was also varied, ranging from 18 to 65 years old. Most samples were White (Braithwaite & Fincham, 2007), Asian (Constantino et al., 2015), and Black (Koziol-McLain et al., 2018), and they spoke English (Constantino et al., 2015; Decker et al., 2020; Ford-Gilboe et al., 2020; Glass et al., 2017, 2022; Hegarty et al., 2019; Koziol-McLain et al., 2018), Dutch (van Rosmalen-Nooijens et al., 2013), Spanish (Constantino et al., 2015), and Swahili (Decker et al., 2020).

3.3 Study designs

The review included fourteen RCT studies and two quasi-experimental studies (Fiorillo et al., 2017; Hassija & Gray, 2011). The target population in most RCTs included adults or youth with specific experiences, such as domestic violence or post-traumatic stress disorder. In order to analyze the data, statistical methods such as analysis of variance (ANOVA) and Cohen's d effect size were applied. Computer algorithms were used to randomize the participants, and group allocation was kept secret from the researchers and participants. Some articles included qualitative as well as quantitative analyses during the follow-up period. Most studies used questionnaires to measure outcomes, the most frequently used being CES-D (Center for Epidemiologic Studies Depression Scale) or PHQ-9 (Patient Health Questionnaire-9) (Braithwaite & Fincham, 2007; Glass et al., 2017; Hegarty et al., 2019; Koziol-McLain et al., 2018), PCL-C (PTSD Checklist-Civilian Version) (Constantino et al., 2015; Fiorillo et al., 2017; Glass et al., 2017), Decisional Conflict Scale (Glass et al., 2017, 2022; Hegarty et al., 2019; Koziol-McLain et al., 2018), and GAD-7 (Generalized Anxiety Disorder 7-item scale) (Braithwaite & Fincham, 2007; Fiorillo et al., 2017; Glass et al., 2017).

Studies of long-term follow-up indicated sustained improvements in mental health, maintenance of security and decision-making conflict, and the reduction of symptoms of mental disorders. There was a strong emphasis on the positive effects of the interventions on the safety, mental health, and overall wellbeing of participants. Publication bias was not formally assessed using statistical methods due to the small number of studies available for each outcome ($<$10), as such analyses have low statistical power and can yield misleading results. To reduce the potential for publication bias, we conducted comprehensive searches across multiple databases, manually reviewed key journals, and screened the reference lists of included studies.

3.4 Type of intervention

Interventions were implemented in a variety of platforms, including internet-based (Bloom et al., 2014; Braithwaite & Fincham, 2007, 2009; Fiorillo et al., 2017; Ford-Gilboe et al., 2020; Glass et al., 2017, 2022; Hegarty et al., 2019; Hesser et al., 2017; Koziol-McLain et al., 2018; van Rosmalen-Nooijens et al., 2013), computer-based (Braithwaite & Fincham, 2007, 2009; Creech et al., 2022; Hesser et al., 2017), and application-based (Decker et al., 2020), but most studies (10 out of 16) involved internet-based

interventions. The content goals of the interventions, in addition to the safety decision aid feature, which has been the primary goal of the interventions, include risk assessment, action plans to enhance decision-making, health improvement, social support, modules on healthy relationships, promoting psychological flexibility, health education, legal support coping strategies, modules on healthy relationships, training in effective communication techniques, problem-solving skills, enhancing relationship satisfaction, as well as promoting mental health and well-being.

Interventions have also been based on motivational interviewing and psychoeducation (Creech et al., 2022), Acceptance and Commitment Therapy (ACT) (Fiorillo et al., 2017), Dance/movement therapy (Özümerzifon et al., 2022), Cognitive Behavioral Therapy (Hesser et al., 2017), and trauma-focused psychotherapy (Hassija & Gray, 2011). In the studies, myPlan and ePERP appear to be the most notable and frequently used interventions (Decker et al., 2020; Glass et al., 2022).

Despite the fact that some studies did not mention the duration of the interventions, according to Table 1, they were usually weekly for a period of six to twelve months. Additionally, to assess the long-term effectiveness of a program, follow-up periods are often extended to six or twelve months.

3.5 Outcomes

In addition to security and decision-making problems, most studies considered mental health problems, particularly depression, anxiety, and PTSD, as targets of their interventions. Three studies used them as secondary outcomes (Braithwaite & Fincham, 2007; Hegarty et al., 2019; Koziol-McLain et al., 2018) and four studies used depression, anxiety and post-traumatic stress disorder as primary outcomes (Constantino et al., 2015; Fiorillo et al., 2017; Glass et al., 2017; Hassija & Gray, 2011). Fifteen of the studies examined depression as an outcome, of which 13 had positive results, one did not significantly reduce depression (Hegarty et al., 2019), and one did not report about changes (Bloom et al., 2014). Anxiety was the subject of five studies. All of these found positive results (Braithwaite & Fincham, 2007, 2009; Constantino et al., 2015; Fiorillo et al., 2017; Hesser et al., 2017). Eight studies were conducted with PTSD as an outcome, 6 of which reported a significant reduction in symptoms (Fiorillo et al., 2017; Ford-Gilboe et al., 2020; Glass et al., 2017; Hassija & Gray, 2011; Özümerzifon et al., 2022; van Rosmalen-Nooijens et al., 2013), while one showed no effect (Creech et al., 2022) and one did not report any effect (Bloom et al., 2014). In none of the studies were negative outcomes or increased symptoms of depression, anxiety, or post-traumatic stress disorder reported.

Regarding comparator conditions, the included trials employed varied control designs. Some compared ICT-based interventions with no intervention or a waitlist; others used treatment-as-usual/standard counseling; several used active non-ICT comparators (for example, face-to-face versions of the same program or "screen-and-referral only" controls); and a subset evaluated ICT delivered alongside usual care, comparing ICT + usual care with usual care alone. In treatment-as-usual comparisons, control participants typically received standard in-person counseling, printed materials, or referrals, without access to the ICT component. Two studies did not include a comparator arm (one before–after study and one uncontrolled trial).

3.6 User experience of interventions

Online interventions have generally been perceived as being satisfactory, accessible, useful, and effective by users, despite problems mentioned by users that included technical difficulties (Glass et al., 2022; Hassija & Gray, 2011), the challenging content (Fiorillo et al., 2017), and duration of the interventions (Braithwaite & Fincham, 2009; Hegarty et al., 2019). My Plan intervention, for example, has been met with satisfactory results in terms of availability, ease of use of the application, as well as the user-friendliness and practicality of the content. However, some users encountered technical difficulties while working with the program, which included problems with the program itself as well as Internet access (Glass et al., 2022).

Additionally, some couples found it challenging to commit to the entire duration of the ePREP program, as well as the training on effective communication skills (Braithwaite & Fincham, 2009). Users of the iCAN Plan program considered it to be effective and personalized, although some participants found the initial setup process to be complex (Ford-Gilboe et al., 2020). Several users complained that the modules in

the I-DECIDE program are lengthy (Hegarty et al., 2019). In addition, some users found the six-session web-based ACT program emotionally challenging (Fiorillo et al., 2017).

3.7 The quality of interventions

The random sequence generation method was reported in all studies except two (Constantino et al., 2015; Hassija & Gray, 2011). Most studies did not clearly indicate the blinding method, and one did not use it. In only two studies (Hegarty et al., 2019; Hesser et al., 2017), blinding was reported and selective reporting was prevented by not reporting the intervention. There was no mention of allocation concealment in any of the studies (Creech et al., 2022; Hassija & Gray, 2011; Özümerzifon et al., 2022). The least "low risk" bias violations were for random sequence generation, and the most "high risk" bias violations were for outcome assessment blinding (detection bias). The quality assessment results of the included studies are shown in Table 2.

Table 2: Quality assessment of studies

	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective outcome reporting	Other potential bias
Braithwaite & Fincham, 2007	✓	✓	-	-	×	×	×
Braithwaite & Fincham, 2009	✓	✓	-	-	×	×	×
Constantino et al., 2015	×	✓	-	-	×	×	×
Fiorillo et al., 2017	NA	NA	NA	-	×	×	×
Glass et al., 2022	✓	✓	-	-	×	×	×
Glass et al., 2017	✓	✓	✓×	-	×	×	×
Hassija & Gray, 2011	×	×	×	-	×	×	×
Hegarty et al., 2019	✓	✓	✓	✓	×	×	×
Hesser et al., 2017	✓	✓	✓	✓	×	×	×
van Rosmalen-Nooijens et al., 2013	✓	NA	NA	NA	×	×	×
Koziol-McLain et al., 2018	✓	✓	✓	-	×	×	×
Ford-Gilboe et al., 2020	✓	✓	✓	×	×	×	×
Decker et al., 2020	✓	✓	✓×	×	×	×	×
Creech et al., 2022	✓	×	NA	NA	×	×	×
Bloom et al., 2014	✓	✓	-	-	×	×	×
Özümerzifon et al., 2022	✓	×	NA	NA	×	×	×

4 Discussion

This systematic review aimed to evaluate the efficacy of interventions using emerging technologies in helping victims of intimate partner violence (IPV) who suffer from anxiety, depression, and PTSD. Moreover, the study sought to determine gaps existing in the literature that require further investigation. While numerous systematic reviews have examined interventions related to IPV, encompassing various domains such as addictions (Wilson et al., 2014), women's economic empowerment (Eggers del Campo & Steinert, 2022), and behavioral, cognitive, and psychological interventions (Arroyo et al., 2017; Hameed et al., 2020; Tirado-Muñoz et al., 2014), based on our knowledge none of them have specifically focused on technology-based interventions and their influence on mental health outcomes such as depression, anxiety, and PTSD.

Among the most significant strengths of the studies are the diversity of interventions, including computer-based interventions, internet-based interventions, application-based interventions, a wide range of participants' ages, a variety of assessment tools, such as self-report and diagnosis, and the varying lengths of the interventions, ranging from a few weeks to one year. Moreover, the extensive content used in the interventions, including safety plans, mental resilience, flexibility, and problem-solving skills training, is an important strength. Another strength of the studies is the variety of approaches used in the studies, including cognitive-behavioural approaches, trauma-based approaches, and a variety of follow-up times, which all are important factors that contribute to the generalizability of the results.

Overcoming geographical barriers is one of the most important advantages of utilizing new technologies to address IPV. The availability of online platforms makes interventions more accessible to those living in remote areas and those with limited access to specialized services (Braithwaite & Fincham, 2009). By facilitating early intervention and support, these accessible online interventions reduce service gaps and facilitate early intervention. Women can also find help and support in a safe, confidential environment without fear of judgment or stigma, thereby decreasing underreporting of violence experienced by women (Bloom et al., 2014; Constantino et al., 2015; Fiorillo et al., 2017; Hassija & Gray, 2011).

Because digital interventions are crucial to connecting with victims and overcoming barriers to access, we can bridge the gap between service providers and victims, especially when access is difficult, such as during Covid-19 (Emezue, 2020).

The services for victims of IPV, typically provided in person or via transfer to short- or long-term protective facilities such as shelters and safe houses (Weeks et al., 2021), have been limited as a result of the Covid-19 pandemic, and public health regulations have been loosened. As a result, many organizations have been unable to provide in-person services and use online communication technologies such as video calls and applications to provide services (Jeyaraman & Chandan, 2020; Schafer et al., 2023; Su et al., 2022). However, there are concerns about safety, privacy, ethics, and equitable access to these interventions (Baird & Tarshis, 2022; Novitzky et al., 2023).

The included trials varied in their choice of comparator. Some evaluated ICT-based interventions against no intervention or a waitlist, others compared them with treatment-as-usual/standard counseling, and several used active non-ICT comparators (e.g., face-to-face versions of the same program or "screen-and-referral only"). In some studies, ICT was delivered alongside usual care and compared with usual care alone. Beyond clinical outcomes, many interventions were designed to support service delivery by providing digital educational content, safety planning, and remote follow-up — approaches that extend reach when in-person resources are constrained.

4.1 Study gaps for future research

It is relevant to consider factors such as inequality in access to new tools, victims' access to digital services, and the benefit of online intervention particularly in areas with limited resources. The use of new technologies can be a challenge for victims with mental or cognitive disabilities (such as mentally retarded, elderly, cognitively impaired, deaf and blind, etc.). Considering the high cost of smartphones and internet services, low-income victims are often unable to access and use these services. Furthermore, the use of such technologies requires technological literacy.

Digital interventions have not been fully explored as a means of improving access to health care in low-income areas. Future research must pay more attention to this important gap. By utilizing low-cost and low-bandwidth Technologies, future research should assess the effectiveness and feasibility of these interventions in such areas, explore hybrid interventions combining digital methods with in-person support to reach individuals in underserved areas, and conduct field studies in underserved areas where access to technology and the internet is limited to determine how they can be adapted to local conditions.

Security issues and spyware create a complex obstacle to monitoring these interventions, as well as to the use of these types of digital interventions. In light of these challenges, service providers should consider using digital interventions in conjunction with routine care, and further research is necessary to determine the safety of using technology for interventions.

To maintain safety, security, and privacy, studies have examined the use of personalized safety planning (Bloom et al., 2014; Ford-Gilboe et al., 2020), risk assessments (Glass et al., 2017), visual feedback (Bloom et al., 2014; Hassija & Gray, 2011), and victim anonymity. It is essential, however, that more attention is paid to security and the prevention of cyber abuse of people's personal information, especially in future research. PINs and passwords were an important consideration in the studies (Bloom et al., 2014; Decker et al., 2020; Glass et al., 2022), but it is critical that additional information be provided concerning the security of servers that store user information, the level of access to those servers, and the number of individuals with access to those servers to prevent cyber abuse and other potential harms.

According to Table 2, more studies achieved good performance characteristics in random sequence generation and concealment, however, incomplete data, selective reporting, and other biases were observed in other similar studies. In many studies, insufficient attention has been paid to reducing biases and ensuring the quality of the data, which may negatively affect their results. Therefore, future intervention studies should pay more attention to these issues.

There was a high concentration of articles in the review that dealt primarily with specific populations within localized contexts. For instance, a substantial number of studies (10 out of 16) were conducted in USA, while there were no related studies conducted in Asian countries. The lack of national diversity of participants and the focus on mainly English-speaking participants make it difficult to generalize the results. To ensure generalizability and applicability across cultural, social, and geographical contexts, future research should incorporate diverse samples and global perspectives. The complexities of IPV and technology-based intervention effectiveness can be better understood by studying a diverse group of participants.

Finally, it is imperative to explore the subjective experiences of individuals with online interventions. It is possible to gain a deeper understanding of victims' perspectives, emotional responses, sense of security, self-reporting behaviors, and help-seeking tendencies by using qualitative research methods. By conducting precise research of this nature, survivors of IPV can gain valuable insights into the usability, acceptability, and potential enhancements of technology-based interventions. When interventions are designed with survivors' subjective experiences in mind, they can be more effective and empowering.

4.2 Study limitations

There are several limitations to the study: The search was conducted in four databases (PubMed, Scopus, PsychInfo, Google Scholar) which, while extensive, may have missed relevant studies from other databases or grey literature. As can be seen in Table 1, due to the focus on various technological interventions, the results may not fully reflect the effects of all types of interventions. In addition, the inclusion of a wide range of interventions and methodologies may have contributed to a high level of heterogeneity, which may limit the generalizability of the results. We restricted our search to articles published between 2000 and 2022, which may have excluded older relevant studies. It is possible to eliminate these limitations in future research in order to reach robust conclusions.

4.3 Conclusion

This systematic review demonstrated technology-based interventions can significantly influence the mental health of survivors of intimate partner violence, as well as empower them and enhance their coping abilities.

Furthermore, future research can improve such interventions by addressing privacy concerns and survivors' subjective experiences of using technology-based interventions, and by conducting studies in more diverse places around the world. Also high-quality trials and replication studies with harmonizing outcome reporting are needed.

Declaration of competing interest

None.

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Causes of Decapitation in Dvin: Interpretation of Historical Evidence

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Abstract

This article examines the excavated fire temple in Dvin, the capital of medieval Armenia. Dvin was located at the crossroads of numerous external trade routes as well as internal commercial networks. During the course of the excavations, skulls were recovered that displayed clear evidence of violent trauma. Fractures of the occipital condyles and damage to the left mastoid region were observed at the base of the individuals' skulls. These injuries suggest that the victims were held by the hair, and their heads were struck with a sword. This study explores the potential causes of the observed violence and considers whether these acts may have been connected to ritual practices, particularly sacrificial offerings associated with the fire temple or with Zoroastrian religious traditions.

Keywords: Armenia, Dvin, Early Middle Age, Fire temple, Trauma, Decapitations

The article is dedicated to the blessed memory of archaeologists A. C. Zhamkochyan and F. S. Babayan.

1 Introduction

In the Peace Treaty of 387 AD, Armenia was divided between the Roman Empire and Sasanian Iran. By the Act of Nisibis, Eastern Armenia was included in the sphere of Sasanian political, socio-economic, and cultural life, first with the status of a kingdom (until 428 AD), then with the status of a Marzpanate. Armenia was located at the junction of strategic, transit, and trade caravan routes stretching from East to West that also served as cultural highways, connecting two opposing dynasties, Byzantium and Sasanian Iran. Armenia and Armenian culture found themselves in a very difficult situation, when the task of the day became not only to resist, to preserve the national identity and originality, but also to secure a stable place in the future competition.

Early medieval Armenian religious thought and concept were formed in the competition between two opposing ideologies: Sasanian Zoroastrianism and Armenian Christian thought, when the former often forcibly dictated its approaches and norms. The Sasanian state-religious elite, unlike its predecessors, the Achaemenids and the Parthian Arshakunis (Boyce, 1987, pp. 95–96, 102), imposed religious intolerance.[1] The eloquent evidence of this is the behaviour of the military commander, Great Minister and king Yazdgird. Armenian historian Elishe wrote: "He was the ruler and master of all the kingdom of Persia, and his name was Mihrnerseh; and there was no one who would dare to disobey him. And not only the nobles and the little ones, but also the king himself was counted with his commands." (Elishe, 1957, p. 88). Being a fanatical Zoroastrian, anti-Christian and anti-Armenian, he gave the command: "All the peoples and languages that are under my power, let them abandon the laws of their false teachings, and let all of them, to the last one, come to worship the sun, bringing sacrifices to it, and calling it a god, and performing the service of fire. And besides all this, let them fulfil the laws of the teachings of the Mogs, without making any omissions" (Elishe, 1957, pp. 17–18), and "if you accept our faith of your own free will, you will receive gifts and honours from him [the king], and you will receive taxes from the treasury, but if you do not agree of your

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[1] Some kings of this dynasty, such as Yazdegerd I (399-420 AD), treated Christians and Jews with tolerance.

own free will, then we have an order to erect shrines in villages and cities and light the fire of Vram in them, and to appoint Mogs and Mogpets as servants of the faith throughout your entire country." (Elishe, 1957, pp. 70–71). This edict led to the establishment of fire temples in the capitals of Armenia, Artashat and Dvin. The Sasanian shahs were always strict regarding matters of faith, and their magi lit fires in Georgia as well: the Nekresi fire temple in eastern Georgia, in Kakheti, and the Atashgah fire temple in the historic area of Old Tbilisi.

In 531 AD, Khosrow I (Anushirvan) ascended the Sasanian throne. While he is often credited with military and economic reforms, his religious policy was also significant. According to modern scholars, he reinforced Zoroastrian orthodoxy, suppressing heterodox practices and dissenters. Payne (2015) argues that Khosrow punished nobles who deviated from the imperial religion — in some cases by execution — in order to stabilize his reforms and strengthen the role of the Zoroastrian clergy. According to Payne (2015, pp. 67–70), the ruler prosecuted and punished adherents of "irrational" or "deviant" religious practices that diverged from the norms of the state Zoroastrian church, including, in some cases, the execution of high-ranking offenders.

Fire temples were built in villages and cities, while in remote mountainous regions pirs — shrines composed of sacred rocks, caves, and holy springs — were deeply venerated (Canepa, 2013; Shenkar, 2024). Archaeological and textual scholarship supports the idea that many of these mountain sites were already sacred pagan locations long before they were integrated into a formal Zoroastrian religious framework. Canepa (2013) argues that several of the most important Zoroastrian sanctuaries were deliberately founded in locales with dramatic natural features — mountains or lakes — but lacked prior monumental construction, suggesting a re-appropriation of pre-existing sacred geography. Moreover, Shenkar's (2024) research indicates that early Iranian worship of fire often took place in the open air, without closed temple buildings, and that sacred natural places — including rock outcrops and springs — played a central role in early fire cult practices.

The Greek historian Herodotus (5th century BCE) reports that the Persians (early-Iranian people) did not erect statues, temples, or altars, considering such practices foolish; instead, they offered sacrifices on the highest mountain peaks. According to him, they sacrificed to "Zeus" (a Hellenic name for the sky), as well as to the sun, moon, earth, fire, water, and winds. Furthermore, he describes their sacrificial ritual: no altar is built, no fire is lit, and when a man wishes to sacrifice, he brings the victim to a pure, open place and invokes the deity while wearing a wreath of myrtle. However, in the course of the centuries when these natural sacred sites were used, more formal temple structures began to be built. This process is especially well documented in the Sasanian period: Canepa (2013) argues that many "Avestan" sanctuaries, initially located in spectacular landscapes such as mountains or lakes, were transformed into monumental ritual centres. According to architectural scholarship, the enclosed fire temples familiar from later Zoroastrianism developed only at a later stage, while for much of their history, worship at these elevated, remote sites continued in open-air contexts. These mountain sanctuaries (pirs), — such as Pir-e Sabz (Chak-Chak), — became major pilgrimage destinations.

The Zoroastrian cult gave rise to a network of fire temples stretching along the Silk Road throughout, - Greater Iran, from Armenia through Central Asia and into China (Pulleyblank, 2018). Archaeological and historical research supports this. For instance, scholars point to the presence of Zoroastrian shrine-temples in Sogdian settlements along the route (Pulleyblank, 2018; Zamotaeva & Kring, 2017). In China, contemporary sources indicate that Zoroastrianism had a recognized status by the sixth century. There were temples in Chang'an, Luoyang, and other cities along the Silk Road, operated by foreign Zoroastrian communities (Pulleyblank, 2018; Zamotaeva & Kring, 2017). Moreover, archaeological work in Central Asia shows early cultic architecture. For example, at Kyzyltepa, a fire-altar structure dating to the Achaemenid or early Sasanid period has been unearthed, including a terracotta pan blackened by soot (Xin, 2023). Finally, recent excavations have uncovered a site at Mingchaqtepa (Uzbekistan) where a square building with a circular fire pit bearing signs of burning was identified — this has been interpreted as a Zoroastrian temple (https://www.youtube.com/shorts/NDcIcL3_al8). The Silk Road had a profound impact on the spiritual life of the peoples living along the route, pulling them out of isolation and fundamentally changing their worldview. Zoroastrian burial rites became predominant throughout the Silk Road.

In the 5th to 7th centuries, during the peak of trade, castles and other civil buildings were hastily converted into fire temples. The architecture of roadside fire temples was characterized by simplicity in layout and design. Some archaeological (Aspāḳu, Dayr-e Gachin) and historical evidence suggests that during the Sasanian period, certain fortified structures, including caravanserais, may have been re-consecrated or adapted as Zoroastrian fire temples (https://www.iranicaonline.org/articles/khorasan-xxiv-monuments-of-khorasan; https://www.iranicaonline.org/articles/dayr-e-gacin).

Zoroastrian traditions in Armenia have a long history. The burials of dismembered bodies found in cemeteries from the Late Iron Age (Lori Berd, Nor Armavir) relate to pre-Zoroastrian beliefs (Khudaverdyan et al., 2013, 2021). Osteological material from the Lori Berd site shows post-mortem changes (Khudaverdyan et al., 2013, p. 86). Two men (burials 105: 18-20 years old; 107: 50-55 years old) had their heads cut off in the middle; only the right parts of the skulls were buried. Neatly arranged chopped fragments of the postcranial skeleton were found under the right part of the skull (burial 105) (Khudaverdyan et al., 2013, Figures 1-3). Marks of pitting, scratching, and defects on articular surfaces were identified on the bones. "Scratches" and "gnawing" sometimes affected the entire circumference of long bones. There is no doubt that these destructions are the result of small animals' activities during the complete or partial consumption of soft tissues. The bodies of the deceased were possibly left on elevated ground for the soft tissues to decay and be consumed by scavenging birds before being buried in the cemetery.

Sacrifices are an important part of the religious rituals of any traditional society. The main idea of traditional sacrificial ritual actions is to appease a particular lower or higher deity in order to free the family or clan from various misfortunes. As is known, local sacred practices allowed for human sacrifices in certain cases. However, this evidence pertains to events from quite some time ago (Khudaverdyan et al., 2013). Materials from the Shirakavan cemetery indicate that the local population practiced sacrifices. In one case, a woman was laid in a curled position, with the skull of a man found near her head; in another case, the skull of a younger woman was found alongside the skeleton of a man; in a third case, the skull of a younger woman was found with the skeleton of a mature woman. It is important to note that the skulls of the victims were located near household items in the graves (animal bones were found in the vessels). It is likely that sacrifices were performed during ritual memorial ceremonies. Anthropological analysis suggests that the victims were first rendered unconscious and then their heads were chopped off. The trophy skulls showed signs of trauma (a strong blow was delivered to the crown). The heads of the victims were severed, most likely with a sword.

The severed human head held significant symbolic value in the cultic systems and magical rituals of the Greeks, Etruscans, Scythians, Carthaginians, Celts, Thracians, Taurians, and other ancient peoples, as noted by ancient writers (Strabo, IV; Herodotus, IV). An explanation for the ritual of decapitation can be found in numerous mythological narratives associated with the veneration of chthonic deities, particularly Dionysus. The tradition of collecting heads is known from prehistoric times to the present day. Attempts to turn to ethnology in search of an explanation for this custom have led to the emergence of many different theories. Some authors believe it relates to ancestor worship, while others see these individuals as cannibals who buried the skulls of their victims for ritual purposes. A third perspective is that the skulls are military trophies buried as treasure. Neolithic skulls from Catal-Hoyuk have been found in unexpected locations, such as open spaces between structures or under the floors of houses. The prevailing view links these skulls to ritual ancestor veneration (Mellaart, 1967). During the excavations at the Areni 1 cave, a series of clay structures and vessels were discovered buried in the cave's deposits at the back of the first gallery. Three of these contained skulls of individuals that, based on radiocarbon analysis results, date to the last quarter of the 5th millennium BC (4300–4000 BC, calibrated — Early to Late Eneolithic) (Khudaverdyan et al., 2017).

Each method of handling the body and the place where a person was buried likely held its own significance. This may have depended on who the deceased was or who performed the ritual.

2 Dvin, capital of Armenia from 5th to 9th century

The vestiges of the capital city of Armenia, Dvin, the one - time centre of trade, crafts and culture, lie some 35 km to the south of Yerevan. The city was founded in the thirties of the fourth century by the Armenian

King Khosrov II Kotak (332-338AD), a descendant of the Arshakoony dynasty. Valuable information on the foundation of the city is available from the historians Pavstos of Byuzand (4th c.) and Movses Khorenatsi (5th c.). They attest that King Khosrov undertook construction work on a hill called Dvin where he transferred the court from Artashat and afforested in the vicinity of the new capital. Dvin developed and thrived till it grew into a hub of international transit trade. Feudal relations were dominant all over Armenia throughout the 4th-5th centuries, with strong Hellenistic traditions. Dvin was in the focus of these complicated historical-political, social and cultural events because it was virtually the only city of major economic and cultural consequence in medieval – Armenia.

The archaeological investigation of this famed city was begun at the close of the 19th century but it was only in 1937 that regular, long-term excavations were launched that have been going on to date. The diggings resulted in rich findings of great scientific value that relate to all domains of Armenian material culture. Discoveries were made in the citadel and living quarters of the city: palatial and church structures, buildings meant for economic and communal facilities, invaluable specimens in profusion betokening the various products of medieval Armenian craftsmanship, imported goods, coins, etc. Archaeological work revealed that the origins of life on the hill of Dvin go back to the Eneolithic period, lasting until the 13th century. Dvin, that important city rich in medieval Armenian fine-arts products, played a key role under "marzpan" (medieval governor) rule and continued its economic significance under Arab sway. It is a unique landmark, and the excavations there have made it possible to draw a picture of Armenian 5th-8th century culture, of its evolutionary stages, and to get an insight into the salient changes in medieval culture as a whole.

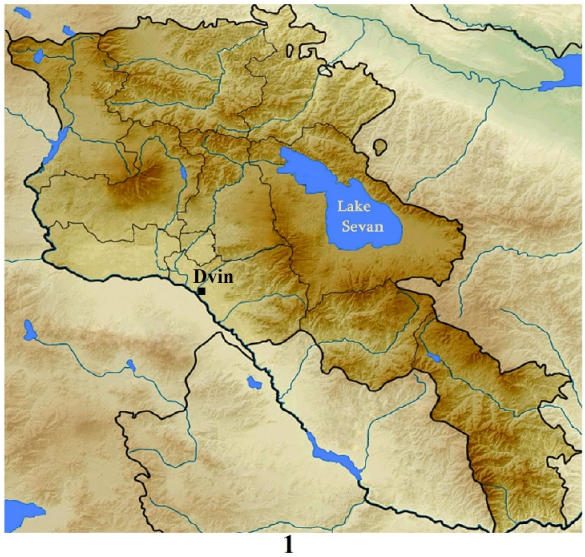
The forced establishment of the Sasanian fire temple in Dvin took place when the marzpan Chihor-Vshnasp Suren seized the Patriarchal seat from Hovhannes Gabeghenatsi, the Catholicos of Armenia (557-574 AD), and turned it into the residence of the Persian official. The Catholicos of Georgia and historian Arseni Sapareli wrote: "From this time on, the Persian marzpans occupied Armenia (Somkher) and the Christian order was neglected, and the church doctrine faded away... and the episcopates were turned into shrines" (Hakobyan, 2020, p. 135). Khosrov Anushirvan ordered the demolition and destruction of monasteries and churches, and the construction of fortifications within the borders of the Sorea, in Persian Armenia (Frye, 1962).

In the 1970s, the Dvin archaeological expedition carried out excavations in the southern part of the Church of St. Gregory the Illuminator. During the excavations, one of the unique buildings of Armenian secular architecture was discovered: the 5th-6th century palace complex, which most likely served as the residence of the Armenian Patriarchs (Figure 1).

Archaeological work revealed that the palace had existed for about a century and then was subjected to fire and destruction in 572 AD during a rebellion. A building was opened next to the columned hall of the palace, which is organically connected with the overall plan of the palace (Kalantaryan et al., 1992). In the centre of the building was a square stone platform made of three large tuff slabs, and covered with a thick layer of ash, next to which a large pot filled with ash was placed in a vertical position. In the centre the platform had a square base for a square pillar, on which a special vessel with a constantly burning sacred fire was placed. The Parthian term for a fire temple — aturosan — has been preserved in the Armenian language as atrushan, meaning "place of the burning fire." The presence of refuse from later periods may suggest the existence of specific sacrificial rites during which, in the course of regular purifications of the sanctuary, the remains of animal offerings and altar ash were deposited in the subterranean chamber (Kalantaryan et al., 1992).

The excavated area of the building was covered with gravel and bone-mixed soil, which is most likely associated with the existence of an earlier pagan shrine. Sacrifices, burning and washing were performed there during the ceremonies. The remains of sacrifices, as sacred relics, were not thrown away, but were buried in the surrounding area. The same applied to the ashes from the sacred fire. Following the Zoroastrian belief, the sacred area was consecrated and cleansed with holy water several times a day, in the morning, afternoon and evening (Boyce, 1987, p. 10, 12, 76, 79, 135; Rak, 1998, p. 16).

Special water jars with lids were kept for this purpose. One such lid, covered with red glaze and bearing a unique design, was found in the area of the prayer hall (Hakobyan, 2020, p. 138; Kalantaryan,



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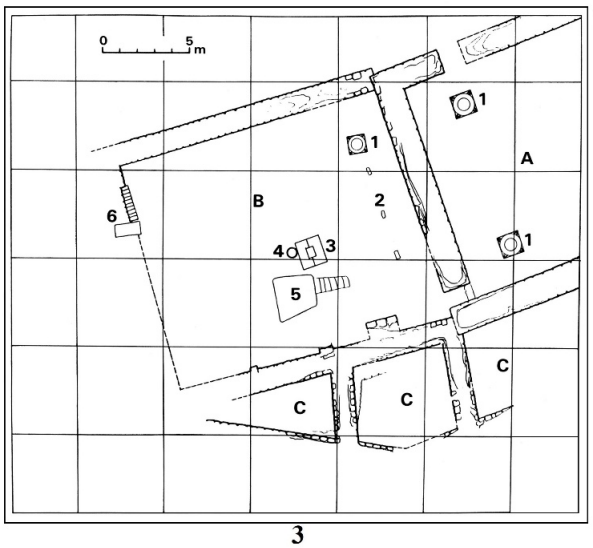

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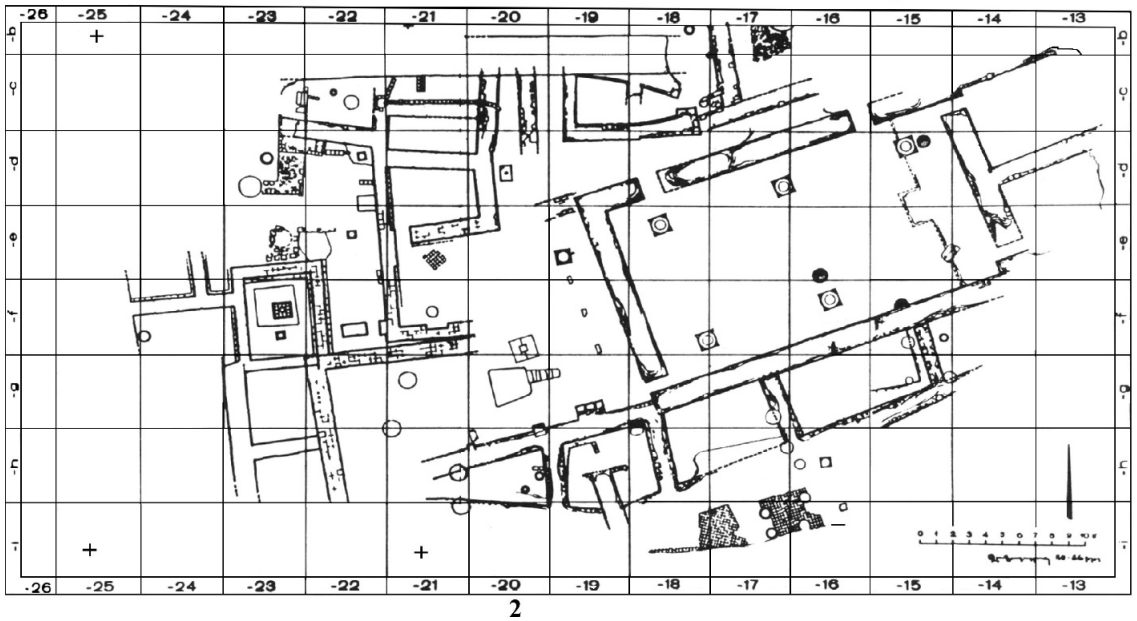

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Figure 1: 1. Location of medieval Dvin; 2. Dvin, city centre, overall plan of the excavation in the area of the old Catholicos Palace; 3. Excavation plan for the reconstruction of the Catholicos' Palace: A. The Column Hall of the Catholicos Palace, probably used as a prayer hall; B. Sasanian annex, most likely fire temple (Kalantaryan et al., 1992); C. Adjoining rooms; 1. column bases in situ, 2. upright stone blocks, 3. stone podium, probably altar base, 4. clay vessel with ashes, 5. underground room with stairs, 6. underground room with stairs (Kalantaryan et al., 1992).

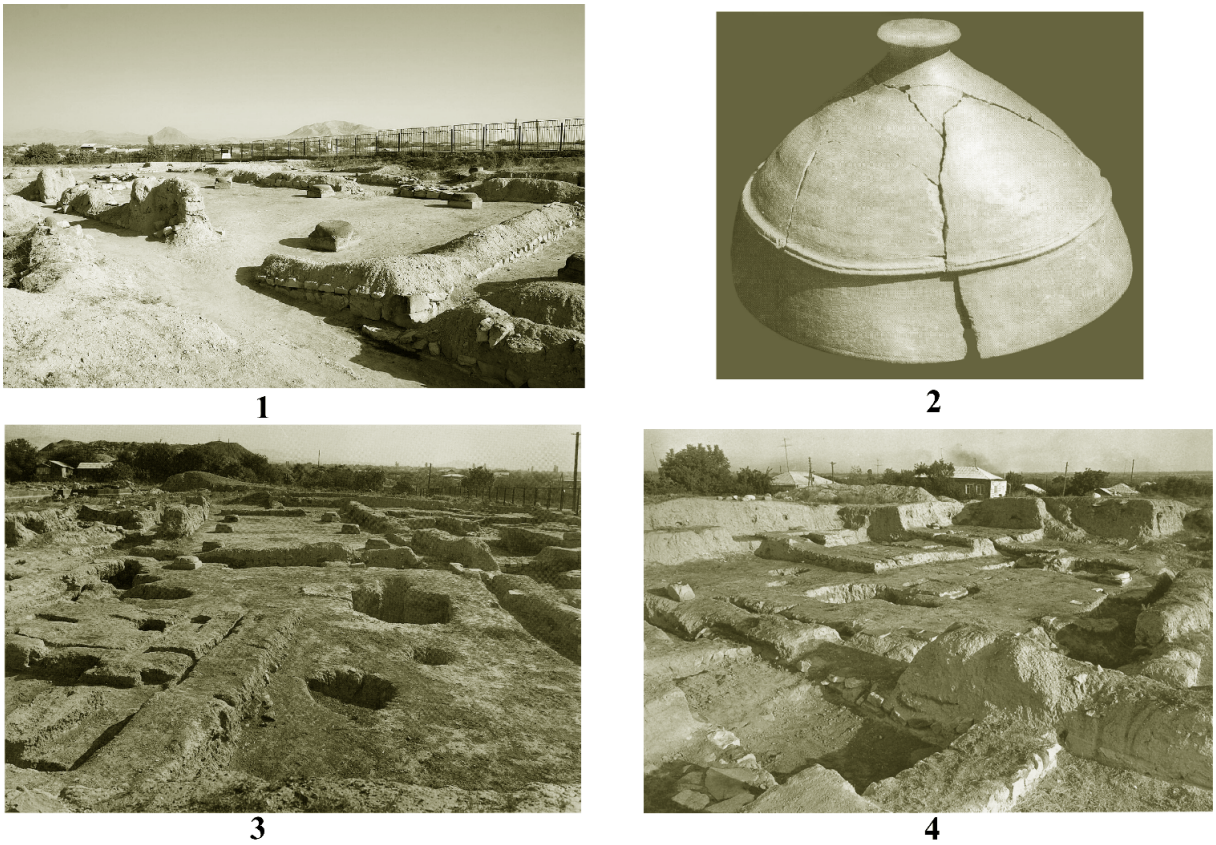

Figure 2: 1. Column of the Catholicos Palace; 2. Pithos lid, ceramic, ca. 6th century AD, from Sasanian addition to palace hall; 3. In front, Sasanian extension, probably fire temple with superstructure of the 9th century, behind it columned hall of the Catholicos Palace, from the west; 4. View from the east into the Sasanian annex, probably a fire temple; on the right, door to the columned hall of the former Catholicos Palace; in the centre of the picture a stone base, probably for a fire altar (Kalantaryan et al., 1992)

1986, pp. 87–88). The jars filled with water were placed on both sides of the platform.

The pagan temple at Dvin, in terms of its architectural layout, is comparable to the forms of Sasanian fire temples, although it does not represent a canonical or fully developed example of the fire-temple type. However, the pagan temple was destroyed by Armenian rebels during the rebellion of Karmir Vardan in 572 AD, and it is difficult to accurately restore its layout. After the palace complex was destroyed and burned down together with its "fire house", it was never restored as it was considered desecrated.

3 Material and methods

The human skulls analysed for this article were excavated by archaeologists Nyura Akopyan (excavations in 1978), Frina Babayan (excavations in 2011) and Akhavni Dzamkochyan (excavations in 2013) in Dvina. No post-cranial bones have been buried. The skulls were in a satisfactory state of preservation, allowing for the determination of sex, age, and pathological conditions, which constitute the main focus of this study. Among the analysed skulls, two belonged to females and one to a male. The materials were recovered from a stratigraphic context attributable to the Early Medieval period (400-700 AD).

International standard procedures (AlQahtani et al., 2010; Buikstra & Ubelaker, 1994; Lovejoy et al., 1985; Meindl et al., 1985) were used to morphologically determine the age and sex of the individuals. In addition, gross observations of abnormal changes appearing in ancient skeletons principally provide the basic information for palaeopathological diagnosis. Particular attention has been paid to traumatic lesions that may be associated with violence.

Traumatic injuries to the skeleton can manifest in a variety of patterns depending on the force of impact, its direction, and the structural integrity of the affected bone (Galloway, 1999; Lovell, 1997). Several individuals in the assemblage exhibited evidence of possible perimortem cranial trauma. Perimortem injuries are defined as those sustained while the bone was still fresh and malleable. Specific diagnostic features can be used to distinguish perimortem from postmortem damage. Due to the plastic nature of fresh bone, perimortem fractures frequently exhibit outward bevelling in the direction of the applied force, particularly on the thin laminar bones of the cranial vault. These can present as linear, comminuted, or puncture fractures with corresponding bevelling (Lovell, 1997). The fracture edges are typically irregular, as fresh bone flexes and fragments remain partially attached (Sauer, 1998). Cranial vault fractures, depending on the force of impact, may also demonstrate radiating and, in some cases, concentric fracture lines, which terminate upon reaching an open suture or an existing fracture (Berryman & Haun, 1996). Fractures of the skull base are generally classified into bending and bursting types. Bending fractures result from direct, localized trauma, producing depression at the impact site and typically leading to comminuted or perforating fractures. Bursting fractures, by contrast, are caused by objects with a broad surface area or indirect trauma. The force is transmitted through the cranial bones. In thinner areas with limited elasticity, the bone fails, producing bursting fractures.

In cases of decapitation, a detailed description was recorded, including the specific bones affected, the direction of the blow, indications of the type of weapon used, and the morphology of associated cut marks. These observations were supplemented with schematic drawings of the trauma distribution and a photographic record. Diagnostic skeletal markers of decapitation include damage to the upper cervical vertebrae (and occasionally C7 or T1), mastoid processes, occipital regions, posterior mandibles, and first ribs (Anderson, 2001; Ardagna et al., 2005; Aufderheide & Rodriguez-Martin, 1998; Buckberry & Hadley, 2007; Khudaverdyan, 2017). Beheading-related injuries can also affect the odontoid peg (McKinley, 1993) and transverse processes of the vertebrae, particularly when an axe rather than a sword was employed (Waldron, 1996). Even in the absence of skeletal evidence, contextual indicators may suggest decapitation, such as the absence of the skull (though this may also result from post-depositional processes including intrusive burials, animal activity, or environmental factors) (Okumura & Eggers, 2008), the recovery of an isolated cranium without associated postcranial elements (Nagaoka & Abe, 2007), or the placement of a skull in a non-anatomical position (Boylston et al., 2000).

The presence of antemortem fractures was determined macroscopically (Buikstra & Ubelaker, 1994; Ortner & Putschar, 1985). In the present study, bearing in mind the various diseases, pathological changes were completely described and given tentative diagnosis.

4 Results

4.1 Individual 1

The columned hall excavated in 1978 bears resemblance to the Armenian glkhatun with its tent-shaped roofing, a type of dwelling widely attested in civil architecture and preserved as a vernacular housing tradition in many rural regions of Armenia to the present day. The stone bases of the wooden columns are of simple workmanship, consisting of a square lower section with a rounded socket designed to support the posts. In the second excavation sector, at a depth of 1.5–2 m (Figure 2), archaeologist N. G. Akopyan recovered the skull of a female individual aged approximately 20–25 years (Table 1, Figure 3-1). The skull is incomplete, and the facial skeleton is poorly preserved. This deterioration may be indicative of an intentional attempt to disfigure the facial features of the deceased — possibly as a means of erasing personal identity — or it may be the result of pathological processes, such as an infectious disease (e.g., leprosy).

An exostosis in the external auditory canal was identified in this individual. Auditory exostoses are bony outgrowths commonly associated with repeated exposure to cold water, often linked to habitual aquatic activities such as diving (Kennedy, 1986; Manzi et al., 1991). Prolonged exposure to cold air and water is known to stimulate the thickening of the bone surrounding the external acoustic meatus, leading to canal narrowing and, in some instances, complete occlusion. Alternative etiologies proposed in the literature

include chronic otitis, genetic predisposition, and repetitive biomechanical stress associated with mastication (Aufderheide & Rodriguez-Martin, 1998).

A small, circular "button" (or "ivory") osteoma, measuring approximately 12 mm in diameter, was observed on the left parietal bone. This benign osteogenic lesion is composed of dense lamellar bone with vascular channels and displays minimal marrow space (Aufderheide & Rodriguez-Martin, 1998; Ortner, 2003).

Signs of nasal trauma were identified in Individual 1, specifically affecting the left side of the nasal region (Figure 3-1). The right side of the facial skeleton is largely absent, most likely due to a combination of postmortem damage and taphonomic processes.

Skeletal changes consistent with *facies leprosa* were also noted (Figure 3-1). These include destructive lesions within the nasal cavity, along with atrophic changes and marginal pitting of the nasal bones. The nature and pattern of these nasal alterations strongly suggest leprosy as the underlying condition — more so than any other known pathological process documented in medieval Armenia (Vardanyan, 1995, 2000).

Mechanical fractures of the occipital condyle and damage to the mastoid processes were observed at the base of the individual's skull (Figure 3-1). These bone fractures are considered perimortem in nature, dated to the moment of death. Such injuries are definitively interpreted as resulting from the decapitation of an individual in an upright position (Manchester, 1983, p. 63). The head is severed from the body with a sharp blow from the chopping implement. The blow was delivered from behind, evidently by a right-handed individual. All of the above circumstances suggest a criminal context for the event. However, a ritual aspect cannot be entirely ruled out — for example, the possible existence of fire-worship sanctuaries.[2]

Woman beheaded for leprosy? Medieval citizens feared individuals afflicted with leprosy due to uncertainty, misinformation, ignorance, and a desire for self-preservation. Myths and misconceptions surrounding the disease profoundly influenced societal attitudes and responses toward those who suffered from it. For the afflicted, these misunderstandings were historically devastating. Branded as outcasts, they were often seen as symbolic embodiments of evil. Leprosy served as a stark moral warning — interpreted as divine punishment for sin — and reinforced societal adherence to religious norms, as well as fear of divine retribution.

4.2 Individual 2

During the 2011 excavations archaeologist F.S. Babayan uncovered at a depth of 40 cm the cranial vault and mandible of a female individual aged 18–20 years. Associated faunal remains were also present at the site (Table 1, Figure 3-2).

[2] There is no direct ritual connection between severed heads and Zoroastrian fire temples known from historical, textual, or archaeological evidence. However, several indirect considerations may be relevant for interpretation:

1. Pre-Zoroastrian traditions:

In the Iranian cultural sphere, some pre-Zoroastrian groups may have practiced forms of ritual violence, trophy-taking, or display of enemy heads. If the site exhibits cultural continuity or syncretism, the act might reflect older local customs rather than orthodox Zoroastrian ritual.

2. Political or military symbolism:

In Sasanian contexts, decapitation is more commonly associated with punishment, warfare, or public demonstration of power, not with fire-temple ritual. A severed head near a temple could therefore reflect political intimidation, execution, or suppression of resistance rather than religious practice.

3.Secondary use of sacred or administrative spaces:

Temples were sometimes reused or repurposed during periods of conflict or regime change. Violent acts occurring near such structures might be linked to political messaging rather than liturgy.

4.Local syncretism and elite ideology:

In frontier regions (including Armenia), Zoroastrian elements sometimes merged with local cults. While still speculative, unusual ritual behavior could reflect hybrid practices not found in normative Zoroastrian texts.

If a severed head is found in association with such a site, political violence, punitive display, or local non-Zoroastrian ritual traditions are more plausible explanations than orthodox Zoroastrian rites.

During the restoration process, it was determined that the facial skeleton and the base of the skull were absent. The left mastoid process was partially preserved and exhibited no signs of trauma. In addition to several small, healed, and superficial cut marks observed on the frontal bone, four shallow incisions (1–3 mm in length), consistent with sharp-force trauma, were recorded on the right ramus of the mandible (Figure 3-2). An additional cut was identified on the left side of the basal surface of the mandible, measuring approximately 4.5 mm in length. These injuries were inflicted perimortem. The absence of bone healing or signs of infection suggests that the woman died as a direct result of these violent acts.

4.3 Individual 3

While clearing the inner wall of a large building during the 2013 excavations, archaeologist A.S. Zhamkochyan (with the participation of A.Yu. Khudaverdyan) uncovered, in layers dating to the 11^{th}–13^{th} centuries, large deep pits (tonir – circular hearths dug into the floor and coated internally, primarily used for baking bread [lavash]) with brick linings, ceramic drainage pipes, and scattered fragments of plain and glazed pottery. At a depth of 1.63 m, near one of these pits, an isolated male skull was discovered (Table 1, Figure 3-3), accompanied by animal bones. The pit itself contained the skeleton of a large bovine. The biological age of the individual was estimated to be between 20 and 25 years. The skull displays signs of microcephaly — a congenital condition characterized by an abnormally small cranial vault, typically resulting from reduced brain volume. In such cases, cranial development is restrained by failure of the brain to grow to normal size. Potential aetiologies include congenital infections such as measles, varicella (chickenpox) or cytomegalovirus, as well as various genetic syndromes.

The individual also presents with cranial deformities, including plagiocephaly without evidence of cranial suture synostosis, facial skeletal asymmetry, and abnormalities of the atlanto-occipital joint. The facial skeleton is markedly deviated to the left. However, a definitive diagnosis of muscular torticollis cannot be established due to the absence of cervical vertebrae and the mandible. The skull is more malformed on the right side.

Multiple instances of enamel hypoplasia were identified. Enamel hypoplasia represents a disruption in amelogenesis and is indicative of systemic stress during early development. While genetic factors may contribute (Goodman & Rose, 1990), nutritional deficiencies and infectious diseases remain the most common causes.

Evidence of maxillary sinus inflammation (sinusitis) was observed. Acute maxillary sinusitis is typically secondary to viral upper respiratory infections, during which mucosal oedema obstructs the maxillary ostium, leading to the accumulation of purulent material. Chronic rhinitis, characterized by persistent mucosal thickening, can also result in similar obstruction. Notably, an enlargement of the left infraorbital foramen (7×6 mm) was documented, accompanied by signs of infection spreading into the orbital cavity (Figure 3-3). This may have led to orbital inflammation (ophthalmia), a serious complication that can arise in the absence of timely intervention.

A perimortem trauma was identified in the region of the right infraorbital foramen. Post-trauma, an osseous outgrowth developed at the injury site, forming a broad-based bony projection with irregular yet well-defined margins. The dimensions of this lesion are approximately 7×6.5 mm.

In addition, several antemortem cut marks consistent with sharp-force trauma were found on the frontal bone. Six superficial linear incisions ranging from 3 to 6 mm were present on the frontal region, and two additional cuts (2.5–3 mm) were observed on the left parietal bone. No signs of post-traumatic osteomyelitis were detected.

Mechanical fractures of the occipital condyles and damage to the left mastoid process were observed at the base of the individual's skull. The nature of the fractures indicates that they occurred perimortem, at the time of death (Figure 3-3). We have already noted that injuries of this kind have only one explanation, beheading of an upright person (Manchester, 1983). A linear fracture of the left mastoid process on the external surface, along with specific destruction of the occipital condyles, indicates that the blow was delivered from behind, most likely by a right-handed individual. Analysis of the reconstructed trauma has made it possible to reconstruct the circumstances of the individual's killing. It is probable that the fatal

blow was inflicted by a person standing behind the victim. Holding the victim by the hair, the head was severed by the sword with a sharp left swipe.

Table 1: Bioarchaeological characteristics of Individuals 1–3

Category	Individual 1	Individual 2	Individual 3
Sex	Female	Female	Male
Age at death	20–25 years	18–20 years	20–25 years
Preservation/ general description	Incomplete skull; facial skeleton poorly preserved; right facial region largely absent	Cranial vault and mandible preserved; facial skeleton and cranial base absent	
Pathologies/ diseases	Possible facies leprosa (destructive nasal lesions, bone atrophy, marginal pitting); exostosis of external auditory canal; "button" osteoma (left parietal, 12 mm)	No systemic pathology; healed superficial cut marks on frontal bone	Microcephaly; plagiocephaly; facial asymmetry; possible congenital cranial deformities; enamel hypoplasia; maxillary sinusitis; enlarged infraorbital foramen with possible orbital infection
Trauma antemortem/ perimortem	Nasal trauma (left side); perimortem fractures of occipital condyles and mastoid processes — indicative of beheading from behind	Several perimortem cut marks on mandible (right ramus and left basal surface), no healing — lethal sharp-force trauma	Multiple antemortem sharp-force cuts on frontal and left parietal bones; perimortem fractures of occipital condyles and mastoid process — beheading from behind; perimortem trauma at right infraorbital foramen
Taphonomy	Facial region partly destroyed (possible intentional disfigurement or pathological process)	Skull base absent due to taphonomic processes	Skull isolated; associated faunal remains
Interpretation/ context	Beheading, likely from behind by a right-handed individual; possible social stigma and exclusion due to leprosy (fear, myths, ritual component not excluded)	Violent death caused by sharp-force trauma to mandible; no healing indicates immediate lethality	Violent death by beheading; cranial asymmetry congenital; additional antemortem injuries reflect earlier episodes of stress or interpersonal violence

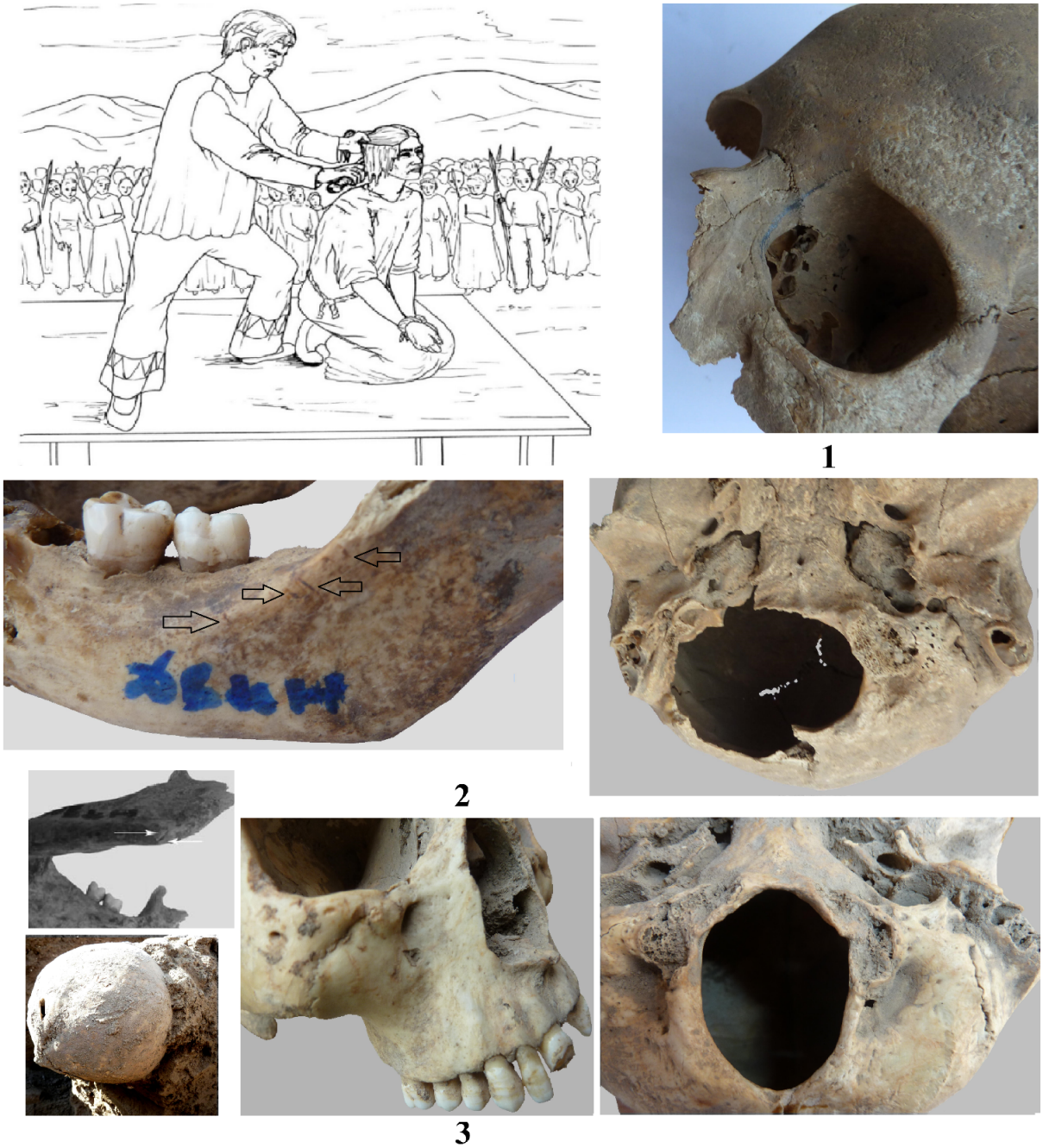

Figure 3: Reconstruction of the execution; **1.** *Individual 1:* fracture in the nasal bones and facies leprosa, mechanical breaks of occipital condyles and damage of the mastoidal; **2.** *Individual 2*: traumatic injury to the mandible; **3.** *Individual 3*: direct traumatic injury in infraorbital foramen, mechanical breaks of occipital condyles and damage of the left mastoidal.

5 Discussion

Zoroastrianism is a religion with a history spanning over 2,500 years — and possibly even more (Boyce, 1987, p. 16). It continues to be practiced today by the Parsees, primarily in the Indian state of Maharashtra (mainly Mumbay) and most of the rest in Gujarat. Parsees also live in certain regions of Iran, notably in the provinces of Kerman and Yazd, and in the capital city of Tehran.

Fire holds a central and multifaceted role in Zoroastrianism. It serves two primary functions:

A. The eternal fire (atash) is sacred and must never be extinguished. It is to be meticulously protected not only from being put out, but also from direct sunlight and exposure to the open air. Even within the temple, the fire is kept in a sheltered area, tended exclusively by a priest who maintains it by adding fuel. High flames are not required; maintaining glowing embers is sufficient.

B. Fire also functions as a medium for conveying prayers to the divine, much like in other religious traditions. It receives ritual offerings such as water, milk, incense, and fragrant or precious woods. Ceremonies may be conducted directly at the eternal flame, at a secondary flame kindled from it, or in an adjacent room where lay worshippers can participate.

This brief and schematic overview is intended to highlight the distinctions within Zoroastrian fire worship — namely, the existence of different types of sacred fire and the corresponding architectural accommodations within temples.

Offerings to fire and water formed the foundation of daily worship rituals, known to the Indo-Aryans as *yajna* and to the Iranians as *yasna* (from the root *yaz-* meaning "to sacrifice, to worship"). These rituals involved libations to fire, often derived from blood sacrifices, which were evidently performed on a regular basis. The Indo-Iranians approached the act of taking animal life with reverent awe and solemnity. They never killed without an accompanying consecratory prayer, which, according to their beliefs, ensured the continuation of the animal's soul.

The awareness of a kinship between humans and animals is reflected in ancient sections of the *Yasna* liturgy: "We pray to our souls and to the souls of domestic animals who nourish us... and to the souls of beneficial wild creatures" (Yasna, 39, p. 1–2). At times, this cult assumed ominous forms. Specifically, human sacrifices were offered to the royal sacred fire of the Sasanians in the temple of Anahita at Istakhr. It should also not be ruled out that there may have been political motives aimed at creating an atmosphere of fear and deterring potential uprisings against the newly established Sasanian administration. During the Parthian period, a child was reportedly sacrificed once a year to the fire deity in a Zoroastrian temple in Adiabene (Lelekov, 1991).

Armenia was under Achaemenid rule and, as an Achaemenid satrapy, was significantly influenced by Persian culture — including, naturally, the impact of Zoroastrianism. During the Seleucid period, the country was divided into several independent principalities whose rulers bore Persian names and paid tribute. Following the Roman victory over the Seleucid army in 190 BCE, Roman influence extended throughout Asia Minor. From that point onward, Armenia functioned as a buffer state between Parthia and Rome, periodically allying itself with one or the other.

In the year 572, dissatisfied with Persian policies, the Armenian nobility and clergy initiated an uprising. The struggle was led by the Armenian nakharar houses of the time, under the leadership of the Mamikonian family and with the support of the Armenian Apostolic Church. The national liberation movement was headed by Vardan Mamikonian the Younger (also known as Vardan the Red) and the Catholicos of All Armenians, Hovhannes II, who gathered an army of 10,000 warriors. In 572, the marzpan Suren (builder of the Sasanid fire temple in Dvin) traveled to Ctesiphon to report the events to the Sasanian authorities, and subsequently returned to Dvin, the capital of Marzpanate Armenia, with a force of 15,000 troops. By that time the number of Armenian rebels had doubled, and they succeeded in defeating the Persian army. Marzpan Suren was killed in his own residence in Dvin, and his severed head was sent to the Byzantine patricius Justinian, who resided in the city of Theodosiopolis (Simocatta, 1996).

The motif of the severed head frequently appears in battle scenes described in the History of Taron (Mamikonyan, 1989, p. 76–78). For instance, Tigran Kamsarakan beheads the Persian Vardukhri and, throwing the head to his servant, says: "Hide it; when we reach Matravan, we shall play ball in front of

Surb Karapet" (The Monastery of Surb Karapet was a major religious and cultural centre in the regions of Taron and Sasun. – Author's note) (Mamikonyan, 1989, p. 107). In another episode, Prince Vahan mocks Persian prisoners by tossing the head of the Persian general Mihran into a sieve, declaring: "When this man entered our land, the armies faced one another and wished to compete. They searched for a ball and could not find one. They did not dare ask the Greeks, for they were mortal enemies. When we looked at our own army, we saw that we, too, had no ball. So we cut off this head and played. But we heard that you have arrived in the city of Bustr from Shahastan, where the land is flat and smooth. We know that you will be skilled at the game. Take your cousin's head, and let it be our ball from generation to generation" (Mamikonyan, 1989, p. 81).

The severed heads found in Dvin are more likely linked to criminal or socio-political events rather than Zoroastrian religious practices. Ritual beheadings were not part of canonical Zoroastrian rites. However, during periods of religious conflict, executions motivated by faith could have taken place. It is quite possible that beheading was used as a means of demonstrating power or instilling fear — not as a religious act, but as a political or religiously-justified action. Beheading could also have been the result of mass executions following uprisings, interethnic clashes, criminal activity, or public punishments. Thus, these findings more likely reflect the complex socio-political environment of the time rather than a religious tradition.

Dvin's strategic location along the Silk Road made it easy for Zoroastrian traders to come in contact with the local population. This geographic and economic position facilitated continuous migratory movements, which can be considered a contributing factor in the transmission and spread of infectious diseases.

All of the individuals examined in this study exhibited pathological signs indicative of infectious conditions, including leprosy and maxillary sinusitis. The individuals under investigation appear to have belonged to a lower social stratum that suffered from a lack of essential nutritional resources. Malnutrition and physical debilitation would have made them particularly vulnerable to disease. No evidence of formal burial practices was identified in relation to these individuals. Attention should also be drawn to the associated faunal remains. The nature and proximity of the animal bones to human crania are unlikely to be coincidental. In the case of the female individuals, the facial bones were either absent or severely damaged. This may reflect the deliberate destruction of facial features in an effort to obliterate individual identity, or alternatively, the result of pathological processes, such as those caused by advanced leprosy.

Throughout history, individuals with pronounced physical disabilities have often been regarded with prejudice — not only because their impairments limited their participation in social life, but also because they evoked a sense of mystical fear among the able-bodied. In medieval culture, the worldview closely intertwined the microcosm (the human being) with the macrocosm of universal existence. Within this rigid conceptual framework, there was little room for those perceived as physically "imperfect" from birth. It is reasonable to assume that disability was interpreted as a deviation from the divine order — that is, from the concept of the human as created in the image and likeness of God. Consequently, individuals with visible impairments were often viewed as incomplete beings, unworthy of attention or inclusion. They could not expect even a neutral attitude from society, as the dominant belief at the time held that blindness, congenital deformities, and other disabilities were either divine punishment for sin or the result of satanic intervention in a person's fate. Such individuals are frequently mentioned in historical documents, literary texts, and legal codes from both antiquity and the medieval period (Malofeev, 2003, p. 66).

During the early Christian period in Armenia, leprosaria (Classical Armenian: borotanotsner) were already in existence (Khorenatsi, 1893, p. 41). In 260 CE, Princess Agvida Salakhuni (wife of the noble Suren Salakhuni) founded what is considered the world's first leprosarium, with a capacity of 35 beds (Vardanyan, 2000, p. 29). Later, in 365 CE, the Council of Ashtishat decreed that leprosaria and hospitals (bzhshkanotsner, in Classical Armenian) be established throughout Armenia. It was also decided that pharmacies and healing institutions be exempt from taxation. Historical sources attest that monasteries began to build charitable hospitals and free "pharmacies for the poor" at an accelerated pace, providing care for the indigent (Buzand, 1987, III, VIII). According to law, Armenian physicians were not permitted to refuse medical assistance — even to the destitute.

Given the presence of such institutions, a question arises: Why was the woman from Dvin executed?

Was her death connected to an infectious disease, such as leprosy? In contrast to Armenia's relatively progressive medical care, lepers in medieval Europe were typically banished from settlements — or, in more extreme cases, killed (Malofeev, 2003, p. 125). Moreover, institutional leprosaria did not appear in Europe until some 300 years later than in Armenia (Vardanyan, 2000, p. 29). During this period, hundreds of thousands of individuals accused of witchcraft or satanic affiliation were executed. What explains this mass hysteria surrounding impurity, sorcery, and the demonic that swept across Europe during the 15^{th} to 17^{th} centuries? It is conceivable that leprosy was perceived not merely as a physical ailment, but as a mark of moral and spiritual corruption. The afflicted body of the leper was interpreted as evidence of inner sin and divine punishment. Notably, so-called "witches' marks" — lesions or discolorations of unknown origin — were commonly cited as proof of a pact with the devil.

In his work on Medieval witch trials, Kantorovich (1990) writes that individuals bearing such marks were often subjected to the "needle test". If a particular area of the skin failed to register pain, it was interpreted as insensitivity to divine judgment — a trait of the damned. Assuming that accounts of these "witches' marks" have a factual basis, one must ask: What were these marks in reality? It is plausible that a significant number of those accused of witchcraft suffered from a common disease. In leprosy, affected skin areas often develop white or reddish patches that become anaesthetic — lacking sensitivity to heat, cold, or pain. In some cases, lepromatous nodules form in the dermis or subcutaneous tissue, which may coalesce into larger conglomerates. Whether inquisitors and judges genuinely believed they were condemning incarnations of evil rather than sick human beings remains an open question. It is worth noting that medieval physicians had a relatively accurate understanding of leprosy and its symptoms (Vardanyan, 2000, pp. 28–29).

Individual 3 from Dvin presents with a microcephalic cranial structure and marked facial asymmetry, characterized by a leftward slant. In the context of the Middle Ages, such physical anomalies were frequently met with societal stigma and harsh treatment. This response was largely rooted in prevailing religious doctrines, pervasive superstition, and the absence of medical knowledge regarding the aetiology of disability. Individuals exhibiting visible physical differences were often perceived as portents of misfortune or ill omens, which frequently resulted in their social exclusion, marginalization, or even persecution.

Despite the scarcity of historical records, it is still possible to attempt a reconstruction of the circumstances surrounding the deaths of these individuals. Persons suffering from infectious diseases or physical disabilities were often treated as a form of "scapegoat", upon whom society projected its fears, sins, and misfortunes. They were suppressed or eliminated because they were perceived as a threat, with society mystically transferring all evil onto them — evil that the collective sought to expel in order to restore order and purity.

6 Conclusions

Human sacrifice was a complex and multifaceted ritual practice found in various ancient societies across the world. Although its forms and meanings differed substantially between cultures, it was generally embedded in broader religious, social, and political systems. In many cases, human sacrifice functioned as a means of communicating with deities, ensuring cosmic order, legitimizing political authority, or marking critical moments of social transformation. Archaeological and textual evidence from the Near East, the Mediterranean, Mesoamerica, and parts of Eurasia indicates that such rituals were often associated with ideas of purification, propitiation, or the renewal of life (Propp, 1998). In some cultures, sacrificial victims were perceived as intermediaries between the human and divine spheres, and their deaths were thought to secure divine favour during warfare, agricultural cycles, or periods of crisis. In other contexts, human sacrifice represented an instrument of social control, reinforcing power hierarchies within stratified communities. Despite their ritual significance, human sacrifices were never merely acts of religious devotion. They were embedded within a broader ideological framework that reflected the values, fears, and worldviews of ancient societies.

The interpretation of these practices requires careful integration of archaeological data, written sources, and anthropological models, allowing modern researchers to understand not only the mechanics of ritual killing, but also the cultural logic that shaped its use and eventual decline. In the context of ancient

Iranian religion, the relationship between human sacrifice and Zoroastrian belief is characterized primarily by rejection. The teachings attributed to Zoroaster (Zarathustra) explicitly emphasize the sanctity of life, the necessity of moral choice, and the importance of maintaining purity in both the physical and spiritual realms. Within this doctrinal framework, the taking of human life for ritual purposes was considered fundamentally incompatible with the principles of asha — truth, order, and righteousness. Historical and textual sources suggest that certain Zoroastrian Iranian tribes may have practiced forms of ritual killing or violent rites associated with warrior cults or funerary customs (Lelekov, 1991). However, Zoroastrian reform introduced a strict moral distinction between legitimate ritual practice and acts that were regarded as demonic or chaotic, associated with druj — falsehood and disorder. Consequently, human sacrifice came to be viewed as a corrupt and impure act, condemned by Zoroastrian religious authorities.

In the Middle Ages, two conceptions of impairment — and, by extension, of illness more broadly — coexisted in a state of ambivalent tension. On the one hand, impairment was frequently interpreted as a consequence of sin; on the other, it was also regarded as a condition necessitating physical healing. A central medieval idea was the perceived deviation of the impaired body from a culturally constructed norm, whereby such a body was viewed as disordered and inherently challenging. In medieval eschatological thought, the impaired body appeared to be denied continuity in the afterlife: Resurrected bodies were not imagined as retaining the physical defects or imperfections they bore in life. Certain categories of medieval historical sources, such as chronicles and historiographical works, often omitted references to individuals with impairments, as such figures were not considered appropriate subjects for narratives focused on the deeds of the powerful and the noble. Moreover, the belief that physical impairments and infectious diseases were manifestations of divine judgment for moral transgressions was deeply entrenched in the cultural and religious consciousness of Dvin during this period. However, this perception seems paradoxical given that Armenia was the first country to establish leprosaria, suggesting a more compassionate and institutional approach to the care of individuals afflicted with such conditions.

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Impact of Immigration on Demography, Human Capital and Segregation in Sweden, Norway, Denmark and Finland from 2026 to 2100

Kyösti Tarvainen *

Abstract

Immigration into Nordic countries significantly impacts their population composition, which in this study includes the following cultural subpopulations: the native population, the Western foreign-origin population, the Muslim population and the non-Western, non-Muslim foreign-origin population. If current immigration and birth rate trends continue, the native populations of Sweden, Norway, Denmark and Finland are projected to become minorities within this century. Differences in culture and human capital among these subpopulations have led to segregation in residential areas, schools, employment and marriages in these countries, which were once among the most homogeneous and egalitarian societies. Human capital is measured by the Human Capital Index (HCI). Because HCI correlates strongly with intelligence quotient (IQ), we focus on IQ, as there is considerably more data available on IQ than on HCI. Cultural differences among subpopulations served as the initial cause of residential segregation. This segregation has been reinforced by IQ gaps of 10-20 points between natives and certain immigrant groups. One reason is that differences in children's cognitive abilities are immediately reflected in teaching difficulties. This reinforces residential segregation, as natives and successful immigrants tend to avoid schools with many low-performing immigrant students. IQ differences also contribute to wage gaps, which deepen residential segregation due to varying living costs across neighbourhoods. Disparities in living standards and the low average IQ of some immigrants make them vulnerable to higher crime rates, which further reinforce residential segregation, as natives and successful immigrants tend to avoid many immigrant neighbourhoods for safety reasons. The average IQs of these Nordic countries, which were previously around 100, are projected to decline to 90–94 by the end of the century due to demographic shifts. Additionally, the article discusses the political measures proposed to dismantle segregation and stop the demographic changes.

Keywords: Immigration, Nordic countries, Demography, Human capital, IQ, Segregation, Remigration

1 Introduction

Immigration to Nordic countries is leading to unprecedented demographic changes. We will first describe these changes by dividing the population into four culturally defined subpopulations and producing population projections for each of them.

The article then discusses the segregation of society in residential areas, schools, employment and marriages. We primarily concentrate on Sweden, which has the largest population with a foreign background and where many books and reports are written about segregation. Iceland had to be excluded from the following discussions because there was insufficient data to establish demographic models using the cohort-component method; however, Statistics Iceland provides much information on the country's immigrant population.

The cultural differences among ethnic and religious groups naturally led to the segregation of residential areas, as people tend to prefer living with those similar to themselves. In Sweden, this tendency is often explained by a phrase that, when translated literally, sounds like: 'Similar children play best'. The corresponding English proverb is 'Birds of a feather flock together'. In social science, this tendency is referred to as homophily ("Homophily", 2025).

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Segregation has been further reinforced by differences in human capital. We focus on its most important component, general intelligence, which is measured by the intelligence quotient (IQ). Basic information on IQ is provided. It is explained how to estimate the average IQs of the four subpopulations and project each country's average IQ using demographic forecasts. Drawing on general IQ research and Swedish reports on the social consequences of immigration, it is explained how IQ differences contribute to societal segregation.

Besides the cultural and IQ differences among subpopulations, there are also variations in personality traits, which are more difficult to define and measure. Therefore, they are not discussed in this article, although these traits relate to the core characteristics and lifestyles of ethnic groups. Daun (1996) has written an in-depth, research-based study on Swedish mentality. There is a noticeable similarity in the mentality and attitudes of all Nordic nations, which is reflected, for example, in the fact that since 1954, Nordic citizens have been free to move to and reside in other Nordic countries. Finally, policy measures proposed to reduce segregation and stop demographic changes are discussed.

2 Demographic changes caused by immigration

2.1 Demographic projections for subpopulations up to 2100

Coleman (2006) categorised the rapid demographic changes caused by immigration as the third demographic transition. He estimated that if the trends continue, Sweden will have a majority of foreign-origin population by the end of the century.

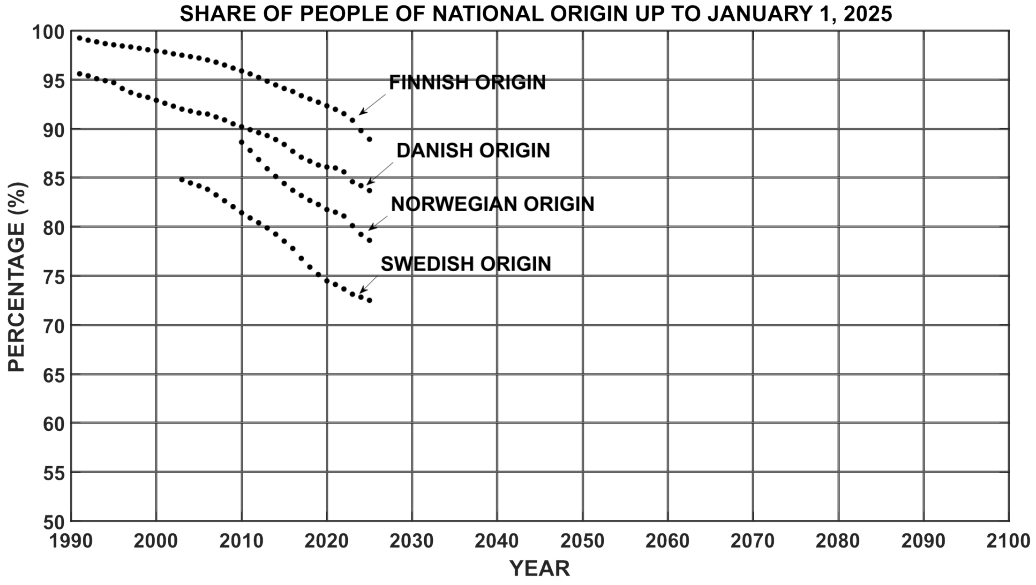

Figure 1: Historical share of people of national origin in four Nordic countries.

The data is directly obtained from the Nordic statistical centres regarding the proportions of the population by national origin (Statistics Denmark, 2025; Statistics Finland, 2025; Statistics Norway, 2025; Statistics Sweden, 2025). According to the common main principle of the Nordic statistical centres, an individual is of national origin if the individual and at least one parent is born in the country. The trends in Figure 1 suggest that Nordic people of national origin will become minorities during this century if immigration continues at the current rate.

We delineate demographic changes caused by immigration using three previously applied subpopulation partitions: the national-origin/foreign-origin division used by all Nordic statistical centres (cf. Figure 1), the Western/non-Western partition employed by Statistics Denmark and the Muslim/non-Muslim classification

considered by the Pew Research Center (2015, 2017). Thus, we project the demographic development of the following subpopulations: (1) the native population, (2) the Western foreign-background population, (3) the Muslim population, and (4) the remaining group, or the non-Western, non-Muslim foreign-background population. In this model, the native population includes also those non-natives who marry a native, as these foreign spouses slowly alter the native population.

This cultural division is essentially the same as the country division used in Denmark by the Finansministeriet (2021), where the country group MENAPT comprises 24 Muslim-majority countries, corresponding to the Muslim subpopulation in the present study.

Table 1 presents subpopulation projections for Sweden using the cohort-component method[1] (Preston et al., 2001). The forecasts mainly assume the continuation of 2024 figures: a net immigration of 22,050 foreign-origin people (excluding Ukrainian refugees); among these immigrants, Westerners' share is 48% and Muslims' share is 23%. The total fertility rate (TFR) is 1.47 for non-Muslims and 2.7 for Muslims, but the latter is assumed to fall to 2.1 by 2100.

It is assumed that the TFR for non-Muslims remains stable, as the decrease in their TFR seems to have levelled off, and monetary support for childbirth doesn't work in general (Kirkegaard, 2025). The TFR among Muslim immigrants has also been decreasing in Western countries. However, encouragement from imams and Muslim politicians to halt or even reverse this decline might be more effective than efforts by Western politicians. For example, President Erdogan has called on Muslim emigrants in Europe to have five children to help establish a new Europe (AP, 2017). In any case, demographic outcomes are unlikely to be significantly affected by potential future changes in Muslims' TFR. For instance, even if we, in line with Pew Research Center (2017, Appendix A), assume that Muslims' TFR will match that of native populations by 2100, the proportion of Nordic native populations will only increase by 1-2 percentage points by that time. The details of the considered subpopulations and the demographic model are provided (Tarvainen, 2018, 2025).

Table 1: The sizes of four Swedish subpopulations from 2015 to 2100.

Year (Jan 1)	Natives	Western foreign-background people	Muslims	Non-Western, non-Muslim foreign-background people
2015	7,655,000	786,000	535,000	772,000
2020	7,687,000	881,000	853,000	1,035,000
2030	7,523,000	1,008,000	1,110,000	1,210,000
2040	7,278,000	1,082,000	1,296,000	1,278,000
2050	6,995,000	1,161,000	1,496,000	1,359,000
2060	6,597,000	1,233,000	1,688,000	1,429,000
2070	6,149,000	1,295,000	1,836,000	1,447,000
2080	5,680,000	1,345,000	1,945,000	1,423,000
2090	5,113,000	1,405,000	2,031,000	1,395,000
2100	4,551,000	1,461,000	2,115,000	1,378,000

[1] The cohort-component method is a straightforward arithmetic procedure. It starts with the age distribution of the considered subpopulation at the beginning of a given year. If, for example, there are 40,000 people aged 30 at that time, then at the beginning of the following year there will be 40,000 people aged 31, from which the number of people who have died during the year is subtracted and new 31-year-old immigrants are added. A special case is 0-year-olds, whose number at the beginning of the year is calculated by adding up the children born to women aged 15 to 49 during the previous year. The needed historical data is obtained from the tables of statistical centers.

Population development is quite similar in Denmark, Norway and Finland. Table 2 presents the projected subpopulation shares for 2100 across the four Nordic countries (Tarvainen, 2025). The figures in Table 2 illustrate how continued immigration would lead to unprecedented demographic shifts.

Table 2: Projected subpopulation shares in 2100

	Natives	Western foreign-background people	Muslims	Non-Western, non-Muslim foreign-background people
Sweden	48%	16%	22%	14%
Norway	49%	24%	18%	9%
Denmark	49%	18%	13%	20%
Finland	35%	8%	26%	31%

2.2 Demographic changes initiate segregation

In this section, we explain how demographic changes have led to societal segregation. We reference books and studies that offer a more detailed account of these social issues. Our focus is on Sweden, which is the Nordic country with the largest immigrant population both in absolute terms and as a proportion of the national population.

The most comprehensive research-based summary of the socioeconomic effects of immigration on Sweden is the book by Sanandaji (2020), *Mass Challenge—The Socioeconomic Impact of Migration to a Scandinavian Welfare State*. Sanandaji arrived in Sweden as a 9-year-old Kurdish refugee, enabling him to offer insights into immigration issues from the perspective of immigrants. He often emphasises the importance of human capital but does not analyse its variation between population groups quantitatively, as will be done below.

A central theme of Sanandaji's book is residential segregation, which has led to the formation of parallel societies. Residential segregation began when many immigrants naturally settled in areas where earlier immigrants of the same ethnic, religious or cultural background had already established themselves and could provide support to the newcomers. Many refugees and migrants, particularly those from non-European backgrounds, continue to reside in the neighbourhood where they first arrived (Vogiazides, 2020). As the number of immigrants in a municipality increased, native Swedes began to move out or avoid the area for cultural and other reasons, as discussed below in relation to human capital.

The research by Aldén et al. (2018) examined when this phenomenon, often called 'white flight', started in the twelve largest Swedish municipalities. It was observed in nine municipalities, where it began once the proportion of non-European immigrants exceeded an average of 4.1% (range: 1.3%-19.0%). This segregation of residential areas has been sociologically analysed in a report by Lilja (2015), titled 'The best for my child'. A Swedish parliament member recounts the historical development of the country's immigration policy that led to segregation and the creation of parallel societies (Eriksson, 2023).

The city of Boras examined the differences between Muslim and traditional Swedish populations, noting, for example, that the Muslim community has its own jurisprudence (Borås Stad, 2019). In areas with a substantial Muslim population, a new cultural trait in Sweden is that Muslims predominantly feel a sense of belonging to their clan rather than to Swedish society as a whole. Muslims are generally organised into clans (a form of tribe) in their home countries, and they mostly uphold the clan system as immigrants in Western countries.

An in-depth analysis of clans and Islamist separatism is provided in the book by Rojas and Hannah (2023). The Clapham Institute's report by Pasbakhsh et al. (2022) systematically compares Swedish and Islamic cultures and values. These differences have also led to some confrontations (e.g., ("2022 Sweden riots", 2023)). A French security report warns of the spread of the radical Muslim Brotherhood ideology in Sweden (Le Monde, 2025). Egyptson (2023) has authored a doctoral thesis on the influence of the Muslim

Brotherhood in Sweden. The Muslim population in traditionally Lutheran countries has sparked numerous debates, especially in Sweden, where the Muslim community now accounts for 9% (Tarvainen, 2025). In accordance with the principle of religious freedom, official attitudes towards Lutheranism and Islam do not differ.

A notable study on the cultural implications of demographic development in Sweden is the study by Jonsson et al. (2022) on integration. Its subtitle summarises the development: 'A multicultural generation is growing up'. Until the mid-1970s, most immigrants to Sweden were European workers. Because their culture closely resembles that of Sweden, these Europeans integrated into Swedish society and often assimilated into the native Swedish population through marriage. However, the situation changed when more immigrants arrived from outside Europe. Many of these immigrants hold a high regard for their own culture. For example, in the integration study by Jonsson et al. (2022, Figure 6.24), 57% of 14-year-old respondents with backgrounds in Asia and 79% of those with backgrounds in Muslim countries supported the statement: 'Immigrants should do everything they can to preserve their culture and traditions.'

A sign of cultural shifts in Sweden is that, according to the reading study of PIRLS (PIRLS, 2021, Figure 3.6), only 53% of children aged 10 in Sweden always use Swedish at home. Around 150 different mother tongues are spoken in Sweden. In some regions, Swedish is a minority language, which limits opportunities to learn it.

During the 2022 parliamentary election campaign, politicians extensively evaluated Sweden's development. For instance, politicians who had migrated as refugees expressed their gratitude and appreciation for multicultural Sweden. However, many politicians emphasised societal issues. The Social Democrat Prime Minister, Magdalena Andersson, stated that the country has failed to integrate many immigrants, leading to a nation of parallel societies living in different realities (Guardian, 2022).

Also, the new centre-right Swedish government highlighted integration problems in its statement (Government of Sweden, 2022) in October 2022: 'Immigration to Sweden has been unsustainable. The result has been dangerous social exclusion among many people born in other countries, but also among children and young people born here in Sweden. The integration problems now affect all of society in the form of housing segregation and overcrowding, unemployment and benefit dependence, health problems and poor school outcomes, crime and vulnerability to crime'.

The new Swedish government decided to restrict immigration in October 2022 (Tidöavtalet, 2022). However, in Figure 1, there is only a slight change in the slope of the curve for the Swedish-origin population in recent years. Denmark has already implemented over 100 immigration restrictions for cultural reasons in the last 20 years (Reynié, 2023). Nevertheless, Figure 1 shows that the Danish native population is declining at roughly the same rate as other Nordic native populations. However, Table 2 indicates that Denmark has managed the cultural goal better than other Nordic countries regarding Muslims, who, in the World Cultural Map (WVS, 2023), are located in the opposite corner to the Nordic countries (Figure 2).

Next, we extend the previous analysis by examining the effects of gaps in human capital between natives and certain immigrant groups. Roughly half of the segregation and other immigration issues are explained by cultural and personality differences, while the other half stems from differences in human capital. The high human capital of some immigrants benefits public finances; however, overall, current immigration in Nordic countries is detrimental to public finances, as shown by Tarvainen (2025) and its references.

3 Differences in human capital reinforce segregation

3.1 On the relationship between the Human Capital Index (HCI) and intelligence quotient (IQ)

Immigration to Nordic countries brings in people whose cultures differ substantially from those of traditional Nordic societies. Additionally, there are differences in human capital, a crucial factor in the industrial and post-industrial Nordic countries. 'Human capital includes knowledge, talents, skills, abilities, experience, intelligence, training, judgment and wisdom possessed individually and collectively' (Britannica, 2025).

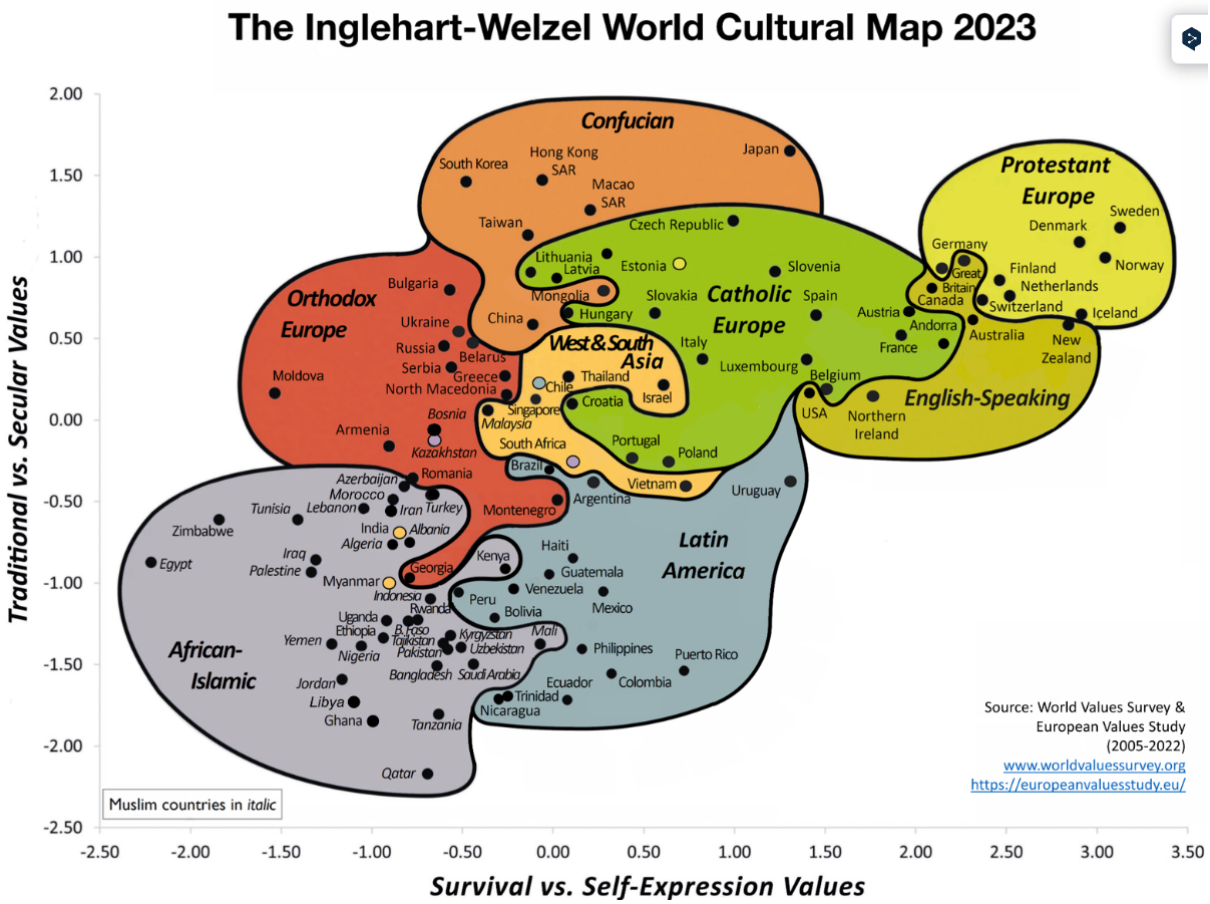

Figure 2: World cultural map (WVS, 2023).

Hafer and Hafer (2018) established a strong correlation of $r = .69$ between the Human Capital Index (HCI) values of countries (World Economic Forum, 2015) and their national IQs (Lynn & Vanhanen, 2012). The national IQ of a country refers to the estimated average IQ within that country.

Similarly, Figure 3 shows a strong correlation between HCI and IQ in Finland across the considered four subpopulations (correlation coefficient of .98, $p = .02$). The same pattern is observed in the other Nordic countries. In Figure 3, the average IQ scores for each subpopulation are calculated by weighting the national IQs of the background countries (Lynn & Becker, 2019) based on the number of individuals with backgrounds from those countries. In Section 3.3, it is demonstrated that the average IQ of a Nordic subpopulation of foreign origin can be estimated by using the national IQ scores of the background countries. Likewise, the HCI scores of the subpopulations are determined using the HCIs of the background countries. The most recent HCI scores defined by the World Bank (2025) are used.

Hafer and Hafer (2018, Figure 2) also observed that gross domestic product per capita correlates almost as well with the average IQ as it does with HCI. Similarly, Figure 4 illustrates the strong economic impact of average IQ on the mean lifetime net contribution to public finances in Denmark across the four subpopulations. The contribution of the natives is normalised to zero for comparison purposes. The correlation coefficient is 0.97 with a p-value of .03; details are provided by Tarvainen (2025). A corresponding correlation is observed also when, instead of subpopulations, different background countries are considered in Denmark and Finland (Kirkegaard, 2017).

Additionally, Hafer and Hafer (2018, Table 2) observed that IQ has a positive correlation with many components of HCI. They concluded that all their findings suggest that both HCI and the country's average IQ are viable statistical measures of human capital.

Accordingly, regarding human capital, we focus on its core element, cognitive abilities, and its measure,

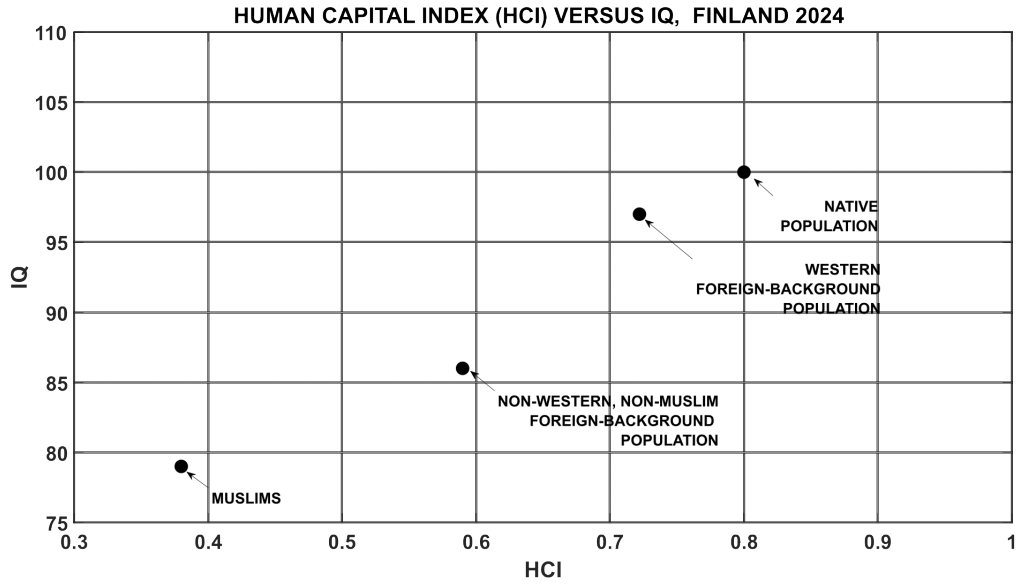

Figure 3: Relationship between the Human Capital Index (HCI) and intelligence quotient (IQ) in four Finnish subpopulations.

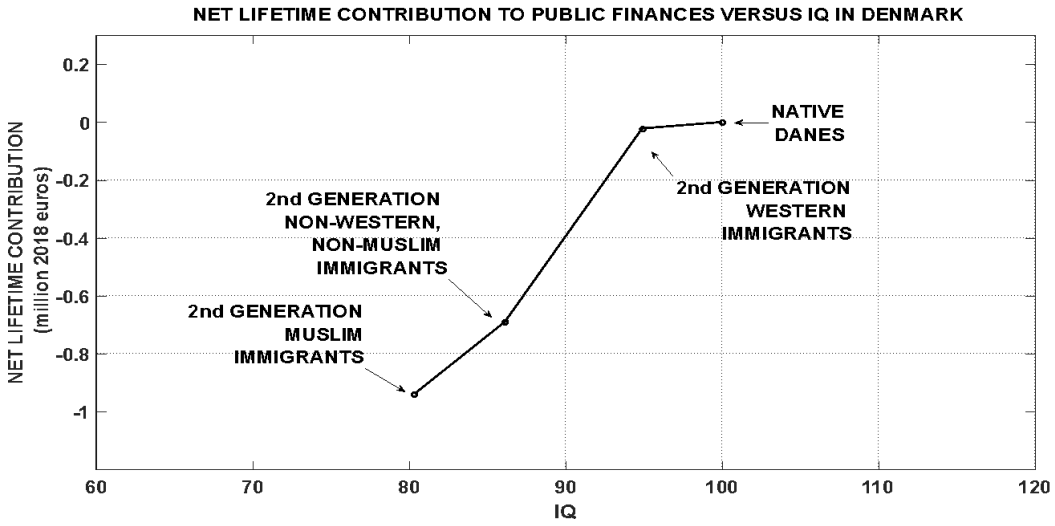

Figure 4: Lifetime net contribution to the public finances as a function of the subpopulation's average IQ in Denmark.

IQ, which has been studied for over a hundred years. IQ is generally regarded by intelligence researchers as a very accurate measure of the construct of general intelligence, with substantial explanatory power for understanding human behaviour and life.

3.2 On the general understanding of IQ

The term 'human capital' relating to countries is widely used with only some criticism ("Human capital", 2025). However, national IQs, the average IQ values of countries, are a taboo subject in the mass media. This is strange because of ample evidence that national IQ and the results of international scholastic assessments are highly correlated at about $r = .9$ (Rindermann, 2018, Figure 4.2). This means that at the aggregate level, these kinds of tests measure the same thing. Therefore, it is odd that national IQ scores are a taboo subject, although the PISA program is celebrated as a major achievement.

In contrast, when it comes to individuals' IQ, the media generally has no problem discussing IQ. For example, *Helsingin Sanomat*, the largest Finnish newspaper, has covered individual IQs in 48 articles over the past five years. Nine articles mention an individual's measured or estimated IQ, while 18 articles refer to specific studies on individuals' IQ. Furthermore, many people are familiar with the international organisation Mensa, which requires its members to have a high IQ.

Nevertheless, even on an individual level, many misconceptions exist about the definition, measurement and importance of IQ. Warne (2020) discusses 35 misconceptions and explains, based on scientific research, why they are myths.

Given the thousands of scientific books, surveys and articles on IQ, recent authoritative overviews of scientific research are valuable. Haier et al. (2024) authored the 400-page summary of all areas of intelligence studies, *The Science of Human Intelligence*. The book by Rindermann (2018), *Cognitive Capitalism*, is a 550-page overview focusing on scientific studies of the differences in average cognitive abilities among nations.

While the term IQ is familiar to most people, the fact that its average value varies across countries is not widely recognised. *Helsingin Sanomat* has never addressed this issue. Nordic politicians can discuss demographic changes and cultural differences, especially in relation to Islam. However, the author has never heard a Nordic politician mention the varying average IQs of countries or immigration groups, even though politicians could learn about these matters from scientific literature and Nordic social media.

Politicians and journalists could also look at the PISA scores. The PISA organisers write: 'PISA goes beyond assessing whether students can reproduce what they have learned in school. To do well in PISA, students have to be able to extrapolate from what they know, think across the boundaries of subject-matter disciplines, apply their knowledge creatively in novel situations and demonstrate effective learning strategies' (OECD, 2019). Here, one can note that the abilities listed by the OECD are a perfect definition of intelligence. It means the PISA tests also are intelligence tests, and they work well, as noted above.

Perhaps the mass media's reluctance to mention the average IQs of countries and population groups stems from underestimating the public: It is feared that if a low average IQ is reported, people might believe all members of that group share this low IQ. However, everyone within a group can see that there is considerable variation in cognitive abilities: Some individuals are more intelligent than others. One possible way to prevent the feared misconception could be to present data showing the IQ range that covers 95% of a country's population. For example, we might state that the IQ of the British is 100 $\pm$ 30 points, whereas in another country, the national IQ might be, for instance, 90 $\pm$ 30 points.

As explained below, the differences in average IQs between subpopulations are sufficiently significant and damaging to Nordic societies that it would be irresponsible not to treat them scientifically. When formulating immigration policies, it is essential to ensure they do not create significant IQ disparities within the country. As early as 1869, Francis Galton discussed the impact of immigrants' abilities on a country's success (Lynn, 2011, p. 280).

Based on flawed principles of equality, some individuals who are not intelligence experts deny the existence of IQ differences across countries and groups. They wish to believe that all people not only share

the same human value but are fundamentally alike in human traits. The following points demonstrate that, by ignoring the findings of scientific IQ research, they are doing a disservice to many people

1. IQ studies show that consanguineous marriages (marrying cousins) tend to lower the average IQ of the children (Rindermann, 2018, pp. 313–316). Therefore, such marriages should be discouraged. Since they are common among some immigrant groups, Norway banned them in 2024. The Swedish government is planning a similar ban.

2. In countries with low average IQ, every effort should be made to address physical and biological environmental factors (for example, lead, fluoride, pregnancy conditions, breastfeeding and nutrition) that can affect IQ (Rindermann, 2018, Section 3.4.4), and effective support should be provided at various levels of ability (Rindermann, 2013). Even if a person's IQ is low, they can still learn useful skills in an appropriate learning environment.

3. In countries with a low average IQ, the selection of government officials should also include cognitive tests, such as those already used in ancient China and currently employed by the EU (European Personnel Selection Office, 2025, see 'logical reasoning tests').

4. In countries with notable IQ differences, achievement tests or IQ tests can be used to allocate students to different classes or schools, thereby ensuring that there are no large IQ disparities within a class, which can hinder learning.

The average IQ of countries and subpopulations is a crucial issue because IQ, on average, is highly heritable. The heritability effect has been estimated at 80% among adults when all genes are fully expressed (Haier et al., 2024, Section 6.3). Besides immigration, a significant factor that can gradually influence a country's or subpopulation's average IQ is whether individuals with high or low IQ have more children (Dutton & Woodley of Menie, 2018).

3.3 Assessing the average IQ of Nordic subpopulations

In the following IQ forecasts, it is estimated that the average IQ of individuals immigrating to a Nordic country is roughly equivalent to the average IQ in their country of origin. However, this does not hold true for all countries receiving immigrants (Rindermann, 2018, Table 10.2). For instance, English-speaking countries attract talented immigrants from across the globe who speak English. The following list provides some examples supporting the mentioned estimation.

- In Denmark, Kirkegaard (2013) observed that the IQ data from the military draft for the foreign-background population practically give the same IQs as determined based on the average IQs of background countries.

- Rindermann and Thompson (2016, p. 75) obtained an IQ estimate of 93.75 for Sweden's foreign-background students born between 1985 and 1997, based on PISA, TIMMS and PIRLS results. Statistics Sweden does not publish information on individuals of foreign background born during these years. However, Statistics Sweden earlier provided information on the countries of origin of people living in Sweden in 2000. Using the national IQs of these background countries, the IQ of foreign-born residents in Sweden in 2000 was estimated to be 92. This figure is close to the mentioned value of 93.75 for foreign-background students born between 1985 and 1997.

- The Swedish Integration Study (Jonsson et al., 2022, p. 264) reports on a test involving young people aged 14. The test consisted of two parts: an intelligence test and a language test, which have also been proven to be effective measures of intelligence. The median score was 38 for young people of Swedish origin and 33 for those from 'Generation 2', who were born in Sweden with both parents born abroad. Because the test's standard deviation is 8 points, the difference between the scores is 0.63 standard deviations. On the other hand, when the corresponding difference is calculated based on the IQs of the background countries (cf. Table 3), the difference is approximately the same, 0.71 standard deviations.

- In the initial tests of the Finnish pre-primary education experiment (Sarvimäki et al., 2023), children aged 5 to 6 years whose parents were born in Finland scored 0.80 standard deviations higher on an arithmetic test than those whose parents were born abroad (p. 59 in the report). In a literacy test, the corresponding difference was 0.77 standard deviations (p. 51 in the report). The difference between the average IQs of native Finns and people in the children's background countries is nearly the same, 0.74 standard deviations.

In these studies, we first pay attention to the details regarding the first- and second-generation immigrants. At the end of Section 3.4, the Danish school results suggest that second- and third-generation immigrants have the same average IQ. However, many studies suggest that the average IQ of first-generation immigrants is somewhat lower than that of the second generation. For example, in the 2022 PISA mathematics test (PISA, 2023), this score difference was 18.75 PISA points on average across the four Nordic countries, which corresponds to $18.75/6.5 = 2.9$ IQ points.

The main reason for this is clearly that first-generation immigrants have not learned the host country's language from birth. Therefore, they encounter difficulties in learning mathematics and answering PISA questions, which results in a lower IQ estimate than their actual IQ. However, first-generation immigrants encounter similar challenges in their lives as in their studies and the PISA test. Therefore, we can regard their IQ estimates based on PISA or other tests as effective IQ scores.

Regarding the proportions of first- and second-generation immigrants in the four studies mentioned above, we have the following information. In the second study, the shares of first- and second-generation immigrants were not detailed. The third and fourth studies consider second-generation immigrants. According to the author of the first study, this group is most likely primarily composed of second-generation immigrants.

Therefore, in these four studies, second-generation immigrants are probably overrepresented since their share of the Nordic immigrant population was only 22% in 2019 (Mixed Migration Centre, 2024). This means that these four studies possibly slightly (by 1-2 IQ points) overestimate the current immigrant population's average IQ. However, as the proportion of second-generation immigrants increases, this potential overestimation decreases.

Overall, the available tests indicate that the average IQ of the immigrant population in Nordic countries is approximately the same as in their countries of origin. As mentioned, the situation is not the same in all countries. For example, in the UK, PISA results and school grades indicate that immigrants' average IQ is approximately the same as that of native Brits.

As a side note, we would like to mention that PISA reports and other studies often reveal a lack of knowledge about intelligence studies when attempting to explain the poor results of some immigrant students by referring to their parents' low socioeconomic status. However, IQ studies demonstrate a strong link between IQ and socioeconomic status (Haier et al., 2024, Figure 7.6). This implies that the main reason why some immigrants with parents of low socioeconomic status perform poorly in school is their inherited low IQ.

Lynn and Vanhanen (2002) wrote the first book to list the average IQs of the world's countries. They later updated the list (Lynn & Vanhanen, 2012). In the present study, we have utilised the national IQ estimates from Lynn and Becker's book (Lynn & Becker, 2019, Table 16, second-to-last column).

The lists of national IQs have been criticised because over 30 countries still lack psychometric IQ tests or international student assessments, which can be used to estimate IQ. The average IQ of these countries is estimated as the mean of the measured average IQs of the adjacent countries, as the national IQs of neighboring countries correlate. This estimation introduces inaccuracies, but fortunately, individuals from these countries who lack their own IQ measurements make up only 0.8%-1.4% of the total foreign-background population in the Nordic countries. Therefore, these countries do not significantly impact the accuracy of the current study.

Some individuals have questioned the accuracy of the low national IQs for sub-Saharan countries. However, more recent studies (Warne, 2022) support these low IQ estimates. In Nordic countries, the largest sub-Saharan immigrant group is Somalis. For example, comparisons of different immigrant groups' educational attainment (Statistics Sweden, 2022, Diagram 6) and net contributions to public finances

(Kirkegaard, 2017, Figure 3) confirm that this sub-Saharan group's average IQ is somewhat lower than that of all Muslims.

Naturally, there are some inaccuracies in national IQ estimates, as there are in all measurements of human traits. In this study, these inaccuracies are not critical for two reasons. Firstly, we do not consider the average IQs of singular foreign countries, but rather the average IQs of subpopulations, which are weighted averages of the IQs from over 40 background countries, like those in Figures 2 and 3. In these weighted averages, the inaccuracies in the national IQs of individual countries tend to be reduced and partly cancel each other out. Secondly, some Nordic subpopulations exhibit such large differences in average IQ that measurement errors cannot account for them.

Nyborg (2011) was the first researcher to predict changes in the average IQ of a Nordic country due to immigration. We develop Nyborg's methodology and provide IQ predictions for the four Nordic countries. We first examine the current IQ values, which serve as the basis for these projections.

3.4 Assessing the average IQs of subpopulations in 2025

Lynn and Becker (2019) provide the following national IQs for Nordic countries: Finland, 101.2; Sweden, 97.0; Norway, 97.1; and Denmark, 97.8. The influence of a significant immigrant population is evident in the last three values. Consequently, we use a common rounded IQ estimate of 100 for the native populations of the Nordic countries. We determine the average IQs of the foreign-background subpopulations as of January 1, 2025, by weighting the IQs of the background countries (Lynn & Becker, 2019) according to the number of individuals from the background country. Table 3 summarises the obtained average IQs of the subpopulations.

Table 3: Average IQs of subpopulations on January 1, 2025, based on Lynn and Becker's 2019 book. For the rounded IQ values of natives, see the main text.

Subpopulation	Finland	Sweden	Norway	Denmark
Natives	100	100	100	100
Western people of foreign origin	97.0	96.8	95.5	95.0
Muslims	79.1	79.3	78.1	80.3
Non-Western, non-Muslim people	86.6	88.8	86.6	86.1

The Muslim IQs in Table 3 are close to the average IQ of 81 for all Muslim countries, as determined by Templer (2010). The notable IQ differences among subpopulations are immediately visible in schools. In Sweden, there are 'adapted primary schools' for pupils with intellectual disabilities (Skolverket, 2025). In line with Table 3, pupils with a foreign background are over-represented, making up 45% compared to 27% in standard primary schools. Similarly, the decline in Swedish pupils' PISA test scores is partly due to the lower average scores of pupils from foreign backgrounds (Skolverket, 2023, Chapter 6).

In Danish primary schools, it has been recorded that 3rd-generation non-Western immigrants perform at the same level as 2nd-generation non-Western immigrants, a level that is notably lower than that of students of Danish origin (Statistics Denmark, 2024, Figure 8.5). Non-Western boys' average grades across all compulsory examinations for the school leaving certificate in 2022-2023 were 5.5 for 3rd-generation immigrants and 5.7 for 2nd-generation, whereas it was 6.7 for boys of Danish origin. The corresponding figures for girls of non-Western origin were 6.3 (third generation), 6.2 (second generation) and 7.4 (Danish origin).

We can understand the grade improvement that happens from first to second generation by the fact that first-generation immigrants have not learned Danish from birth. The lack of improvement between the second and third generations can be understood by thinking that they have reached their genetic IQ limitations: Academic performance in primary education correlates strongly ($r = .58$) with IQ (Haier et al., 2024, Table 8.1), and both have high heritability.

3.5 Projections of the country's average IQ

When the population composition changes due to immigration, the country's average IQ also changes because of variations in the average IQs of the subpopulations (Table 3). In IQ projections, we utilise the demographic forecasts discussed earlier, which indicate the direction in which we are currently heading.

Regarding the future average IQs of the subpopulations, we estimate they will remain consistent with those shown in Table 3. This is because immigrants often relocate to countries where their compatriots and relatives live, and individuals from foreign backgrounds living in Nordic countries frequently import foreign spouses from the same ethnic or cultural background.

There is also some mixing of subpopulations through marriages, but this only slightly alters the average IQs of the subpopulations. The reason is that such marriages are relatively rare among all marriages; for example, the probability that a native marries a non-native is 6%-8% in Nordic countries (Tarvainen, 2018). Furthermore, spouses' IQs tend to be strongly correlated (Plomin & Deary, 2015). Statistics Sweden previously published data on the birth countries of foreign spouses of individuals born in Sweden. Assuming that these foreign spouses have the same average IQs as those in their country of origin, it was estimated that mixed marriages involving Swedish natives lowered the natives' average IQ by only 0.3 points in 2021. A similar, relatively small IQ effect is also likely for mixed marriages within the Western population for the same two reasons.

Overall, a reasonable estimate is that the future average IQs of the immigrant subpopulations will reflect the IQ levels of the subpopulations listed in Table 3. However, future shifts in a subpopulation's immigrant composition could slightly alter its average IQ. For example, Sweden and Finland have recently increased the minimum wage for workers from outside the EU, which, to some extent, may raise the average IQ of these work-related immigrants and the overall average IQ of their subpopulation.

The average IQs could also change in the countries of origin. However, here we observe notable historical stability (Rindermann, 2018, Chapter 4). According to the IQ development scenarios presented by Rindermann (2018, Chapter 13) for different regions up to 2100, it is unlikely that IQ-related problems will be significantly alleviated in Nordic countries. For example, in extreme scenarios speculating on the Flynn effect (Haier et al., 2024, pp. 379–381) in developing countries, the above IQ gap of 20 points between the natives and Muslims (in Rindermann's book, 'people living in North Africa and the Middle East') would still be 10 points in 2100.

In light of the previous discussion, we estimate, for example, Sweden's average IQ in 2100 as the mean of the current average IQs of the subpopulations (Table 3), weighted by the sizes of these subpopulations in 2100 (Table 1, here unrounded):

$(100 \times 4551292 + 96.8 \times 1460673 + 79.3 \times 2115002 + 88.8 \times 1378492)/(4551292 + 1460673 + 2115002 + 1378492) = 93.3$

That is, Sweden's projected average IQ is 93 in 2100. We similarly determine the forecasted IQ values for other years and Nordic countries, yielding the results in Figure 5.

According to Figure 5, Finland's average IQ is projected to fall below 90 in the early years of the next century. In the empirical study by Vanhanen (2009), it was observed that maintaining democracy becomes challenging when a country's average IQ drops below 90. Based on studies about the effects of average IQ (Lynn & Vanhanen, 2012), we can expect negative impacts on various aspects of life in the Nordic countries due to a decline in IQ.

In IQ studies, alongside the average IQ of a country, the average IQ of the most intelligent individuals, such as the top 5% of the population, is also considered (Rindermann, 2018, Section 8.1). It has a significant impact, for example, on economic and scientific development. Due to native and Western populations, the average intelligence of the top 5% in Nordic countries is very high (cf. Table 3) and remains so over a long period. For instance, Sweden ranks second, after Switzerland, among the 133 economies featured in the Global Innovation Index 2024 (WIPO, 2025). However, the high-IQ individuals in Nordic countries appear to have no significant influence on segregation and other issues caused by immigration.

Figure 5 shows that immigration significantly lowers the average IQ in Nordic countries compared to China, which has a national IQ estimate of 104. We cannot fully understand China's rapid economic and

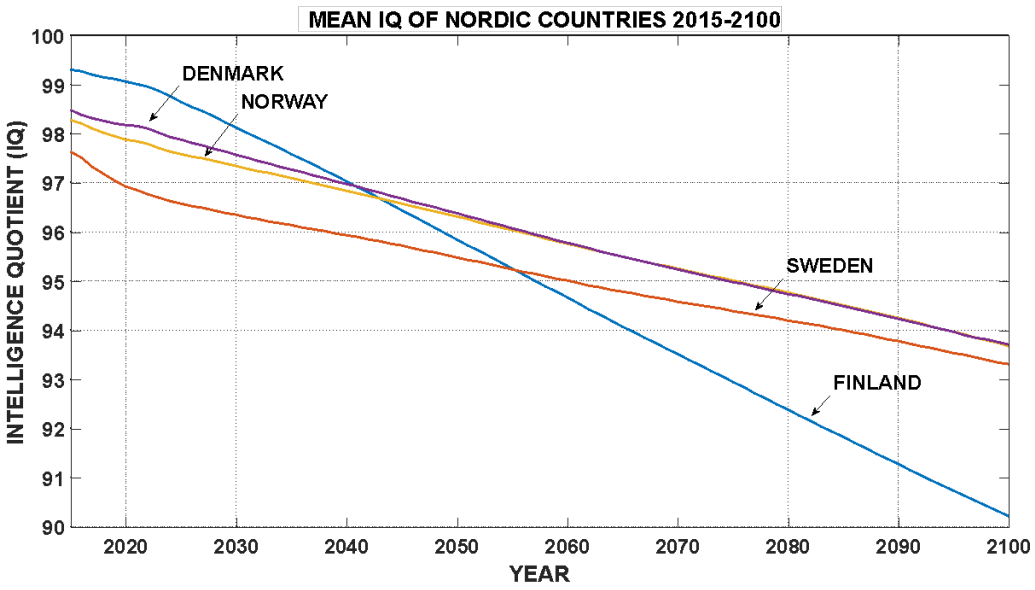

Figure 5: Nordic countries' average IQs 2015–2100.

technological progress without considering its high national IQ. In China, supercomputers are searching for intelligence genes to improve the country's IQ through embryo selection (Miller, 2023).

3.6 IQ differences among subpopulations reinforce segregation

Richard Herrnstein was among the first researchers to propose that IQ differences — stemming from genetic inheritance and closely linked to earnings — contribute to hereditary societal inequalities (Herrnstein, 1971a, 1971b). He contended that American society was dividing into two strata due to assortative mating: (1) the wealthy and more intelligent individuals, and (2) the less wealthy and less intelligent individuals.

According to Plomin and Deary (2015), assortative mating is stronger for intelligence (spouse correlation $r = .40$) than for other behavioural traits, such as personality and psychopathology ($r = .10$), or physical traits, like height and weight ($r = .20$). However, let us note that assortative mating for some traits, such as political values ($r = .58$) and religiosity ($r = 0.57$), is even stronger (Horwitz & Keller, 2022). Various reasons besides heritable cognitive abilities have been suggested for the stratification of Western societies. However, cognitive abilities are now regarded as the most significant factor (Marks, 2022; Marks & O'Connell, 2023).

In Nordic countries, social stratification has long existed, resulting in some segregation in residential areas between the wealthy and the less affluent. However, due to shared ethnicity, language, religion and culture, the poor and rich have been able to live near each other (Boverket, 2023, the figure on p. 14). Today, immigration contributes to the growth of large-scale, segregated residential areas.

As discussed earlier, residential segregation initially emerged naturally due to cultural differences. Significant IQ disparities reinforce this separation and the formation of parallel communities for the following reasons. First, teaching students with significant differences in cognitive abilities is very demanding, and school achievement suffers (Lindblad et al., 2018). The growth of foreign-background populations (cf. Table 1) suggests that if immigration continues at the current rate, teaching difficulties will become even more severe.

It has been observed that allocating additional teaching resources to schools with a high proportion of immigrant children does not significantly improve academic outcomes (Hellberg, 2021). In several experiments, immigrant students have been relocated to schools with fewer immigrant children; however, this change has not led to a notable improvement in their academic performance (Arneback et al., 2022).

The key cause of these educational shortcomings is clearly the relatively low average IQ among some immigrant groups (Table 3).

Due to poor study results, parents of native and successful immigrant students avoid schools with many immigrant students and move to areas with fewer people from foreign backgrounds (Lilja, 2015). As a result, issues related to significant IQ differences in schools contribute to the segregation of residential areas and schools.

Besides learning difficulties, IQ studies indicate that IQ differences cause variations in employment and wages, as also implied by Figure 4. Wage variations related to IQ further contribute to residential segregation, as house prices and rents differ greatly across neighbourhoods.

Furthermore, IQ studies indicate that lower IQ contributes to the higher crime rates among some immigrant groups. Accordingly, the head of a compulsory youth centre for young offenders told Eriksson (2023, pp. 45–46) that many young offenders are intellectually deficient and do not always grasp the consequences of their actions. The Swedish Crime Prevention Council Bra reports on suspected criminal offences among individuals with both domestic and foreign backgrounds (Brottsförebyggande rådet, 2021). Kirkegaard (2021) provides an illustrative English summary of the crime rates reported for individuals with a foreign background in the Bra study.

Organised crime led by individuals of foreign origin has increased significantly (Häggström & Brun, 2019; Polismyndigheten, 2023). In the high-trust Swedish society, criminals of foreign origin have managed to infiltrate numerous social institutions, gaining influence and income in businesses, banks, healthcare, local government, insurance companies, public authorities, the non-profit sector, the police and the judicial system (Wierup, 2024). The high crime rate in certain areas with a large number of individuals of foreign background is an additional factor that causes natives and successful immigrants to avoid these places.

In the worst case, cultural and cognitive differences lead to areas dominated by immigrants where school results are poor, many individuals do not speak Swedish well, unemployment is high, average earnings are low and living conditions are substandard, with significant crime. Esaiasson (2020) wrote an illuminating social report based on hundreds of interviews in two such neighbourhoods, which are often called 'vulnerable areas' or 'suburbs' in Sweden.

The Swedish police have classified 59 residential areas with low socioeconomic status, where criminals affect the local community, as vulnerable (Polisen, 2023). Out of their total population of approximately 550,000 individuals, 74% are of foreign origin. The report (Järvaveckan Research, 2019) offers insights into socioeconomic issues in vulnerable areas, the countries of origin of residents, and the concentration of people from specific origin countries. The report (Borås Stad, 2019) describes the problems within a single vulnerable area in the city of Boras.

Segregation within the Nordic countries also involves the segregation of workplaces and marriages. The report by Skans and Åslund (2010) is a comprehensive study of ethnic segregation in Sweden's residential areas, workplaces, schools and marriages from 1985 to 2006. Segregation in marriage is described using comparisons, as in the following example. A person born in Turkey is more than 70% likely to marry someone born in Turkey, whereas the probability of such a marriage would be only 2% if marriages were random.

A more recent 2022 report by Delegation mot segregation (2022) employs five distinct socioeconomic area types to illustrate socioeconomic residential segregation. The report indicates a sharp rise in segregation between 1990 and 2020. In Sweden, there is also an unknown number of undocumented, illegal immigrants working underground. The book by Alexandrova-Zorina (2023) describes the Russian-speaking shadow society.

4 Proposed strategies to dismantle segregation

Denmark is the Nordic country that has taken the most decisive action to dismantle and prevent the emergence of parallel societies. The 2018 'ghetto' legislation (Time, 2018) has been complemented by the 2021 parliamentary agreement and the government plan 'Mixed Neighbourhoods - The Next Step in the Fight against Parallel Societies' (Indenrigs- og Boligministeriet, 2021). This new plan covers 58

neighbourhoods at risk of becoming 'vulnerable' due to high crime rates, low educational levels, low income, high unemployment or a significant proportion of people with a non-Western background.

The goal is that in neighbourhoods with more than 1,000 residents, the percentage of individuals of non-Western origin should not surpass 30% by 2030. This will be accomplished by limiting movement into these neighbourhoods and renewing the housing stock by demolishing old buildings and constructing new ones. Those relying on subsidies might be restricted from accessing council housing and encouraged to apply for subsidised housing available in the private market. Critics worry that the government's plans will simply lead to the spread of segregation from highly segregated areas to other regions.

The Swedish Social Democratic Party also advocates for mixing different housing types to break down segregation (Socialdemokraterna, 2025). These plans involve constructing affordable homes for immigrants within neighbourhoods where natives reside. Consequently, the Social Democrats' proposals have met significant opposition — many natives now consider segregation the better option.

In fact, a small-scale mixing experiment is already underway in a district of Malmo, where people from various backgrounds live in different types of housing and share common gathering spaces. Jensen and Righard (2022) conducted a follow-up study on this experiment. The article by Jando (2023) describes this follow-up study and concludes that 'mixing people from different backgrounds is not enough to create cohesion and integration.' The other author of the follow-up study states that 'people still tend to associate with those who are most like them.'

5 Discussion

Most Nordic politicians and citizens initially viewed work-related immigration and refugees in a positive light. This attitude arose from the fact that Nordic countries have traditionally been culturally homogeneous, high-trust societies with a limited understanding of other peoples' core characteristics and cultures.

Additionally, the tolerant zeitgeist of the post-World War II era concealed the recognition of differences between cultures and peoples, leading most Nordic politicians and citizens to generally trust and welcome people from around the world — unlike, for example, Hungary, which had extensive historical experience, even after WW II, with foreign cultural influence and recognised the risks associated with immigration from different cultures. And they knew what had happened to multi-ethnic Austria-Hungary.

An astonishing demonstration of the Nordic attitudes and kindness towards all peoples is that, in 1975, Sweden's Parliament unanimously agreed that Sweden is a multicultural society. The parliament decided that 'Immigrants and minorities should be allowed to choose to what extent they want to merge into a Swedish cultural identity or maintain and develop their original identity' (Sveriges Riksdag, 1975).

Furthermore, there has been a lack of awareness about rapid demographic changes driven by even modest annual immigration. For centuries, Nordic countries have benefited from European immigrants who established new businesses and factories, introduced new knowledge, skills and technology. However, immigration from very different cultures has led to segregation and demographic shifts, as described above, which threaten the very existence of the Nordic nations.

Currently, a major motive for immigration in Nordic countries is the shortage of workers in specific professions, which stems from the declining number of working-age natives due to low fertility rates among the native population. However, the study by Lianos et al. (2023), which covers 19 countries, shows that even when the population declines and gross domestic product (GDP) decreases, the standard of living (as measured by GDP per capita) tends to improve. Therefore, to counteract the harmful demographic shifts also linked to some work-related immigration, Nordic countries need to develop strategies to adapt to declining populations until fertility rates increase.

In political discussions evaluating the effects of migration in these once homogeneous and egalitarian Nordic societies, the segregation discussed above has attracted the most attention. The demographic effects of immigration have received significantly less attention. However, as Figure 1 and Tables 1 and 2 demonstrate, the most serious long-term consequence of immigration for native populations is that they are becoming minorities if current trends persist. Furthermore, the influence of Islam continues to grow

steadily; for instance, the continuation of Table 2 suggests that by 2110, there will be as many Muslims as native-born people in Finland.

As shown by the example of the hundred immigration restrictions in Denmark mentioned above, and based on demographic analyses in general, immigration restrictions alone cannot halt or reverse this demographic change. Therefore, to preserve the Nordic cultures, it is also necessary for a part of the foreign-origin population to relocate to their countries of origin.

This remigration would align with the UN Declaration on the Rights of Indigenous Peoples ("Declaration on the Rights of Indigenous Peoples", 2025), as the immigrant population is now leading the Nordic indigenous peoples into minority status (Figure 1 and Table 2). Discussion of remigration has recently begun in Nordic countries, with the first detailed possible remigration policies outlined in an article by Tarvainen (2024) for the Nordic countries and by Ahl et al. (2025) for Sweden.

In Denmark and Sweden, financial support is already available for individuals who voluntarily relocate to their country of origin, but few have taken up this opportunity. Therefore, mandatory emigration is also necessary to preserve Nordic cultures and the rights of indigenous peoples.

Discussions on remigration policies should recognise that the Nordic countries are responsible for accepting immigrants from diverse cultural backgrounds. Therefore, the Nordic countries have a duty to provide generous support to those who voluntarily or mandatorily move to their countries of origin — not only for travel expenses but also for establishing new lives there. Potential economic support is discussed in the article by Tarvainen (2021).

As mentioned above, the culture and mentality of Nordic nations are similar. On the World Cultural Map (Figure 2), all Nordic countries are grouped together in the upper right corner. In many international comparisons, all Nordic countries rank highly. To mark the 100th anniversary of Finland's independence, Statistics Finland (2018) compiled a list of 89 international country comparisons of positive indicators in which Finland is among the top countries, alongside other Nordic states. The Nordic countries are thus unique and respected worldwide as exemplary models of society. Protecting the distinctiveness of the Nordic nations is as important as that of China and Japan, which were wise enough not to accept immigration from two hundred countries.

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Inclusive Development Programmes for Reducing Youth Unemployment in Rural Municipalities

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Abstract

Redressing the social and economic ills bedevilling rural municipalities has not been an easy task for the South African government. Although programmes such as the Youth Employment Service (YES) were channelled into local government, youth unemployment is still a daunting challenge that leads to youth poverty and marginalisation. This study explores the level of inclusivity and accessibility of existing youth development programmes by the youths in the Eastern Cape Province. Exploring key issues such as youth exclusion and barriers to participation, this study sheds light on the complex dynamics underlying youth unemployment in the Eastern Cape. The study utilised a systematic literature review analysis. Articles for review were accessed from the Web of Science, Google Scholar, and Science Direct databases. The review indicated numerous challenges of rural development programmes in reducing youth unemployment. These include a lack of inclusivity in empowerment programmes, negative attitudes and minimal participation of youth, limited funding to support youth start-ups and other entrepreneurship ventures, including minimal stakeholder intervention in transforming young lives. Further, we found that some youths had little desire to participate in youth development programmes due to poor information dissemination owing to poor access to modern digital technologies, leading to their exclusion from the programmes. The study contributes to the body of knowledge on youth development in rural municipalities. This is one of the areas of concern for efforts to reduce unemployment in South African rural provinces in line with the National Development Plan Vision 2030 in South Africa.

Keywords: Youth unemployment, Inclusive youth development programs, Socio-economic disparities, Marginalised communities

1 Introduction

Youth development is a topical agenda of many public administrations across the globe as governments and international organisations increasingly prioritise policies and initiatives aimed at fostering youth employment, skills development, and social inclusion (Canton, 2021; Tshilunda et al., 2022; World Bank Group, 2023). Nevertheless, empowering youth from rural backgrounds has been a complex task associated with existing socioeconomic ills, limited skills and, in most cases, an unconducive economic environment that offers limited employment opportunities for the youth (Latiff et al., 2023). This phenomenon has also impacted various African central and local governments, where rural youth face significant employment challenges (African Development Bank, 2016; Dasgupta, 2022). As a result, many young people become discouraged job seekers and lose trust in their governments as unemployment continues to rise with little hope of labour market absorption (Fox & Filmer, 2019). In this study, the term 'youth' refers to individuals aged 15 to 34, consistent with the definition used by the National Youth Policy of South Africa (2015).

Redressing the social and economic ills bedevilling rural municipalities has not been an easy task for the South African government. Although programmes such as the Youth Employment Service (YES) were channelled into local government, youth unemployment is still a daunting challenge that triggers youth poverty and marginalisation. As of the third quarter of 2024, South Africa's official unemployment rate was 32.1%, with youth unemployment (ages 15-24) at 45.5% (South African Government, 2024). In the Eastern

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Cape, the situation is more severe, with an overall unemployment rate of 39.7% and youth unemployment (ages 15-34) at 52.4% in the second quarter of 2023 (Eastern Cape Socio-Economic Consultative Council, 2023). These statistics indicate that South Africa continues to face high unemployment rates among young people, especially in rural areas where job opportunities are often limited.

Notwithstanding several development endeavours, the problem persists and impacts the socio-economic environment of these regions (Dlamini, 2020). Over the years, several youth development programmes have been implemented to tackle this problem and enable young individuals to join the dynamic and somewhat stringent labour force. The programmes include several interventions, such as vocational training initiatives, entrepreneurial programmes, job placement services, skills development workshops, and mentorship schemes (Sinclair et al., 2021). Nevertheless, these initiatives encounter significant gaps and limitations, such as a lack of alignment with local economic demands, limited availability of resources and support services, regulatory constraints, and barriers to employment (Mohammed-Shuker & Hashim-Sadik, 2024).

As observed by Lange et al. (2020), many vocational training programmes do not equip participants with the skills required by the labour market and fail to address transportation obstacles. Similarly, entrepreneurship initiatives face challenges in accessing financing and market networks (Sambo, 2016; Van-Rhyn, 2023). Job placement services and skills development workshops often fail to address the structural barriers that hinder success while providing training that may not be relevant to current market demands (Botha et al., 2023). Similarly, mentorship programmes may have limited impact and reach, especially in rural areas (Keeler et al., 2018). As a result, there has been a growing concern about the effectiveness and inclusivity of these initiatives, as they have failed to adequately address the complex challenges of youth unemployment in rural areas. This discourse highlights the significance of inclusivity in development programmes, acknowledging the necessity of customising interventions to address the specific challenges encountered by youth in rural municipalities (Accord, 2020; Geza et al., 2022; Hlungwani, 2020; Udeh et al., 2023). However, preliminary assessments such as those by Mazwi (2020) and the National Youth Development Agency (2020) indicate that current initiatives frequently do not effectively reach marginalised youth populations in these regions. The issue is worsened by the absence of targeted interventions, resource limitations, and policy implementation challenges.

Fragmentation and lack of coordination among stakeholders such as local municipalities, national departments (e.g., Department of Employment and Labour, Department of Higher Education and Training), development agencies like the National Youth Development Agency (NYDA), and civil society organisations hinders the scalability and effectiveness of interventions, leading to the perpetuation of socio-economic inequalities in rural areas (Mhlongo, 2016). Considering this context, this paper evaluates the level of inclusivity in development programmes that focus on addressing youth unemployment in the Alfred Nzo District Municipality. Inclusivity is a central issue in these programmes, as many youths, particularly those from marginalised communities, are not being reached effectively. The specific objectives of this study are to:

- *Assess the extent to which existing youth development programmes are inclusive and accessible to marginalised youth in the Alfred Nzo District Municipality;*
- *Identify the key barriers that hinder youth participation in these development programmes; and*
- *Explore targeted strategies and policy interventions that can enhance inclusivity and improve the effectiveness of youth development initiatives.*

By addressing these gaps, the paper provides insights and recommendations to enhance the effectiveness of youth development programmes in rural municipalities, ultimately contributing to the broader objective of reducing youth unemployment in South Africa's rural areas. The study seeks to influence policy and practice in the broader area of youth empowerment in public administration while advocating for a sustainable economic and social development model for curbing youth marginalisation in rural municipalities of South Africa. The paper is structured as follows: It begins with an overview of the theoretical framework underpinning the study, namely Human Capital Theory. This is followed by a literature review that examines

the various youth development programmes relevant to rural municipalities. The methodology section outlines the systematic literature review approach employed. The discussion section presents the key findings on the barriers to inclusivity in youth development programmes within the Alfred Nzo District Municipality. Finally, the paper concludes with recommendations aimed at enhancing the effectiveness and inclusivity of such programmes in rural South Africa.

2 Theoretical framework: Human Capital Theory

The notion of human capital highlights the need to invest in education and skills to enhance future career prospects. Early childhood and youth development are essential for creating human capital (Abbas et al., 2022). Within educational organisations, youth communities are seen as crucial catalysts for human capital development. Their primary objective is to execute efficient strategies for youth policy and socio-economic advancement (White, 2021). According to Abbas et al. (2022), Human Capital Theory highlights the need to foster youth development to achieve long-term benefits, promote economic growth, and build social capital. Investing in the abilities and talents of young people at an early stage is essential for achieving success in the future. Thus, investing in youth development and education aligns with the human capital theory, which seeks to nurture skilled individuals for future economic production and societal well-being. Within the framework of youth development programmes, this theory posits that providing young individuals with pertinent skills and information could boost their potential for securing employment and improving their economic opportunities (Almendarez, 2011). These programmes seek to tackle unemployment by enhancing the human capital of young people, making them more appealing to potential employers.

3 Literature review

This section discusses the various types of youth development programmes that can be used to attain inclusive youth development in rural municipalities.

3.1 Technical and vocational education and training initiatives

Vocational training initiatives aim to provide young individuals with the necessary skills and qualifications to enter the workforce or pursue careers in various trades and industries (Udeh et al., 2023). These programmes frequently provide practical training, apprenticeships, and certification in various fields, including plumbing, carpentry, electrical work, and automotive repair (Ismail & Mujuru, 2020). Although vocational training initiatives have succeeded in equipping certain youth with practical skills and enhancing their employability, they are not without limitations. A study conducted by Msibi (2021) revealed that the skills training provided by technical and vocational education and training (TVET) institutes does not meet the necessary standards and lacks alignment with the demands of the job market. In addition, it is worth noting that these institutions frequently encounter issues with inadequate resources, infrastructure, and the recruitment of qualified staff (Andreoni, 2018; Leyaro & Joseph, 2019). Literature indicates that TVET and apprenticeships are limited, making them inaccessible to a wide range of individuals (Filmer & Fox, 2014; Sorensen et al., 2017). Furthermore, Adams et al. (2013) and Sorensen et al. (2017) indicate that individuals from disadvantaged backgrounds or with limited educational attainment are less inclined to pursue vocational education and training (TVET) or engage in informal apprenticeships. Workplace-based learning opportunities are more abundant in urban areas, whereas young individuals in rural areas primarily depend on agricultural work (Ayele et al., 2018). In their study, Cuaulte-Segovia and Costa-Checa (2021) highlight the potential challenges vocational training programmes face in keeping up with technological advancements and changing industry trends. These challenges may hinder the programmes' ability to adequately prepare young individuals for the demands of the contemporary workforce.

3.2 Job placement services

Job placement services strive to connect young individuals with employment opportunities through job matching, résumé support, interview training, and networking assistance (NYDA, 2020). These services facilitate smoother transitions into the workforce by bridging the gap between job seekers and employers (Eseadi, 2024). While such services have yielded some success in placing youth into jobs, their overall effectiveness remains limited, particularly in rural municipalities. As Mazwi (2020) observes, the scarcity of employment opportunities in rural regions, especially within low-demand or seasonal sectors, undermines the potential impact of these services. This limitation suggests that job placement alone cannot resolve the structural employment challenges faced by rural youth. Instead, such initiatives need to be integrated into broader development strategies that consider local labour market realities and the persistent barriers to sustainable employment.

3.3 Skills development workshops

Skills development workshops provide young individuals with opportunities to acquire a broad range of soft skills, technical competencies, and personal development attributes essential for workplace success (Ishak et al., 2023). These workshops often cover areas such as communication, teamwork, problem-solving, time management and financial literacy, all of which are critical for improving employability (Ramos-Monge et al., 2023). While the potential benefits of such programmes are widely acknowledged, particularly in enhancing youth confidence and self-esteem, there are notable limitations in their implementation. Habiyaremye et al. (2022) highlight that many of these initiatives in rural South Africa suffer from poor sustainability, primarily due to inadequate follow-up mechanisms and reinforcement activities. Without ongoing support, the practical application of acquired skills becomes difficult, ultimately limiting the long-term impact of these interventions on youth livelihoods.

3.4 Mentorship schemes

Mentorship schemes connect young individuals with experienced professionals or community leaders who offer guidance, advice, and support as they navigate their educational and career paths (Dube & Nicholson, 2018). Mentorship relationships are beneficial for young individuals, as they provide opportunities to develop networks, gain valuable insights into various career options, and enhance confidence in their abilities (St-Jean & Audet, 2012). A study conducted by Martin et al. (2021) revealed that mentorship programmes in rural municipalities face challenges due to the scarcity of mentors, especially in specific fields or industries. A study by Garringer et al. (2017) revealed that mentoring in rural communities faces a significant obstacle in terms of funding for programme implementation and sustainability. The budget allocated for rural mentoring programmes is considerably lower than that of urban mentoring programmes. The study revealed that many rural mentoring programmes face difficulties in providing services due to geographic isolation. These challenges include transportation issues, limited mentoring activity options, and fundraising obstacles, all hindering their efforts to reach more young people (Garringer et al., 2017). In addition, several challenges need to be addressed. These include limited access to services and resources, difficulties in recruiting and retaining mentors, the need to identify meaningful and diverse mentor-mentee activities, transportation challenges due to the vastness of rural communities and the distance between mentors and mentees, as well as financial constraints (Aschenbrener & Edwards, 2023).

3.5 Entrepreneurship programs

Entrepreneurship programmes are designed to cultivate entrepreneurial skills and inspire young individuals to pursue self-employment or establish their ventures. These initiatives typically include training in business planning, financial management, marketing and networking, along with access to vital resources such as financing and mentorship support (Cho, 2015; Galvao et al., 2020). While these programmes hold considerable potential to empower youth and drive local economic development, their effectiveness, particularly in rural

settings, is often constrained. Agemas and Wondimagegnhu (2020) highlight that limited access to financing and markets, coupled with regulatory barriers, poses significant challenges to entrepreneurship in rural areas. In many cases, restricted credit access prevents young people from translating entrepreneurial training into viable business ventures. These limitations suggest that although entrepreneurship programmes offer a promising avenue for addressing youth unemployment, their impact remains uneven and highly dependent on contextual enablers that are frequently lacking in rural municipalities.

4 State of inclusivity in rural youth development programmes: Case of Alfred Nzo District Municipality

This section discusses factors affecting levels of inclusivity in rural youth development programmes based on Alfred Nzo District in the Eastern Cape as a case study.

4.1 Access and participation

Youth development programmes are designed not only to foster skill development and entrepreneurship but also to promote gender equality and facilitate active youth participation in decision-making processes. However, research consistently highlights several barriers that hinder the participation of specific demographic groups, particularly in rural contexts. These barriers include limited access to education and training opportunities, inadequate transportation infrastructure, and cultural or societal norms that discourage youth engagement, especially among women and marginalised communities (Alla-Mensah et al., 2021; Şerban & Brazienė, 2021; Tele, 2017). Digital exclusion poses another significant challenge, as many young people lack reliable internet access or digital devices, which are increasingly essential for participating in modern development initiatives (Escamilla & Lonean, 2023). Addressing these barriers requires coordinated action from both state and non-state actors to improve access to digital tools, data, and skills. As Şerban and Brazienė (2021) argue, ensuring equitable access to these resources is critical to enabling all youth, regardless of location or background, to benefit meaningfully from development programmes.

4.2 Tailored interventions

Tailoring development programmes to the specific needs and conditions of diverse youth populations is essential for achieving genuine inclusion. Research shows that generic, one-size-fits-all approaches often fail to address the nuanced challenges faced by young people, particularly those in rural settings such as the Alfred Nzo District Municipality (Braithwaite, 2020). This underscores the importance of integrating local context into both policy design and implementation. Geza et al. (2022) argue that considering the socio-economic and geographic realities of youth during policy formulation ensures not only the relevance of interventions but also their feasibility across varied contexts. In rural municipalities, this contextualisation is particularly vital to linking youth meaningfully with employment opportunities that align with their circumstances and aspirations. Without such targeted strategies, development initiatives risk excluding those who are most in need of support (Wilkinson et al., 2017).

4.3 Inadequate information dissemination

A significant gap in youth development programmes is the ineffective dissemination of information, particularly concerning business education and access to market networks. Many young individuals lack adequate knowledge and expertise in critical areas such as entrepreneurship, market analysis, and networking skills essential for capitalising on business and employment opportunities (Ngwenya & Shange, 2019). This gap is especially pronounced in rural areas, where labour market information is either scarce or poorly communicated. Mazwi (2020) notes that limited access to timely and relevant information disproportionately affects vulnerable youth who often lack the networks necessary to learn about available opportunities. The

consequence is a deepening of existing inequalities, where the most marginalised are least equipped to engage in local economic development.

Demographic factors further complicate the dissemination of information. Youth living in remote or isolated regions frequently face restricted access to communication infrastructure (Metelerkamp et al., 2019). Others may lack strong social networks or ties with individuals who can facilitate access to useful information (Kgopolo et al., 2020). Digital exclusion caused by poor internet connectivity or low digital literacy also remains a critical barrier (Matli & Ngoepe, 2020). These factors collectively contribute to the unequal distribution of information and, by extension, opportunity. Addressing this challenge requires development programmes to adopt inclusive and multi-modal communication strategies that account for linguistic diversity, digital access limitations, and the specific conditions of rural youth populations.

5 Methods

As a method of inquiry to understand the implementation of inclusive development programmes to reduce youth unemployment in rural municipalities, we utilised the systematic literature review analysis based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. Utilising the PRISMA in this study enabled the researchers to obtain critical and detailed information from peer-reviewed quantitative and qualitative material on rural youth and unemployment issues, which was critical for completing this study. Further, using PRISMA was fundamental in expediting the efficiency of systematic reviews while improving the clarity, transparency, quality and value of the reviewed reports (Liberati et al., 2009).

Drawing from Sohrabi et al. (2021), the PRISMA flow diagram was revised in 2020 to propose the five phases to adopt when conducting a systematic literature review. These include:

- *Problem formulation*
- *Literature search*
- *Evaluation of data*
- *Analysis*
- *Presentation and analysis of results.*

The researcher adopted these searches: youth development programmes, youth marginalisation, and youth poverty, to improve credibility while avoiding duplication of research articles. To ensure relevance and further enhance credibility, articles that follow up and evaluate programs over a period of at least 5 years were used. To obtain data for this study, the researchers solicited data from three main databases, Web of Science, Google Scholar and Science Direct, to yield 135 relevant results. To further explore issues affecting rural youth in South Africa, Google Scholar was consulted to yield 20 results on academic literature on the subject. This grey literature on youth empowerment, youth development programmes and youth poverty was consulted to provide distinct perspectives on the topic, while enriching the study with recent data on inclusivity in rural development programmes and analysing government publications to examine some of the challenges affecting rural municipalities' efforts to render youth development services in South Africa. To include relevant peer-reviewed articles on the topic, the researchers in the inclusion criteria looked at the scholarly nature and availability of full text. Only articles written in the English language and less than five years old were included. All articles that were irrelevant to this topic were excluded. The keywords used include rural youth, empowerment programmes, youth social cohesion and youth development.

The PRISMA diagram in Figure 1 indicates the process of preparing the article and subsequent appraisal and synthesis.

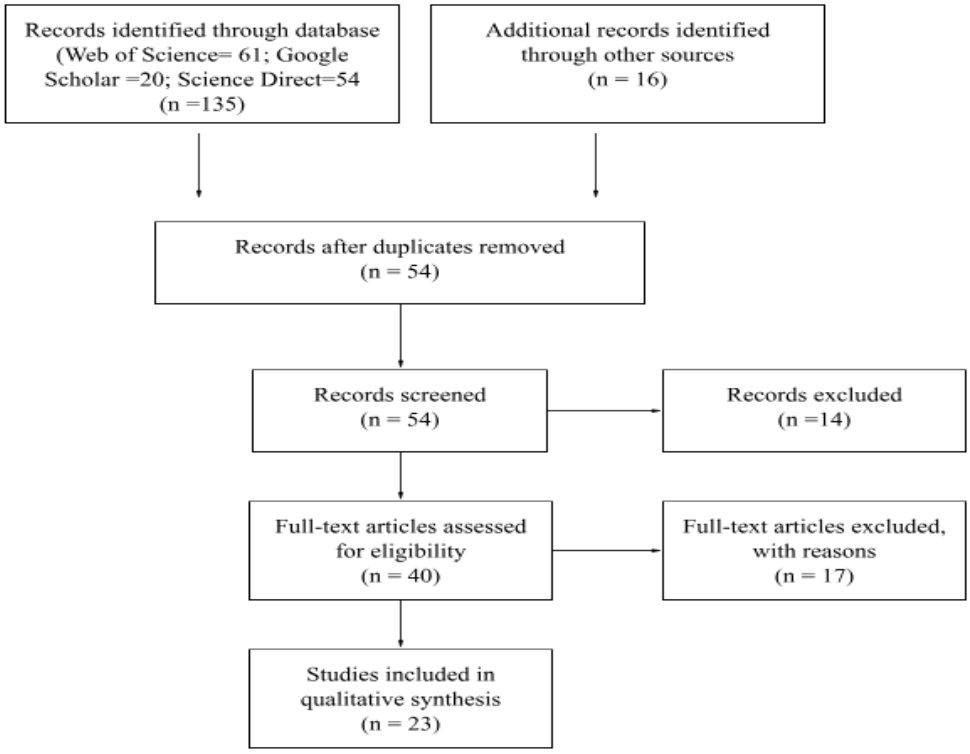

Figure 1: PRISMA flow diagram

6 Findings and Discussion

This section presents findings focusing on the institutional constraints facing rural municipalities in ensuring inclusivity in development programmes targeting youth unemployment.

6.1 Resource allocation

The analysis of documents revealed that the effective functioning of local government institutions is highly dependent on human and financial resources to drive reforms while upholding key service delivery imperatives such as accountability and transparency. Despite the equitable share provided by the national government to local municipalities annually, Shava (2020) argues that it is not enough to cushion rural municipalities from unprecedented shocks and to meet the diversified needs of rural citizens. Insufficient funding was noted from the systematic review as a major obstacle to achieving inclusivity in youth development programmes. While rural youth include able-bodied and also disabled youth, funding for development programmes for such diverse segments is often not available. This is a gap that a stakeholder intervention can fill to address local government limitations.

In the rural Eastern Cape, Alfred Nzo District Municipality is a typical example of local government frequently encountering financial limitations that hinder the effective implementation of youth development programmes (Buntu & Lehmann, 2015). These observations resonate with research conducted by Alexander et al. (2023), where several youth-led organisations face challenges in securing adequate funding and resources to offer essential support, including career exploration opportunities for young individuals who are out of school or unemployed. Consequently, sufficient funding for interventions targeting marginalised youth populations or offering specialised support services is not readily available. Geza et al. (2022) argue that the current financial limitation undermines the programme's effectiveness, diminishes the quality of

services, and restricts the scope and influence of interventions. To tackle this challenge, the South African national government needs to allocate more funds towards youth development programmes, taking into consideration that rurality is often associated with marginalisation and deprivation. This observation was echoed by Ezeudu and Umaru (2023), who believe that leveraging access to adequate and timely funding for youth development programmes helps sustain development programmes a step forward in mitigating youth poverty in rural municipalities.

6.2 Capacity constraints

Public institutions in South Africa are scaling down on service delivery due to limited capacity to drive economic, social and policy reforms. Despite a youth looking actively for employment, the analysis of study documents revealed a widening skills mismatch, which exacerbates unemployment and triggers youth frustration with labour market demands. Owing to emigration and high employee turnover, the local government in South Africa is failing to recruit and retain skilled new talent due to low remuneration or the desire of skilled experts to explore greener pastures with more lucrative remuneration, among other benefits. In 2022, a Skills Supply and Demand Report was published in South Africa by the Department of Higher Education and Training. Its findings confirm earlier assertions that an imbalance exists between labour demand and labour supply. These observations help explain the absence of capacity in the local government sphere to spearhead youth development and other local economic development initiatives.

The systematic review of extant literature showed that South African rural municipalities are not immune to the institutional deficiencies engulfing local governments in South Africa, where capacity constraints have undermined most local economic development plans as municipalities struggle to retain skilled personnel. Consequently, brain drain is evident, and many municipalities fall into medium- to high-risk categories, meaning they face severe governance, financial, and service delivery challenges. A study conducted by Shava (2023) highlighted some of the dangers encountered by struggling rural municipalities, including financial mismanagement, inadequate service provision, and an inability to implement development initiatives effectively. These challenges contribute to persistent poverty and deepening socio-economic inequalities, particularly in marginalised rural communities. Another study, conducted by Diraditsile (2022), confirmed that rural municipalities such as Alfred Nzo District Municipality face a significant challenge in effectively designing, implementing, and monitoring development programmes due to constraints in institutional capacity. The ability of rural municipalities to design focused interventions and assess programme outcomes may be impeded by a lack of human resources, technical expertise, and institutional knowledge. In his study, Mazwi (2020) submits that successful project management in rural municipalities is influenced by the quality of the staff and their level of expertise. Based on these assertions, it remains relevant for rural municipalities to attract and retain skilled expertise, which can help in driving change and developing innovative systems and approaches for effective youth development and service provision at large.

6.3 Reinforcing coordination and collaboration

Silo operations are very common in the implementation of youth development programmes in South African rural municipalities. This view is supported by Mangwanya and Shava (2023), who noted that silo-mentality is a scourge emanating from poor intergovernmental relations in local government planning processes. In our analysis of peer-reviewed literature, we discovered that a significant number of rural municipalities struggle to attract investment due to geographical location and poor infrastructure development, among other institutional challenges that scare stakeholders from doing business with local municipalities. Rural youth are most affected by the absence of economic opportunities, which often triggers rural-to-urban migration. This was confirmed by a study conducted by Mubangizi (2019), who noted the effects of rural-urban migration as detrimental to youth livelihoods in South Africa's rural municipalities.

The study conducted by Bhorat et al. (2014) corroborates these observations, stating that fragmentation and lack of coordination among various stakeholders, including government departments and civil society organisations, poses a significant challenge to effectively implementing integrated and holistic youth development strategies in South African rural municipalities. For instance, Mhlongo (2016) states that the

National Youth Development Agency (NYDA) faces challenges in providing services to rural areas due to the lack of commitment from certain municipalities to collaborate with the agency. One possible explanation as suggested by Mazwi (2020) for this phenomenon

is the municipalities' unfavourable financial situation or consolidation with other municipalities. The geographical challenges faced by the NYDA hinder its ability to empower youth in rural areas and townships effectively. While these challenges are rife in rural youth development programmes, Ezeudu and Umaru (2023) believe that efficient collaboration among pertinent stakeholders is crucial for guaranteeing the inclusiveness of development programmes and their accessibility for marginalised young individuals.

6.4 Policy and planning constraints

Compliance and implementation of legal frameworks and statutory policies have bedevilled various bureaucratic institutions globally. This challenge is widespread and has infiltrated many central and local governments in Africa. The systematic review and analysis of the literature have shown that several South African municipalities are constrained in implementing policy frameworks which also affect local government planning for youth development. Another worrying limitation is that many policies on development at the local government level do not directly offer clear guidance for effective implementation. This results in projects malfunctioning and terminating early. This is confirmed by Escamilla and Lonean (2023), who argue that policies and strategies frequently overlook the diversity among young people, failing to address their specific needs and consequently falling short of providing them with meaningful support.

Furthermore, it is worth noting that youth policies often prioritise a youth-focused approach rather than a youth-centred one (OECD, 2017). This means that young people are seen as recipients of public policies rather than active participants who contribute to the development of policies that directly address their needs. This trend is especially evident in rural youth (Vargas-Lundius & Suttie, 2014). Arguably, insufficient coordination among national policies, provincial strategies and local priorities, combined with a lack of accountability and transparency in programme implementation, can create obstacles to effective programme implementation. As argued by Mthalane (2020), this can result in inconsistencies and gaps in youth development efforts at the municipal level in South Africa. To address some of these limitations, when making decisions, policymakers and programme managers should consider various strategies to overcome financial limitations, enhance institutional capacity, encourage community involvement, enhance infrastructure, and establish reliable and transparent governance. Ezeudu and Umaru (2023) reiterate that by considering these factors, rural municipalities can overcome barriers and promote the successful implementation of youth development programmes for sustainable and inclusive development. This also aligns with Empowerment Theory, which speaks to harnessing the youth development efforts towards realising community sustainability.

6.5 Lack of monitoring and evaluation

Everywhere in the world, managing public institutions is complex due to distinct bureaucratic systems and structures that are often tied to red tape. Such institutions are sometimes immune to change as they delay decision-making in development ecosystems. South African public administration likewise subscribes to the bureaucratic approach to governing rural municipalities. The interpretation and implementation of various institutional structures and systems determine the implementation of youth development programmes in rural municipalities.

Implementing project monitoring and evaluation in rural youth development programmes has been a challenge, as stipulated in the Auditor General Report (2021/22). In our review, we noted that efficient monitoring and evaluation mechanisms are vital in evaluating the performance of rural municipalities and are critical for promoting inclusivity in youth development programmes that aim to address youth unemployment. The problem of insufficient, unreliable, inconsistent, and limited reporting on youth development is connected to frequent staff turnover, low quality of data, and the absence of Key Performance Indicators (KPIs) for youth initiatives. Furthermore, as Mazwi (2020) noted, the measurement of youth empowerment programmes poses challenges due to the absence of a Monitoring and Evaluation Framework. As a result,

the type of data collected to assess the effectiveness of youth interventions is influenced by the lack of standardised evaluation criteria, inconsistent data collection methods, and inadequate institutional capacity to track long-term programme outcomes (Ntoyanto, 2016). The evaluation process aims to examine these development programmes' impact on young individuals' positive growth. Roth and Brooks-Gunn (2016) argue that evaluation efforts frequently fall short in their ability to measure and investigate all aspects of programme initiatives comprehensively. Furthermore, evaluation efforts do not adequately consider the interplay of these external factors and their impact on the lives of those receiving support. To address these challenges and ensure that development programmes are responsive to the needs of all youth in the municipality, it is important to strengthen monitoring and evaluation capacities, invest in training and technical assistance for staff, and engage youth and other stakeholders in participatory evaluation processes.

7 Conclusions and Recommendations

The study utilised Human Capital Theory to understand how skills can be cultivated for rural youth to explore the economic opportunities provided by rural municipalities and stakeholders. This theory emphasises the importance of investing in education, training, and skill development to enhance employability and economic self-sufficiency. By equipping youth with relevant skills, Human Capital Theory challenges the dependency syndrome often associated with welfarism, where rural youth may rely on government assistance instead of actively pursuing economic opportunities. The skills development approach encourages self-reliance and entrepreneurship, ultimately fostering long-term economic sustainability in rural communities. This theory was used in the present study to identify the merit of empowering rural youth through skills development while challenging rural youth to harness every economic opportunity that may come their way to improve their livelihoods.

Nonetheless, the analysis of study documents noted various limitations associated with youth development programmes in the rural municipalities of South Africa. These include capacity constraints due to brain drain, which triggers inefficiency in attaining inclusive youth development. Poor resource allocation and coordination failure to conduct monitoring and evaluation are other limitations affecting youth development programmes. Most studies of poverty and local economic development confirmed these findings, and they are consistent. This is a call for governments and stakeholders to intervene and empower rural youth toward advancing their livelihoods. As the empowering theory stipulates, empowering rural youth not only addresses past inequalities but also reallocates wealth in society, in the process building capacity and confidence in future generations.

The conclusion drawn from this study highlights that to attain inclusive youth development in rural municipalities, coproduction is encouraged, whereby rural municipalities forge ties with other interested non-state actors to support and invest in rural youth in areas such as business education and project management, including monitoring and evaluation. The study at the national level advocates for the need to reinforce the National Development Vision 2030 (NPC, 2012), which aims at redirecting rural economies. Further, provincial and local governments, through other development agencies, need to provide youth with access to start-up finances which are pivotal in spearheading entrepreneurship, while targeting the inclusion of capable rural youth for driving the economy of the country. While this research emphasises the inclusion of rural youth in development programmes, the grey areas of research that could be touched upon by researchers include the uses of modern digital technologies in driving rural entrepreneurial ventures, considering the opportunities that could be triggered by Fourth Industrial Revolution technologies in mining, agriculture, and small businesses, among other economic ventures.

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Community Responses to Floods: A Case Study of Thornwood Township, Mariannhill, KwaZulu-Natal, South Africa

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Abstract

This study explores the community response to flooding in the Thornwood area, with particular focus on the 2022 flood in Thornwood Township, KwaZulu-Natal. A qualitative research approach was employed, utilizing in-depth semi-structured interviews and focus group discussions. A total of 33 participants took part: 13 individual interviews and 20 across four focus groups, each comprising five participants. Findings indicate that the 2022 flood had a severe impact on the Thornwood community, presenting numerous challenges. The study also revealed that residents employed various coping strategies, which many found helpful. However, these strategies had notable limitations, leaving the community vulnerable to the continued effects of flooding. Additionally, the study found a lack of external support, particularly from government institutions, in assisting the affected community.

Keywords: Disaster, Flooding, Africa, Community response, Government response

1 Introduction

Flooding is a recurrent and destructive natural disaster that continues to affect individuals across all walks of life, despite numerous studies, recommendations, and government interventions. Globally, floods are among the most damaging natural disasters, causing extensive human, economic, and environmental losses (Olanrewaju & Reddy, 2022). In Africa, severe floods have affected over one million people across more than 20 countries in recent decades, resulting in the loss of approximately 500 lives (Braimah et al., 2014). Reports by the World Bank (2021) indicate that flood events in Africa have increased by over 200% since the 1980s, while OCHA (United Nations Office. . . , 2022) notes that more than 3.4 million people were affected by floods across the continent in a single year. Environmental degradation, rapid urbanization, and inadequate infrastructure have further heightened flood risks, particularly in low-income urban areas (Di Baldassarre et al., 2010; Douglas et al., 2008). Country-specific examples, such as the 2022 Nigeria floods that killed over 600 people and displaced more than a million, illustrate the urgent need for adaptive responses across the continent.

In Southern Africa, countries such as Mozambique, Malawi, and South Africa experience severe flooding annually (Madzivhandila & Maserumule, 2022). In South Africa, climate change has intensified extreme precipitation events, exemplified by the April 2022 floods in KwaZulu-Natal (Ziervogel et al., 2022). These floods caused significant loss of life, widespread displacement, and infrastructure damage. Scientific studies explain that as temperatures rise, the atmosphere can hold approximately 7% more water vapor per 1°C increase, contributing to intense precipitation events even without a change in overall rainfall frequency (Trenberth, 2011). Between 1980 and 2011, South Africa experienced 77 major flood events, resulting in 1,068 deaths and economic damages of approximately USD 1.1 billion (Zuma et al., 2012). More recent extreme weather events, including heavy rainfall and droughts, have disrupted livelihoods and urban agriculture (Munyai et al., 2021).

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The April 2022 floods severely impacted the Eastern Cape and KwaZulu-Natal provinces, destroying thousands of households, power lines, and road infrastructure, and causing property losses estimated at R17 billion (Mashao et al., 2023; Ngcamu, 2022). Thornwood township, part of Mariannhill in the eThekwini Municipality, was among the areas most affected and was selected as the focus of this study due to the scale of damage and community disruption. The South African government declared the floods a national disaster, highlighting the severity of flooding as a national threat (Aiseng & Gamede, 2023; Mashao et al., 2023). Despite formal disaster response frameworks, communities often rely on indigenous knowledge to cope with and recover from floods, employing strategies such as predicting short-term weather changes, terracing, planting native vegetation, and seeking higher ground during flood events (Auliagisni et al., 2022; Ringo et al., 2016; Ziervogel et al., 2022).

Flooding remains a pressing concern in South Africa, exacerbated by climate change, rapid urbanization, and vulnerable infrastructure. The April 2022 KwaZulu-Natal floods, which caused extensive fatalities, displacement, and economic losses, underscore the urgent need to understand effective disaster response strategies. While formal government interventions exist, the role of community-based coping mechanisms and indigenous knowledge in recovery remains underexplored. This study focuses on Thornwood township to examine how community and government responses interacted during the disaster, providing unique insights into flood resilience and adaptive strategies. By highlighting practical lessons from both formal and local approaches, the study contributes to improving disaster preparedness and resilience in vulnerable communities in South Africa.

2 Theoretical approach

This study is based on the Sustainable Livelihoods Approach (SLA), which aligns with the research questions, aims, and objectives. The study explores and examines the community's response to the 2022 floods in Thornwood Township, specifically focusing on the impact of the disaster on livelihoods. The key research question investigates how the floods affected the community's livelihoods in Thornwood, an urban area on the edge of Pine Town, transitioning from rural to urban, as noted by Cross et al. (1992).

Urban areas, especially those prone to natural hazards, often experience concentrated social vulnerability, and their infrastructure struggles to cope with the growing effects of climate change (Williams et al., 2018). The study emphasizes how external shocks, such as the 2022 floods, can disrupt livelihoods, following the DFID (1999) framework, which highlights trends, shocks, and seasonality as factors beyond individuals' control. The research specifically examines how the floods in Thornwood affected the socio-economic livelihoods of the local population.

The SLA highlights the importance of various assets in resilience building, including financial, physical, social, human, and natural assets, forming the 'asset pentagon.' A recent addition to the framework is the political asset, creating the 'asset hexagon' (Ludi & Slater, 2007). The framework encourages collaboration between local government, municipal authorities, and communities in decision-making, policy formulation, and implementation (Majale, 2002).

Hammill et al. (2005) stress that understanding the livelihoods of vulnerable groups, particularly the poor, is essential for developing effective resilience strategies against climate-related shocks. This insight can help in designing successful adaptation strategies, considering how these communities will be affected by climate change, how they can respond using available resources, and how these responses can be strengthened. Therefore the SLA is an appropriate framework for this study, as it helps explore the vulnerabilities of communities like Thornwood and informs the creation of effective adaptation measures.

3 Methodological approach

This study employed a qualitative research design to investigate the impact of the 2022 floods on the Thornwood community in KwaZulu-Natal, focusing on both community-level experiences and the responses of government structures. Qualitative research was chosen for its capacity to provide a nuanced, in-depth understanding of individuals' subjective experiences, social dynamics, and the broader contextual realities in

which these occur (Moriarty, 2011). This approach was particularly well suited to the study's aims, which required exploring the lived experiences of those affected by the floods, as well as critically assessing the perceived adequacy of both local and institutional responses.

The research was conducted in Thornwood, a township within the Mariannhill area, which was among the communities most severely affected by the 2022 floods. The choice of Thornwood was purposive, driven by the community's high exposure to flood-related damage and its relevance to broader issues of urban vulnerability, infrastructural deficits, and disaster response capacity.

A purposive sampling strategy was adopted to ensure that participants were those most capable of providing rich, relevant, and diverse insights aligned with the study's objectives (Obilor, 2023). Participants were required to be residents of Thornwood and aged 18 or above, ensuring they had the maturity and legal capacity to provide informed consent and meaningfully reflect on the events. The study included 33 participants, a sample size deemed sufficient for qualitative research as it allowed for saturation of key themes while remaining manageable for in-depth analysis. Participants represented varied experiences and roles in the community, including homeowners, renters, informal traders, and local leaders.

Data collection involved a combination of in-depth semi-structured interviews and focus group discussions. Thirteen participants engaged in individual interviews, allowing for detailed personal narratives, while 20 participants took part in four focus groups, each consisting of five participants. This combination facilitated both individualized accounts and collective perspectives, enhancing the depth and breadth of the data. Focus groups were particularly valuable in exploring community-level perceptions and dynamics, enabling participants to reflect and build on one another's insights. Secondary sources, including government documents, policy reports, academic articles, and media publications, were also consulted to triangulate findings and provide broader contextual understanding of the floods and responses.

Data analysis followed a thematic approach. All audio-recorded interviews and focus groups were transcribed verbatim, after which transcripts were systematically coded to identify recurrent patterns, categories, and themes relevant to the research questions. Initial coding was followed by iterative review and refinement to consolidate themes, ensuring that both explicit and implicit meanings in participants' narratives were captured. Triangulation across individual interviews, focus groups, and secondary sources enhanced the credibility and validity of the findings.

Ethical considerations were strictly observed throughout the study. Informed consent was obtained from all participants, who were briefed on the study's objectives, methods, and their rights, including the right to withdraw at any point without penalty. Consent forms and interview guides were provided in IsiZulu to ensure comprehension and cultural relevance. All sessions were audio-recorded after obtaining permission to ensure accuracy in transcription and analysis.

This methodological framework enabled the study to capture a rich tapestry of experiences and critically assess both the immediate and long-term implications of the floods on the Thornwood community, as well as the perceived effectiveness of institutional responses.

4 Results

The April 2022 floods had a devastating impact on Thornwood Township, a vulnerable settlement in the Mariannhill area. This study draws on first-hand accounts from affected residents, supported by existing literature, to explore the wide-ranging effects of the disaster and the community's responses. The findings reveal that the floods caused extensive damage to homes and infrastructure and led to prolonged economic hardship, food and water insecurity, health risks, and psychological trauma. With minimal government intervention, residents relied on improvised coping strategies and mutual aid. These experiences expose both the physical and systemic vulnerabilities of flood-prone communities like Thornwood and highlight the urgent need for comprehensive disaster preparedness, resilient infrastructure, and effective institutional support.

4.1 Effects and challenges of the April 2022 floods on Thornwood Township

Thornwood Township in the Mariannhill area was severely impacted by the April 2022 floods, which caused widespread disruption to residents' lives. This study, based on participant testimonies and supporting literature, identifies the main challenges experienced: property loss, infrastructure damage, economic hardship, health risks, psychological distress, and service disruptions.

Loss of personal property was one of the most severe and commonly reported effects. Residents described significant damage to homes, furniture, clothing, and groceries due to floodwaters entering and saturating their houses. These losses were emotionally and financially devastating, especially for low-income families who had accumulated belongings over years. Literature supports these findings. Badamosi et al. (2024) found that 48 percent of Nigerian respondents experienced structural damage, and 35 percent lost personal items. Hooli (2016) and Davies and Black (2020) emphasize the disproportionate impact of flooding on property in vulnerable communities.

The floods disrupted employment and income. Many residents could not work due to damaged infrastructure, including roads, bridges, and workplaces, and rising food prices worsened financial strain. One participant stated, "We couldn't go to work. Financially, I don't have money." This aligns with studies by Badamosi et al. (2024), Diakakis et al. (2020), and Pant et al. (2018), which highlight how damaged infrastructure leads to job losses and long-term economic instability, especially among households with limited financial resilience.

Many participants reported trauma and emotional distress, having witnessed people being swept away or discovering bodies. The psychological impact remains severe long after the event. One participant explained, "Even now we still have trauma of seeing people being flooded away." Hooli (2016) and Davies and Black (2020) similarly report that exposure to floods exacerbates mental health challenges, particularly among disadvantaged populations.

Flooding led to increased respiratory illnesses, particularly among children. Damaged homes and inaccessibility to hospitals, some of which were closed, worsened health outcomes. One resident shared, "We couldn't even go to the hospitals because they were closed." These issues reflect findings by Burton et al. (2016) and Diakakis et al. (2020), who link infrastructure failure to health service disruptions and increased vulnerability.

The findings reveal that hunger and water shortages were among the most severe consequences of flooding experienced by residents in Thornwood. Many participants reported that they had no access to food due to the destruction of critical infrastructure. Roads and bridges were damaged, preventing movement and access to markets. One participant stated: "Roads were closed due to bridges that were damaged, so we could not make any movement." Electricity outages lasting several months made it impossible for residents to cook, forcing many to rely on bread and sugar water for sustenance.

These experiences highlight the connection between damaged infrastructure and food insecurity. Ainehvand et al. (2019) and Badamosi et al. (2024) stress the importance of emergency food aid and note how market dependency makes urban communities more vulnerable during disasters. Participants also emphasized the lack of government support, stating that they had to fend for themselves.

Water shortages were another major issue. Participants described how floodwaters burst pipes, disrupting the municipal water supply for months. With no alternative, residents were forced to travel long distances to fetch water from rivers, often contaminated and unsafe. One participant lamented, "We had to drink the very same unhealthy water, where there were dead bodies and used pampers." These findings indicate a strong link between flood-induced infrastructure damage and the lack of access to essential services such as food, water, and electricity. The inability of local authorities to respond effectively worsened the crisis. Similar to the study by Karagiannis et al. (2019), the data show that natural disasters significantly delay recovery efforts by damaging critical infrastructure and increasing human suffering. Overall, the study underscores the urgent need for resilient infrastructure, reliable emergency response, and stronger governmental support in disaster-prone communities like Thornwood.

4.2 Community Responses to Floods and Coping Strategies in Thornwood

This section explores the community responses and coping mechanisms employed by residents of Thornwood Township during and after the April 2022 floods. The study aimed to assess the effectiveness of both community-initiated and government-supported responses in enhancing residents' capacity to cope with and recover from flood-related impacts.

Thornwood, like many vulnerable urban settlements, faces challenges such as poor drainage systems, inadequate infrastructure, and limited government support. Residents have resorted to self-devised coping strategies, often informal and immediate in nature. Abubakari and Twum (2019) observe that low-income populations in flood-prone urban areas develop both proactive and reactive coping mechanisms in the absence of systemic support. These coping mechanisms often arise from previous experiences and community-level knowledge but remain limited in terms of long-term sustainability. Similarly, Anwana and Owojori (2023) highlight that due to infrastructure gaps, residents in informal settlements often innovate their own survival methods in response to flooding. Parvin et al. (2016) stress that the economic toll of floods, particularly in rural and low-income communities, leads to significant job losses and income reductions, sometimes by as much as two-thirds. This hampers immediate recovery and undermines resilience to future disasters, pushing affected households deeper into debt and asset loss.

One of the most widely used coping strategies in Thornwood was manually opening ditches to divert floodwaters away from homes. Many participants viewed this as an effective immediate response that prevented water from entering their homes. Participant narratives:

> *"We were able to be safe by opening the ditch." — Group 4, 19 May 2024*
>
> *"What helped us is that we opened the ditch so that the water does not come inside the house." — Group 1, 19 May 2024*
>
> *"Opening the drain helped a lot. Because as I was opening the ditch, my other neighbours did the same, so we managed to control water and made it flow along the drain up until it reached the main river." — Participant 2, 11 May 2024*

This strategy showed moderate success, particularly when efforts were coordinated among neighbours. However, while some residents managed to divert the water, others noted its limitations.

> *"It helped even though it did not really help much but it did." — Participant 10, 11 May 2024*

Although effective for many, ditch-digging was not universally successful and lacked the permanence needed for future flood prevention. Its reactive nature and reliance on community mobilization highlight both its strength in emergency response and its weakness as a long-term strategy.

Another coping strategy adopted was remaining awake throughout the night to monitor flood conditions and respond as needed. Some residents reported evacuating temporarily or working through the night to manage water flow. Participant narratives:

> *"What really helped us was the matter of not sleeping inside our houses. It was very hard, but we did it with some of my neighbours." — Group 4, 19 May 2024*
>
> *"We woke up at night so that we can try and control the water, we worked all night, without sleeping." — Group 3, 19 May 2024*
>
> *"Since it was at night, luckily we watched the news and heard that heavy rain is coming so we did not sleep. That is how we managed to escape." — Group 1, 19 May 2024*

While this strategy reflects a high level of vigilance and responsiveness, it was physically and mentally exhausting. Its effectiveness was limited, and its sustainability was questionable.

> *"It did not help that much." — Participant 8, 11 May 2024*

In sum, staying awake worked as a last-resort tactic but lacked long-term viability and underscores the absence of structured early warning systems or disaster response plans. In more severe cases, residents fled their homes temporarily or permanently due to the severity of flooding and structural damage. Participant narratives:

> *"For me, running away was the solution. There was a big hole, so I did not have another option but to run away." — Group 1, 19 May 2024*
>
> *"I took my children, IDs, and other things and ran away." — Participant 1, 11 May 2024*
>
> *"At night we ran away from our houses. We slept outside in the trees and there was water everywhere." — Group 3, 19 May 2024*

While escape provided immediate physical safety, it was a temporary solution. Most participants had to return home within days, often to damaged property.

> *"We ran away from our houses to stay in other people's houses where we felt it was safe enough for three days." — Group 3, 19 May 2024*

This strategy, though essential for life preservation, offers no long-term security and exposes displaced families to further risks, including poor sanitation, exposure to the elements, and psychological stress. A few participants attempted to use household items such as blankets and clothing to block water entry into homes. Participant narratives:

> *"It was that I didn't sleep, took out blankets, and put them on the floor to block water from entering." — Participant 7, 11 May 2024*
>
> *"We closed with clothes." — Participant 11, 18 May 2024*

This method was largely ineffective. While it may have offered psychological comfort or limited water intrusion temporarily, it required constant effort and was ultimately unsustainable.

> *"I would say that it didn't work till the end of floods because I used to change blankets every time until the floods were over." — Participant 7, 11 May 2024*

This illustrates the desperation and lack of flood preparedness within the community. Solidarity among residents played an important role in coping with the flood's aftermath. Many participants mentioned mutual aid and collective action as key elements of their survival. Participant narratives:

> *"What I did was that I became very close with my neighbours, and they really helped me a lot until I was able to go back to my place after my things were dry." — Participant 5, 11 May 2024*
>
> *"When one has a problem, we all contributed to helping that person, that is how we managed to escape." — Group 4, 19 May 2024*

This strategy was among the most emotionally and practically effective. Community-based support helped fill gaps left by institutional failures.

> *"Seeking help from my neighbours did help a lot. They gave me money to buy food for my children." — Participant 5, 11 May 2024*

However, as Islam et al. (2018) note, such community-based strategies are generally short-term and driven by immediate necessity. Once the crisis subsides, the burden of recovery often falls back on individuals without long-term solutions in place.

The coping strategies used in Thornwood reflect a combination of improvisation, communal support, and individual resilience. However, most of these approaches were reactive and lacked institutional backing or infrastructural support, making them largely unsustainable. While opening ditches and community solidarity proved moderately effective, other strategies such as using blankets or staying awake highlighted the community's vulnerability and lack of preparedness. Ultimately, the study reinforces the findings of Islam et al. (2018) and Parvin et al. (2016), which emphasize that without systemic change and sustainable intervention such as infrastructure improvements, reliable early warning systems, and robust government response, communities will remain trapped in cycles of emergency responses and repeated trauma.

4.3 Government responses in Thornwood Township

The findings from the study indicate a pervasive lack of government intervention and support in Thornwood Township during and after the flooding disaster. Nearly all participants consistently expressed that no assistance was provided by government institutions, leaving residents to rely solely on community-based coping mechanisms. The participants' testimonies underscore a pattern of neglect, where official structures failed to respond to the urgent needs of the affected population. As a result, individuals and families were compelled to survive through mutual aid, community solidarity, and informal support networks. The lived experiences of the residents reflect a broader theme of community resilience in the face of institutional failure. Participant narratives:

> *"No, we did not get any help, but the only help that we got was from our neighbours. No help from the government." — Group 1, 19 May 2024*
>
> *"It was just about helping yourself and helping each other as neighbours. We were just helping each other as a community. As for the government, we received no help at all." — Participant 2, 11 May 2024*
>
> *"The only help I got was from my neighbours, it was only from my neighbour." — Participant 5, 11 May 2024*
>
> *"No, but as a community we were able to help each other here and there." — Group 4, 19 May 2024*

In addition to the lack of direct assistance, participants reported experiences of unfulfilled promises and inadequate follow-up from government authorities. Many expressed disillusionment over the government's initial commitments, which were never realized. This exacerbated the sense of abandonment and further burdened an already distressed population. Participant narratives:

> *"Even today, after registering for losing our home, nothing has been done about it, nothing at all." — Group 3, 19 May 2024*
>
> *"After the floods, we were expecting the government to help us immediately, as promised, but we waited until we were tired. On top of it all, we were still waiting while struggling. There was no food, and we did not know what we were going to eat tomorrow." — Group 4, 19 May 2024*

These accounts reveal not only the lack of material support but also the emotional and psychological toll of waiting in vain for government aid. The persistent inaction has contributed to feelings of frustration, hopelessness, and mistrust toward public institutions. The situation in Thornwood Township is emblematic of a broader systemic issue in disaster response frameworks in vulnerable communities. The findings resonate with the conclusions drawn by Islam et al. (2018):

> *"Though rarely timely, a response to this threat is inevitable. Too often, preparation is lacking, and communities, overburdened by yet another calamity, must deal with the fallout. Without adequate support, those impacted must rely on their own resources, using local knowledge accumulated over decades of fighting the forces of nature."*

This statement aligns directly with the experiences in Thornwood, where residents leveraged community cohesion and indigenous coping strategies to manage the immediate aftermath of the flooding. In the absence of a functioning support infrastructure, such solidarity becomes not only a survival strategy but a testament to the strength of communal bonds. However, the failure of government institutions to act decisively raises critical questions about accountability, disaster preparedness, and the marginalization of vulnerable populations. When governments fail to deliver on their promises, it undermines trust and exacerbates social inequalities, particularly in impoverished or underserved areas. While Marianhill experienced severe flooding, there were no incidents of looting reported. In response, the community came together in solidarity, working collectively to protect one another and safeguard their belongings amidst the chaos.

5 Conclusion

The April 2022 floods in Thornwood Township exposed the acute vulnerabilities of a low-income, poorly serviced urban settlement in the face of natural disasters. This study illuminates the multifaceted challenges experienced by residents, including widespread property damage, infrastructure collapse, economic disruption, health hazards, psychological trauma, and a severe breakdown in basic services such as food, water, electricity, and healthcare.

The testimonies gathered highlight a stark reality: While the physical impacts of the floods were devastating, the absence of institutional support and preparedness greatly intensified the suffering of Thornwood's residents. Critical infrastructure was not only damaged but remained unrepaired for extended periods, leaving communities isolated and dependent on fragile informal networks for survival. In the wake of the disaster, government response was not only delayed but often entirely absent, eroding public trust and reinforcing a cycle of marginalisation.

Despite these challenges, the community demonstrated extraordinary resilience. Informal coping strategies such as digging drainage ditches, remaining alert through the night, evacuating homes, and supporting one another proved crucial in mitigating immediate risks. However, these strategies were predominantly reactive, temporary, and unsustainable. They underscored the creativity and solidarity within the community but also revealed the deep systemic failures in disaster management and urban planning.

The findings affirm existing literature that warns of the disproportionate burden borne by impoverished communities during disasters and the critical role that infrastructure, governmental accountability, and preparedness play in disaster response and recovery. Thornwood's experience is a powerful reminder that resilience alone is not enough. Without proactive investment in resilient infrastructure, reliable early warning systems, and inclusive government intervention, vulnerable communities like Thornwood will continue to face repeated hardship and slow, painful recoveries.

In conclusion, the 2022 floods were not only a natural disaster but also a governance failure. Addressing future risks in Thornwood and similar communities requires urgent systemic change that focuses on the needs of the most vulnerable, builds local capacity,

and ensures that disaster response is swift, equitable, and sustained.

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Culture of Leisure of Men and Women in the 18th – 20th Centuries and Modern Kazakh Society: A Comparative Analysis

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Abstract

This research contributes to the understanding of the cultural heritage of Kazakhstan by studying the evolution of gender-divided leisure practices of Kazakh society from the 18th century to the present, a time of deep social transformations. The aim of the work is a comparative analysis of leisure practices among men and women in Kazakh society, revealing the changes that occurred under the influence of external factors and modernization processes. The methodological basis of this research is the historical-comparative approach, which involves analysing ethnographic sources, archival data, and modern research to systematise and compare data on traditional and modern forms of leisure. The results show that in traditional Kazakh society, leisure culture was deeply connected to the nomadic lifestyle, where men's leisure time predominantly included physical activities and women's leisure time was centred on domestic crafts and family festivals. The influence of the Russian Empire and the Soviet Union led to a transformation in these practices, including the emergence of new social forms of leisure, such as sports sections, clubs, and cultural activities in which women began to actively participate. In modern Kazakhstan, there is an integration of traditional and modern activities where both men and women can engage in a variety of leisure activities, from fitness to participation in ethno-festivals, reflecting both the modernization of society and a return to national roots. The findings of the paper confirm that leisure culture has become more universal, offering a wide range of opportunities for self-expression while strengthening gender equality.

Keywords: Gender, Crafts, Social norms, Values, Globalisation

1 Introduction

The last three centuries were a time of profound transformations of social and cultural norms that have influenced gender roles and leisure practices. In Kazakh society, leisure culture, like other social spheres, was originally closely linked to the nomadic way of life and fulfilled important cultural functions, including the strengthening of family and interpersonal ties and the transmission of traditions and values. However, the intervention of the Russian Empire, then the Soviet Union, and later globalisation led to significant changes, forcing Kazakh society to adapt its cultural norms and leisure practices under the influence of new economic, political, and cultural conditions. Understanding these transformations can contribute to a better understanding of contemporary gender practices and cultural heritage in Kazakhstan, as well as strategies for maintaining cultural identity in the face of globalisation.

Globalisation has transformed leisure culture into a universal space where traditional and modern forms of leisure intersect, in part by enhancing cultural exchange processes. Thanks to access to international information, mass communication media, and the changing pace of life, Kazakh society has become familiar

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with new types and forms of leisure activities, such as mass sports, tourism, and various recreational activities that were not previously characteristic of Kazakh culture. Such exposure has had an impact on the gradual erosion of strict gender boundaries in leisure activities, opening up new opportunities for self-fulfilment for men and women, as well as the formation of more individualised preferences.

Leisure practices in Kazakhstan have long served as a mirror reflecting the shifting contours of gender, identity, and authority across historical epochs. From Soviet-era state campaigns such as the "Women's Red Yurt," which sought to reshape traditional gender roles through socialist mobilisation (Ramsay, 2021), to contemporary online expressions of masculinity and sexuality (Dall'Agnola & Thibault, 2021; Thibault, 2022), leisure has remained deeply entangled with broader socio-political transformations. Scholars have highlighted how Soviet policies produced a unique paradox for women, neither fully colonised nor fully emancipated, within the Soviet modernisation project (Kandiyoti, 2007). Post-independence Kazakhstan continues to navigate these legacies amid globalisation and re-traditionalisation, with evolving discourses around marriage, migration, and gender norms (Blum, 2016, 2019; Kudaibergenova, 2018). Recent research has also illuminated how Islamic media articulate male authority through leisure domains such as sport (Bigozhin, 2019), while digital platforms complicate traditional boundaries of gendered behaviour and morality (Dall'Agnola, 2024). These transformations underscore the importance of leisure as a lens for understanding cultural change, gender politics, and the construction of national identity in contemporary Kazakh society.

Abdigapbarova (2023) investigated gender issues in Kazakh literature of the early 20^{th} century, focusing on changes in the cultural and social roles of men and women during this period. In the context of leisure studies, the author draws attention to how the literature of the time reflected traditional and new forms of leisure, influencing the perception of gender roles in Kazakh society. The paper also analyses how changes in social and cultural life contributed to the formation of different approaches to leisure for men and women in the XVIII-XX centuries, as well as in modern Kazakh society. Aralbay et al. (2023) examined the role of women in nomadic Kazakh traditions, emphasising their key importance in shaping the national code and identity. The authors analysed historical practices, focussing on women's contributions to the cultural and social development of Kazakh society. This study offers vital information about the cultural and gender aspects of Kazakh nomadic life and their impact on contemporary social norms and gender roles in Kazakhstan.

Religious syncretism has been studied by Assanbayev and Hanks (2023), as have Sufism and the role of Ishans in nomadic Kazakh society, focusing on spiritual practices and their impact on everyday life. The authors examined how Sufi traditions and the interaction of different religious movements influenced the social structure and cultural practices of Kazakhs, including the recreation and leisure activities of men and women. This study helps us understand religious and cultural transformations in the context of nomadic life and their reflection in contemporary Kazakh realities. Elmuratovna (2024) examined the roles of women in traditional nomadic societies, emphasising their central role in the preservation and transmission of cultural and social traditions. The author analyses how these roles have evolved in the context of nomadic life, as well as the changes that have occurred in contemporary Kazakh society. This study provides valuable insights into how cultural and gender norms influenced the leisure and recreation of men and women in different historical periods.

Ispandiyarova and Absadyk (2024) analysed the concept of women in Kazakh folk lyrics, identifying traditional representations of women's role in society through poetic heritage. The authors examined how these images correlated with changes in the social status of women in Kazakh society in the course of historical and cultural developments. The work helps to understand how cultural representations of women have influenced men's and women's leisure and recreation in different eras, as well as contemporary changes in these practices. Menti and Sideri (2020) analysed the changing position of women in literature from traditional society to modernity, highlighting the impact of cultural and social changes on the role of women in different historical contexts. This study provides a better understanding of how traditional and modern social attitudes have shaped men's and women's leisure and recreation, including in Kazakh society, where the transition from traditional to modern is also accompanied by changes in gender roles and cultural practices.

Nurysheva and Kaldayeva (2020) investigated the image of women in the traditional Kazakh worldview, focusing on the importance of women's roles in family and social life, as well as their cultural and spiritual responsibilities. This study analysed how traditional perceptions of women and their role in society have influenced the culture of leisure and recreation in Kazakh society, as well as changes in these practices from the eighteenth to the twentieth centuries and in modern times.

Since independence, Kazakh society, including the younger generation, has become more interested in ethnocultural festivals, national sports and crafts, which creates a unique cultural space. These processes of transformation and their impact on the culture of leisure emphasise the relevance of analysing the gender aspect of leisure and allow us to identify its role in contemporary cultural practices in Kazakhstan. Despite the many studies on traditional and contemporary gender roles in Kazakh society, little attention has been paid specifically to the comparative analysis of cultural practices of leisure, their gender specificities, and the impact of globalisation on these aspects. The existing gap in research is the lack of comparative data on the differences and similarities in the leisure activities of men and women in different historical periods, which limits the understanding of the process of adaptation of Kazakh society to modern conditions.

The aim of this paper is to conduct a comparative analysis of men's and women's leisure culture in Kazakh society in the 18^{th} – 20^{th} centuries and in the modern era to reveal the patterns of leisure transformations under the influence of socio-historical changes and globalisation, as well as to determine the significance of these changes for the preservation of cultural identity and for gender equality. The main objectives of the research are to study the traditional forms of leisure activities for men and women in the nomadic community and to consider the influence of religious, social, and cultural norms on gender aspects of leisure. The novelty of this study lies in its comprehensive comparative analysis of gender-specific leisure practices in Kazakh society from the 18^{th} century to the present, integrating ethnographic, archival, and cultural data to reveal how socio-political transformations, colonisation, Sovietisation, and globalisation, have reshaped gender roles and cultural identity through leisure. Unlike prior studies focused narrowly on either traditional or Soviet periods, this work bridges historical eras and foregrounds the evolution of women's leisure alongside men's, offering new insights into cultural continuity, gender dynamics, and national identity formation in Kazakhstan.

2 Materials and Methods

This study employs a historical and cultural approach with elements of comparative analysis, focusing on the evolution of leisure practices in Kazakhstan from the eighteenth century to the early twenty-first century. The timeframe allows for a comprehensive analysis of how cultural practices of recreation evolved over several eras, encompassing key historical, social, and political transformations. The study draws on a range of historical, ethnographic, and cartographic sources. Specific archives consulted include the Central State Archive of the Republic of Kazakhstan and the State Archive of Scientific and Technical Documentation, which hold relevant historical records. These archives provided documents, including official records, reports from colonial administrators, and sociological surveys from the Soviet period, which shed light on the structure of leisure practices in Kazakhstan during the respective periods. Ethnographic data from 20^{th}-century field studies were pivotal in understanding the symbolism of leisure activities. These sources included oral histories, ethnographic notes, and participant observations. These materials allowed for an exploration of how leisure practices functioned as vehicles for expressing cultural values, gender roles, and social hierarchies within Kazakh society. The ethnographic studies also highlighted how these practices were modified or displaced during Soviet modernization efforts.

The methodology of this study combines comparative-historical, ethnographic, and cultural analysis. The comparative-historical method was used to examine how leisure activities evolved through key political events such as Russian colonisation, Soviet collectivisation, and the post-independence era. This approach highlighted continuities and shifts in leisure practices across different times. Ethnographic analysis focused on understanding the symbolism and cultural significance of leisure activities, with particular emphasis on gendered rituals and family-orientated leisure practices. The study also applied a cultural studies approach

Table 1: Social structure of Kazakh zhuzes

Elements of social structure	Characteristic	Role in society	Peculiarities
Zhuzes (Senior, Middle, Junior)	Three large communities based on blood and territorial ties.	Coordination of the internal life of society, protection of the territory from external threats.	Each zhuz specialised in a specific area, such as trade, cattle breeding, or military functions.
Auls (tribal communities)	Small social and economic units consisting of several families united by kinship.	Conducting economic activities, ensuring self-sufficiency in the community.	They led a nomadic lifestyle, shared pastures, and provided mutual support to their families.
Aksakals (elders)	Respected members of the community who decided key issues in domestic and foreign policy.	Reconciliation of disputes, management of the economy, leadership of defence.	Authority was determined by age, experience, knowledge of traditions, achievements in protecting the family.
Batyrs	Military leaders who had distinguished themselves in battles and defence of their native lands.	Protection of the community, participation in military campaigns, protection from raids.	Important roles in strengthening the authority of the Zhuzes and making decisions on defence issues.

Notes. Source: Berdyguzhin et al. (2020).

to interpret how leisure activities were linked to the formation of cultural identity, particularly in response to state-imposed cultural changes during the Soviet era.

The study further employs genealogical, sociocultural, and linguistic methods to deepen the analysis. The genealogical method traced changes in tribal organisation and kinship structures, revealing how these social systems influenced leisure practices. Sociocultural analysis examined the evolution of family relations, rituals, and symbolic customs, exploring how these daily practices were intertwined with leisure activities. Linguistic analysis focused on language shifts, particularly the loss of traditional vocabulary associated with leisure, to explore the cultural transformations resulting from Soviet and post-Soviet policies. Together, these methods offer a comprehensive understanding of how leisure practices in Kazakhstan reflect broader socio-political changes and cultural identity formation.

3 Results

3.1 Kazakh society in the 18^{th} – 20^{th} centuries

In the eighteenth to twentieth centuries, Kazakh society went through socio-economic, cultural, and political transformations caused by both internal processes and the influence of external powers. A special social structure and distribution of responsibilities between men and women had been formed under the conditions of nomadic life, which together formed the basis for the sustainable existence of Kazakh society. In the 18^{th} century, Kazakh society existed in the form of three major tribal divisions, or zhuzes (junior, middle, and senior), each of which was linked by blood and territorial ties (Table 1). The zhuzes included separate clan communities (auls), which were units of social and economic organisation. Management in the aul was organised around elders, aksakals, who decided important internal and external issues. The clan's hierarchy was based on seniority and merit in protecting it, sometimes in battles.

Nomadic livestock breeding (horses, camels, sheep, and cows) formed the basis of economic activity. Sheep breeding was particularly important, as sheep provided not only food but also wool for clothing. Horses played an important role in locomotion and warfare, as well as in symbolising wealth and social status. Kazakhs were skilled horsemen and nomads, expertly organising migrations between summer and winter pastures. Men in Kazakh society were traditionally engaged in herding and hunting and played a central role in providing security for the community, but in times of protracted warfare, women were also

trained in horsemanship and took part in battles. They took part in military campaigns to defend their lands from raids and engaged in inter-clan conflicts. Warfare and the ability to fight on horseback were considered important qualities for a man. Men were also engaged in judicial proceedings, participated in social life, and solved foreign policy issues, making Kazakhs active participants in the political processes of Central Asia (Abdakomov, 1997).

Women were crucial in managing the household and nurturing children. Cooking, processing wool, making clothes, sewing, and other crafts supported the stability and autonomy of auls. Women were also engaged in milk processing (production of koumiss and butter) and feltmaking, which required knowledge and skills passed from generation to generation.

The Russian Empire began actively developing Kazakh territories at the beginning of the 19th century. In 1822, the Statute of the Siberian Kirghiz (Kazakhs) was introduced, which effectively abolished the authority of khans in the Middle Zhuz (Holdsworth, 1952). The Russian Empire gradually strengthened its control over the Kazakh steppes by dividing them into administrative units, which reduced the influence of tribal ties. Russian officials and military officers, who often interfered in local affairs, became important. Russian colonisation led to changes in the economy. Taxes were introduced, sedentarisation increased, and the traditional nomadic system began to break down. New forms of economy, such as farming, emerged, which changed the nomadic way of life. Settlements and towns began to appear, and some Kazakhs were forced to adopt a sedentary lifestyle. Men who had previously been pastoralists were now forced to work on farmland or engage in trade, especially those living near cities. Women also experienced changes in their everyday lives. A sedentary lifestyle meant a change in craft activities: felting and wool gave way to the production of textiles and products necessary for a settled life. The nineteenth century also saw the emergence of Kazakh women scientists and writers, a consequence of the influence of Russian culture and education, which opened up new opportunities for women.

With the advent of Soviet power in the early twentieth century, Kazakh society underwent another fundamental change. The collectivisation policy implemented in the 1930s meant the forced removal of livestock and forced sedentarisation. Most nomads were forced to join collective farms, accompanied by mass repression and famine, which led to the death of a large part of the population. Soviet power also destroyed the old system of social hierarchy by proclaiming equality. This changed the position of women, expanding their rights and involving them in social production. Women began to participate actively in collective farms, working on an equal footing with men (Didenko, 2022). For the first time in the history of Kazakh society, women began to receive education, becoming teachers, doctors, and labourers. Vocational schools emerged alongside the propaganda of women's social emancipation, offering women opportunities to advance in new fields. Men who in pre-revolutionary times had been cattle herders became part of the working class. Many men went to work in factories, mines and industries, as industrialisation and urbanisation were among the main thrusts of the Soviet economy. The Soviet government, while introducing universal education, also actively involved men in education to train a new generation of specialists.

When Kazakhstan gained independence after the Soviet Union collapsed in 1991, the process of revitalising national culture and restoring lost traditions could begin. During the years of independence, Kazakh society began to revitalise former social institutions such as aitys (poetry competitions), develop the Kazakh language, and study folk art. Interest in history and traditional culture began to grow, which in turn affected everyday life. Economic reforms led many to return to traditional economic activities, including herding and agriculture. Men became entrepreneurs, and women became active in various sectors of the economy, including management and science (Tiberghien & Lennon, 2019). In the 21st century, Kazakh society retains many aspects of traditional culture while combining them with the achievements of modern civilisation.

3.2 Leisure culture of Kazakh men in the 18th – 21st centuries

In the eighteenth century, the leisure culture of Kazakh men was closely linked to their nomadic lifestyle, which emphasised physical endurance, horseback riding, and adaptation to harsh environments. Daily activities involved herding, hunting, and guarding livestock, leaving little time for recreation in the modern

sense. However, Kazakh men incorporated physical and social activities into their lives to strengthen bonds and develop skills. A popular form of recreation was horseback wrestling, or audaryspak, where men competed to drag each other off a horse. Ground wrestling, or kures, was another popular activity, symbolising masculinity, fortitude, and strength. During this period, traditional competitions such as wrestling, horse racing, and archery were integral to their cultural practices. These events were often organised during seasonal gatherings, marking significant occasions such as spring's arrival or the harvest period. While specific frequencies are not documented, the recurrence of these activities was closely tied to the nomadic calendar and communal needs.

Physically demanding activities held cultural significance and were common in traditional societies. However, in contemporary times, engagement in these traditional recreational forms has become more symbolic and institutionalised, frequently restricting it to organised festivals and rural locales. A minuscule minority of Kazakh men currently participate in traditional sports such as falconry or horseback wrestling. These traditions are frequently endorsed by government-funded cultural efforts rather than reflecting common daily activity.

In metropolitan environments, leisure culture has undergone significant transformation. The majority of males now participate in sports mostly as spectators, especially via televised football and international events. Although national sports like buzkashi and falconry are heralded as emblems of heritage, genuine participation is limited and increasingly restricted to aficionados or certain cultural occasions. Simultaneously, sedentary recreational activities, like extended screen time and digital media engagement, have gained popularity, particularly among adolescents. These tendencies reflect global trends and are linked to increasing health issues, such as obesity and diminished physical activity levels.

Although traditional sports play a significant symbolic role in shaping national identity, their integration into daily life remains limited. Contemporary Kazakhstan faces the difficulty of integrating its symbolic legacy with accessible, inclusive, and health-enhancing recreational activities that meet the requirements of modern urban living.

Nomadic women also followed the wrestling tradition, regularly organising matches to foster masculinity and physical fitness. Sometimes a man and a woman fought in Kazakh wrestling. The contest between Bayrak and Banu-Sheshek described in the book "Korkyt Ata" is a perfect example of such rare situations. A strange maiden, who met a young warrior who was looking for the beautiful daughter of Baybidjan, introduced herself as Banu-Sheshek's maid and said that she would not introduce him to her mistress until he fulfilled the conditions of the competition with her. In the competitions of riding, shooting and wrestling, the young warrior is victorious and finally meets his Banu. This young girl, disguised as a maid, turns out to be Banu Sheshek herself. Practically all mass cultural events (fairs, dinners, weddings, seasonal festivals such as New Year's Eve, etc.) were not without wrestling. At the Kymyzmuryndyk holiday, women were the first to taste koumiss. The peculiarity of this event is the organisation of women's wrestling, with the main condition of the competition being the participation of women only: the participation of young girls is strictly forbidden. Women started the wrestling by tying a long cloth around their waist at the bottom of the kimeshek (Toktabai, 2004).

Cultural gatherings were an integral part of Kazakh recreation and often included equestrian games, a central element of Kazakh identity. Buzkashi (goat pulling), where men competed on horseback to carry a goat carcass to a specified point, was one of the main types of games. Such games were more than just entertainment: they demonstrated the riding skills, physical strength and tactical prowess of the participants, which were necessary for survival in a nomadic society. Cultural festivals also included poetry performances and storytelling, where akyns (poets) shared stories of heroism and history, helping to pass on traditions and strengthen community ties (Akyildiz, 2022).

Hunting, especially using birds of prey, was a prestigious occupation among Kazakh men and remains so to this day. Falconry, especially hunting with golden eagles, required patience, skill, and training. It was seen as both a pastime and a rite of passage for young men, symbolising their readiness to contribute to the life of the tribe. In addition to being a source of food and clothing, hunting served as a rallying point, as men often hunted in groups, strengthening ties within their community.

By the nineteenth century, Russian influence began to penetrate Kazakh society, leading to changes

in lifestyle and recreation. Under Russian colonial rule, traditional Kazakh customs began to intersect with new social and economic factors, changing the leisure activities of Kazakh men. The influx of Russian settlers and administration led to more structured farming, reducing the need for constant migration and changing the pace of life. Although many Kazakhs retained their nomadic lifestyle, some adapted it by incorporating agricultural work, which somewhat reduced the emphasis on traditional recreational activities such as horseback riding and hunting. The Koyandy Fair, which began in 1848 and continued until 1930, was a notable event during this period (Temirgalieva, 2003). Held annually in the Karkaraly region, the fair attracted participants from various regions, including Kazakhstan, Siberia, Central Asia, and western China. By 1900, the fair had expanded significantly, encompassing 276 shops and 707 yurts over an area of 55 km^2. Each year, the fair sold over 200,000 livestock, including horses, cows, sheep, and goats, demonstrating a high level of engagement and participation. The fair also featured cultural activities, including wrestling matches and performances by akyns (poets), highlighting the integration of traditional competitions into larger communal events.

The Russian military presence introduced new recreational elements into Kazakh culture, especially among men who enlisted or interacted with soldiers. The emphasis on military exercises and training gave Kazakh men new forms of physical activity and new leisure activities, such as wrestling. Traditional Kazakh wrestling and equestrian games, however, remained popular, reflecting the resilience of Kazakh cultural identity in the face of growing external influences.

With the establishment of the Soviet Union, Kazakh recreational practices underwent significant changes. Nomadic lifestyles were discouraged, and the Soviet state promoted a collectivised, agricultural society. This shift affected men's recreation: Sports and physical education were encouraged by the state as a means of fostering loyalty and physical fitness. The state rejected traditional games and introduced Soviet-style sports like football and boxing into organised community settings. As part of state-sponsored leisure activities, Kazakh men were required to participate in activities that promoted Soviet values. During World War II and the post-war years, Kazakh men's leisure activities were shaped by the demands of Soviet society. Physical labour on construction sites and collective farms often replaced traditional leisure activities. Soviet ideology popularised organised sports like football, wrestling, and weightlifting, promoting them as a means to develop a 'strong Soviet man'. Villages and workplaces often held competitions, creating a new form of social bonding and recreation in a structured, controlled environment.

Since the 1960s, there has been a renewed interest in preserving traditional Kazakh culture, including recreational activities. Soviet policies allowed the revival of the Kazakh language, music and some traditional sports, although these were integrated with Soviet values. Equestrian wrestling and falconry re-emerged with the support of cultural institutions. Many men were involved in both Soviet-style sports clubs and traditional Kazakh games, reflecting a hybrid identity (Talinbayi et al., 2018). The collapse of the Soviet Union in 1991 brought new freedom for Kazakh men to reconnect with their heritage. Traditional recreational activities, such as audaryspak and falconry, were celebrated and organised into national festivals. There was a revival of Kazakh customs, and men once again took part in traditional games, hunting, and storytelling. However, the economic hardship curtailed leisure activities, as many men prioritised survival and adjusted to the shifting economic conditions. The freedom to choose a style of leisure, whether traditional or modern, became an important part of the evolving Kazakh identity.

In the 21^{st} century, recreation for Kazakh men has become a balance between traditional and modern lifestyles. National sports such as kures and buzkashi are increasingly emphasised, and tournaments are held to promote Kazakh heritage. Falconry and equestrian wrestling are becoming increasingly visible cultural symbols, supported by both the state and private organisations. At the same time, modern Kazakh men have utilised a wide range of recreational opportunities, from Western sports such as football and basketball to leisure activities such as hiking and fishing, combining Kazakhstan's natural landscape with recreational pursuits (Gallo, 2020). Quantitative data from the 2024 cultural statistics of Kazakhstan indicates a robust engagement in cultural and leisure activities. The number of events held by cultural and leisure organisations increased by 8.8% compared to the previous year, reflecting a growing interest in organised cultural activities. Additionally, attendance at cultural institutions saw significant rises, with zoos experiencing a 30.0% increase, concert organisations 12.1%, and cultural and leisure organisations 11.5%.

These figures suggest a high level of public involvement in cultural events, including traditional festivals and competitions (Bureau of National Statistics. . . , 2024a).

Urbanisation and globalisation have brought a variety of recreational activities beyond the traditional ones into the lives of Kazakh men. The emergence of gyms, sports clubs and social media has helped popularise fitness and bodybuilding among young men, while urban events and music festivals offer new recreational opportunities. While traditional Kazakh games are less common in urban areas, they still hold significance in rural areas and during national holidays. Modern Kazakh men have a wide range of leisure choices, reflecting a combination of global and local influences in contemporary society (Pelizzo & Knox, 2021).

From the eighteenth century to the early 2020s, Kazakh men's leisure culture has evolved from traditional nomadic practices driven by the need for survival to a modern society influenced by both local and global trends. Despite political and social changes from Russian colonisation to Soviet rule and independence, Kazakh men have retained a deep connection to traditional activities such as wrestling, falconry, and equestrianism, although these sports have adapted over time. In the twenty-first century, Kazakh men's leisure culture reflects both pride in national identity and openness to modern influences, balancing the old and the new, thus celebrating Kazakhstan's unique history and cultural diversity.

3.3 Culture of recreation of Kazakh women in the 18th – 21st centuries

In the 18th century, Kazakh women's lives were defined by their role in a nomadic, clan-based society where women managed households, cooked meals, practised crafts, and cared for children. Daily life required resilience and adaptability. Kazakh women's leisure activities were often intertwined with these tasks, combining work and socialising. Embroidery, weaving and felting — essential skills for the production of household items and clothing — were both practical and creative activities. Storytelling played an important role in the social life of Kazakh women. Women gathered to share stories, folktales and oral histories, which served both as recreational activities and as a means of transmitting cultural values. These gatherings allowed women to relax, exchange ideas, and strengthen community ties. Women often passed along songs, riddles, and proverbs, creating an oral tradition that preserved Kazakh heritage. These community gatherings, although informal, were central to Kazakh women's leisure culture, which promoted mutual support and cultural continuity. Kazakh women participated in traditional songs that accompanied holidays, festivals and daily work. The dombra, a two-stringed instrument, often accompanied the singing. Although men traditionally played instruments, women contributed through voice and dance, which were important for community gatherings (Peterson, 1999).

Festivals, especially those that celebrated seasonal changes and important life events, provided Kazakh women with opportunities for recreation and cultural expression. Women participated in holidays such as Nauryz (Kazakh New Year), where they participated in the preparation of traditional foods and ceremonial duties. These events allowed them to break from their daily routine by participating in feasts, games, and dances. The festivals strengthened social bonds and allowed women to express their creativity and pride in cultural traditions, reflecting the communal nature of Kazakh recreation (Lewandowska-Tomaszczyk & Utegaliyeva, 2020).

With the growing Russian presence, new social norms began to permeate Kazakh society. Russian education and Christianity introduced customs that influenced how Kazakh women spent their leisure time. While many women continued to engage in traditional activities, social practices such as tea parties and Russian-style celebrations began to emerge, particularly in urbanised areas. However, these new forms did not entirely displace pre-existing cultural practices shaped by Islam, which had long played a role in structuring everyday life and social interactions. For instance, Islamic religious holidays such as Eid al-Fitr (Oraza Ait) and Eid al-Adha (Qurban Ait) remained significant communal events, during which women participated in preparatory activities, communal cooking, and hospitality. These events served not only religious functions but also provided women with opportunities for socialising, storytelling, and reaffirming communal bonds. Thus, the leisure culture of Kazakh women during this transitional period reflected a

synthesis of influences, where Islamic traditions coexisted with emerging Russian customs, illustrating the layered and dynamic nature of cultural adaptation.

Russian colonisation facilitated educational reforms, resulting in the first school for Kazakh girls in the late nineteenth century (Aldashev & Guirkinger, 2017). Education provided new opportunities for recreation and personal development as girls and young women began to read, write, and share cultural values. For those who attended school, leisure activities expanded to include literary and artistic pursuits encouraged by Russian education. Although formal education was still rare in rural areas, its spread led to an important increase in Kazakh women's leisure opportunities, allowing them to engage in intellectual activities and socialise outside the home (Roy et al., 2023).

Kazakh women's leisure activities changed during the early Soviet period, as Soviet policies promoted collectivisation and discouraged traditional practices. The Soviets encouraged women's participation in community organisations, introducing new forms of recreation consistent with Soviet values, such as sports clubs, community festivals, and literacy programmes. Traditional crafts and gatherings were discouraged, and collective farms and communal labour projects created new spaces for women to socialise. The Soviet programme aimed to create a "new Soviet woman", and recreation became a means of promoting state values and collective identity.

The Soviet women's sports policy introduced structured recreation, which had previously been a rarity in Kazakh society. Kazakh women participated in organised sports, such as gymnastics, athletics, and group exercise, which were encouraged by the state to build physical strength and community spirit. Women's involvement in sport was encouraged as part of the Soviet ideology of equality and collectivism. While traditional leisure activities were restricted, Soviet sports programmes created new recreational opportunities, especially among young Kazakh women in urban areas. In the later years of the Soviet Union, there was a renewed interest in preserving Kazakhstan's cultural heritage, and traditional leisure activities among women began to revive. Embroidery, weaving, and other crafts became popular again, and state-sponsored cultural centres promoted these arts. Women reintroduced traditional dance, music and storytelling, often during national festivals. This period saw a mix of Soviet and Kazakh leisure activities: traditional crafts and Soviet-style sports coexisted with each other. Many women combined modern work with a renewed interest in traditional arts, reflecting a hybrid cultural identity.

After Kazakhstan's independence in 1991, there was a renewed focus on Kazakh heritage, with particular attention paid to revitalising traditional customs and women's recreation. National pride and efforts to preserve culture led to the return of festivals and traditional crafts as the main forms of women's leisure activities. The freedom to follow Kazakh customs encouraged women to reconnect with their cultural roots, especially in rural areas. However, economic problems and changes in society have also affected women's lives, forcing them to balance traditional customs with the demands of a transitional economy.

In the twenty-first century, Kazakh women's leisure activities reflect a combination of heritage and modern influences. Traditional arts and crafts are popular, and many women are active in weaving, embroidery, and jewellery. At the same time, urbanisation and globalisation have introduced new forms of recreation, including fitness classes, cinemas, and online communities (Bureau of National Statistics. . . , 2024b). Today, women enjoy both modern amenities and the opportunity to participate in national heritage activities, reflecting the diversity of contemporary Kazakh society. Table 2 presents a comparison of men's and women's leisure activities across these periods.

For both men and women, there is a shift towards more active and varied leisure activities. In both cases, there is a growing interest in sports and tourism, and traditional games and festivals are being revived. Women, on the other hand, are increasingly involved in cultural life, and their role in social processes is expanding.

4 Discussion

The findings of this study reveal significant transformations in the role of women in Kazakh society, particularly in relation to leisure practices. Traditional nomadic society closely tied women's leisure activities to family responsibilities and social functions, emphasising community and cultural continuity. This aligns

Table 2: Comparison of leisure activities in nomadic and sedentary cultures of Central Asia

Period	Men	Women
18th century	Horse competitions (kokpar, audaryspak), hunting, wrestling, evening conversations in yurts.	Participation in rituals (Nauryz and weddings), handicrafts, raising children, passing on folklore.
19th century	Hunting, competitions (baiga), men's gatherings, influence of Russian culture, evenings with dombra.	Raising children, handicrafts, participation in rituals, teaching girls how to run a household.
20th century (Soviet period)	Sports (football, wrestling, tennis), clubs, cinema, chess, trips to the countryside.	Theatre, clubs, cinema, family walks, gardening, work in Soviet structures.
Post-Soviet period	Traditional and modern sports, fitness, fishing, participation in traditional festivals.	Fitness, participation in festivals, traditional handicrafts, family leisure.
Modern times	Sports (running, swimming, fitness), tourism, social networks, participation in competitions and marathons.	Cultural events, fitness and yoga, tourism, social networks.
Common features and trends	Transition to sports and tourism, revival of traditional games and festivals, development of sports and technology.	Self-development, participation in cultural life, expansion of the role of women in public life.

Source: Compiled by the authors based on Kendirbay (1997), Mgonja (2020), Aden (2023), The culture of Kazakhstan in 18–20 centuries (2019).

with the findings of Morrison (2023), who argues that socio-economic changes, such as those resulting from World War I, led to shifts in women's roles and increased their participation in public life. However, in contrast to Morrison's focus on political activism, this study highlights the shift towards individualised leisure and the adoption of Western leisure models in the twentieth century, which reflect broader social and economic changes in Kazakhstan. The comparison with Teğin (2024) further supports this interpretation, as both studies show how external factors, like Russian colonisation, reshaped gender roles. This study extends the analysis by examining how leisure culture served as a locus for these transformations.

The study also contributes to the broader literature on gender and social change in Central Asia. While Abildinova et al. (2023) explored the impact of digitalisation and the shift from offline to online leisure activities in post-pandemic Kazakhstan, this study offers a historical perspective on how gendered leisure practices have evolved over centuries. The shift from collective, family-based leisure to more individualised activities parallels Abildinova et al.'s findings on the commercialisation and privatisation of leisure; this study focuses on how gender roles were implicated in this transformation. The absence of religious practices in this analysis, in contrast to Abildinova et al., opens avenues for future research that could integrate religious influences on gendered leisure practices in Kazakhstan. Furthermore, the impact of modernization on gender equality, as identified by Kan (2023), is consistent with this study's findings, where the increasing individuality in leisure practices mirrors changes in women's roles in both the family and society.

This study also challenges existing interpretations of colonial impacts on gender roles in Kazakhstan. Drawing on Teğin's (2024) analysis of Russian colonialism's influence on traditional nomadic life, this research demonstrates how the transformation of leisure practices was not solely driven by external political forces but also by internal social dynamics, such as gendered expectations of leisure. The introduction of Western-style leisure further complicated traditional gender roles, offering new opportunities for women while also creating tensions with longstanding social norms. This study thus expands on Teğin's work by considering not just the economic and political disruptions caused by colonialism, but also the cultural and gendered aspects of transformation. Zhao (2022) provides a similar comparison by analysing the role of migration in changing gender roles in Uzbekistan; however, this study contributes by focusing on how the historical trajectory of leisure practices over multiple periods — colonial, Soviet, and post-independence — affects both men and women in Kazakhstan, thereby offering a more comprehensive view of gendered experiences across time.

In conclusion, this study contributes to a more complex understanding of how cultural practices —

particularly leisure activities — are deeply embedded in social, economic, and gender transformations. It builds on existing research by contextualising changing gender roles within a historical framework that spans multiple political and social transitions. This long-term perspective highlights how leisure culture is both a reflection of and a site for negotiating shifts in gendered power dynamics in Kazakhstan. By situating leisure in the broader social and historical context of gendered change, this study makes an important contribution to the understanding of gender roles in Central Asia, offering a new lens through which to view the evolution of cultural practices over time.

5 Conclusions

The results of the study demonstrate significant changes in the leisure culture of Kazakh men at different historical stages. Traditional nomadic societies viewed leisure activities as functional and collective, closely linked to daily life and economic activities. Activities such as wrestling, equestrian competitions and hunting have important social and educational functions. The Soviet authorities actively introduced standardised forms of leisure activities oriented towards socialist ideology. Mass physical culture events, sports sections and festivals have become an integral part of social life. Since the late 20th century and well into the early 21st century, with the collapse of the Soviet Union and globalisation, there has been a revival of interest in traditional sports and recreation. The study found that, despite the influence of Western culture and global trends, Kazakh men remain committed to their historical traditions in sports and leisure, which emphasises the importance of cultural heritage in shaping national identity.

Recommendations for future research include developing state support to preserve traditional leisure activities and integrating them into education to strengthen cultural heritage. Further exploration is needed to understand the impact of digital platforms and new leisure forms on health and social relationships. Limitations of the study include a lack of primary sources from the 18th and 19th centuries, making it difficult to fully capture the nuances of leisure culture during those periods. Additionally, the study's focus on Soviet and colonial periods requires cautious interpretation due to potential political bias, and the lack of gender-focused research limits a comprehensive analysis of leisure practices across genders in Central Asia.

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Book Review: The Culture Transplant: How Migrants Make the Economies They Move to a Lot Like the Ones They Left

Garett Jones, Stanford University Press, 2023
Reviewed by Aldric Hama

George Mason University professor of economics Garett Jones launches his book with a striking thought experiment: to boost "mediocre" (dismal, really) economies of Egypt, Paraguay and Indonesia by importing Chinese for "about a dozen years", the equivalent of two percent of each nation's population per year (p. ix). According to Jones' math, this would lead to a total of "24 million" Chinese occupying mostly Sunni Muslim Egypt. (There were over 110,000,000 Egyptians in 2021, but who's counting?[1]) There will be more Chinese and mixed Chinese over time if the immigrants marry natives. What kind of Chinese migrant would form the core of Egypt's, Paraguay's and Indonesia's envisioned economic revival? Those with "no criminal record, high school graduate... maybe a little college or some trade school experience." (p. x)

With respect to Indonesia, Jones suggests importing a total of 60 million Chinese into the world's most populous Muslim country, despite its well-known history of anti-Chinese violence. He does mention, in passing, native "hostility" to Chinese immigrants and Chinese-Indonesians in a couple of sentences (p. 129), but goes on to claim that the prospect of "ethnic riots every decade that kills two thousand people" for an economic revival is "worth the risk." (p. 136)

Whether the Chinese government will countenance exporting its citizens as a solution to its social problems (e.g., too many single males or "bare branches") and whether receiving countries will actually welcome mass Chinese immigration, or anyone else who are phenotypically different from the natives, are real issues but well beyond the scope of Jones' book.

Jones bases his thought experiment on the observation that Chinese immigrants and their descendants in Southeast Asia, including Indonesia, are "more prosperous and better educated than the indigenous populations." (p. 123) While Jones optimistically imagines economic benefits trickling down from a well-to-do minority to the *Pribumi* majority, others are not so sanguine. In 2004, Yale Law School professor Amy Chua has pointed out in *World on Fire* that wealth accumulated by the "more prosperous" and "better educated" Chinese throughout Southeast Asia is preserved within Chinese groups via ties of kinship and support by the ruling oligarchy.[2] First-generation Chinese immigrants and their descendants, to varying degrees, retain Chinese cultural practices and language — as other immigrant groups do, as Jones will tell us. In the case of Indonesia, open expression of Chinese culture had the same effect as blood for sharks. Shrugs Jones, "Yes, there will be ... ethnic backlash ... but ..." (p. x)

If one skips Jones' bizarre migration policy suggestion, the rest of his book is in fact an informative and open discussion of immigration.

In the US, modern immigration policy attempts to straddle big business needs, "humanitarian protection" and promotion of "[racial] diversity".[3] Widely held beliefs concerning immigrants in Western countries include immigrants will lose their old culture and values and adopt their new homeland's values. Also, antagonism between natives and immigrants, who are culturally and genetically distinct from the natives, is the natives' fault.

[1] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=EG

[2] Chua, A. (2004). *World on Fire*. NY, NY: Knopf Doubleday.

[3] In the US, "promoting diversity" via immigration falls specifically under the Diversity Visa Program. https://www.americanimmigrationcouncil.org/fact-sheet/how-united-states-immigration-system-works-fact-sheet/

Jones squarely addresses whether immigrants in fact assimilate quickly to their new homeland — or do values and beliefs persist? Jones reports on multigenerational surveys of beliefs and values from the General Social Survey and World Values Survey, putting the "melting pot" process, the homogenization process of assimilation, to the test. He reports that immigrant culture is in fact "transplanted", in that the immigrants' culture "substantially survives migration" (p. 153); assimilation is "partial" and "incomplete" to approximately four generations. (p. 32) At the same time, immigrant values tend to become a part of the natives' values. As the book's title states, the countries that migrants move to will look more like the one they left.

Jones illustrates the persistence of values across generations by tracking values he says are crucial for national prosperity. To economist Jones, the benefits of immigration to raise national wealth outweigh any possible risks. Jones compares values of hyphenated Americans to those of citizens back in the home country. For example, frugality or saving rate tends to last to the third generation. Jones presents studies showing rate of savings in the home country generally predicts rate of savings of immigrants—countries with high savings rates predicted high rate of savings of immigrants, and countries with low savings rates predicted low immigrant savings rates. Furthermore, "people from high-trust societies pass on about half of their high-trust attitude to their descendants, and people from low-trust societies pass on about half of their low-trust attitudes." (p. 14).

At the same time, other values decrease and "fade out" over generations, such as religiousness and trust in the police. Briefly mentioned is the persistence of other traits that do not bode well for stability of liberal democracies such as low social trust, strong role of government in solving social problems, and religiousness. The studies cited by Jones involved mostly European immigrants moving to European countries and the US. European groups show variance in values persistence, but what can we expect with immigrants from non-Western and Muslim countries? In the US, second-generation immigrants are allowed to vote. Regardless of what commentators claim, values of the homeland, rather than values of their adopted home, will affect their choices.

Interestingly, Jones points out that second generation immigrants tend to express stronger country-of-origin values than their parents. For example, some second generation immigrants from high-saving countries appear to save more than their parents. Similarly, not mentioned in the book, immigrants from non-Western countries, such as Muslims, show increased religiousness in the second generation.[4]

Jones suggests that desirable immigrant values are not necessarily good for the country. For example, he says that while "strong family values" sounds like it is good for national prosperity, "stronger family values predict poorer families." (p. 22) Second generation adult immigrants whose parents are from countries with strong family values have lower wages than those with parents from countries with weak family values.[5] Jones (and the study authors) suggest that while job seekers will take jobs close to family, their preference will cause them to miss potentially higher wage jobs elsewhere. Furthermore, "strong family values" is also associated with job security. Immigrants with strong family values are also "more likely to believe that the government should save jobs or directly intervene to regulate wages." (pp. 23–24) As an alternative hypothesis, perhaps poor families, because they are poor, *need* strong family values. Readers are not told what the effect of importing people with "weak" family values would be, but this should be apparent to those living in Western countries, even without immigrants, with weak family values.

For those who notice such things, economically well-off nations with high social trust and low government corruption tend to be those with high average national IQs[6], and Jones in fact has pointed this out in his previous book—but not in his current book.[7] Furthermore, within the US, IQ predicts

[4] Voas, D., & Fleischmann, F. (2012). Islam moves West: Religious change in the first and second generations. *Annual Review of Sociology*, *38*, 525–545.

[5] Alesina, A., et al. (2015). Family values and the regulation of labor. *Journal of the European Economic Association*, *13*, 599–630. "Countries with strong family ties" were in Latin America, North Africa and Mediterranean Europe. Northern European countries tended to have weaker family ties.

[6] Lynn, R., & Vanhanen, T. (2002). *IQ and the Wealth of Nations*. Westport, CT: Praeger.

[7] Jones, G. (2016). *Hive Mind: How Your Nation's IQ Matters So Much More Than Your Own*. Stanford, CA: Stanford University Press.

socio-economic status and propensity to antisocial behaviour.[8] Screening potential immigrants for IQ as well as for job skill level and compatible national values would be a rational measure. Despite the data and common sense, as one will see, Jones does not offer measures based on—the data and common sense.

The transmission of values over generations with gradual acceptance of some native values suggests the heritability of behavioral traits and a gene-culture interaction between behavioral traits.[9] While Jones side-steps heritability of individual traits, he does not entirely ignore genetics. What readers will need to do though is some reading-between-the-lines.

Jones introduces readers to the "'Deep Roots' of comparative economic development" (p. 55), which is based on the concept that current levels of national economic development are the culmination of historical developments such as state or government history since 0 AD, agricultural history "in thousands of years" and technological history since 1500. (p. 52) Obviously, the development of technology and transmission of values necessary for national well-being involve people, and some groups of people are better at developing and transmitting than other groups. Jones also introduces economists who utilized "Genetic Distance" and "Genetic Diversity" (p. 55) to explain why some countries are richer than others.

The measure for genetic distance used in studies Jones cites is the fixation index (F_{ST}). This measure of genetic distance between populations is based on the variance in allele frequency between populations. Jones goes on to state that F_{ST}'s are calculated from "junk DNA" and takes up about two pages to assure us that large genetic distances between populations do not mean anything. Jones also blurts that genes do not "cause prosperity". (p. 58) Genetic distances between the US, as the baseline country, and other countries were examined to explain cross-country differences in economic development: countries genetically similar to the US were richer on average.[10] (p. 58) That more prosperous countries (European countries) are genetically closer to the US (mostly European) highly suggests a heritable factor underlying prosperity.[11]

Finally, in the context of immigration, Jones addresses whether or not "diversity is our strength." At the corporate level, following a literature review, specifically referring to racial ("racio-ethnic") diversity, Jones finds no benefit — even a negative effect — on group performance. (p. 88) Jones points out that studies finding negative effects on group performance of either racial or skills diversity in the workplace usually conclude that "diversity" is a "double-edged sword." Such language, Jones suggests, is a "triumph of hope over experience" (p. 89), that is, people will believe what they want to believe despite data to the contrary.

Increasing national ethnic and cultural diversity increases the risk of violence, but Jones mentions one other cost of increased diversity, the risk of diminished public goods. Underlying government spending on public goods, those goods that are shared and used by all such as "roads" and "public health systems", is a "sense of community" by taxpayers. (p. 98) Increased ethnic diversity "dulls that sense of community" and "amplifies cultural differences". (p. 99) Not only will there be less spending on public goods, but tax money will shift to "private goods", such as "scholarships and government jobs", which will be channeled to politically favored ethnic groups, perhaps as either rewards or bribes. While there appears to be overall no benefit to increasing ethnic and cultural diversity, Western elites, as Jones points out, have nonetheless doubled-down on immigration based on the "outdated, unscientific cliché" that "diversity is our strength". (p. 100)

Jones' immigration suggestions, being framed with an economist's view, leave much to be desired. He suggests: Import immigrants who have more education and more job skills and more "pro-market attitudes" than the average citizen. (p. 100) Importing people who are genetically *distant* rather than genetically *closer* to the average citizen may well be preferable to the political class, but Jones prefers to leave this unsaid. To state otherwise would be xenophobic.

In addition, Jones suggests "welcoming refugees who've suffered great violence in their homelands" because this would be the humanitarian thing to do. Not mentioned is that refugees will most likely be low

[8] Herrnstein, R.J. & Murray, C. (1996). *The Bell Curve*. NY, NY: Free Press.

[9] Plomin, R. (2023). Celebrating a century of research in behavioral genetics. *Behavioral Genetics*, *53*, 75–84.

[10] One of the papers Jones cites: Spolaore, E. & Wacziarg, R. (2013). *Journal of Economic Literature*, *51*, 325–369.

[11] Hill, W. D., et al. (2019). Genome-wide analysis identifies molecular systems and 149 genetic loci associated with income. *Nature Communications*, *10*, 5741.

IQ and genetically distant to the wealthy countries that take them. This suggestion, though, has nothing to do with boosting national wealth. It rather depletes it. Pointing this out and being against such as scheme, however, would be xenophobic.

It appears Western, and more recently East Asian, countries facing declining fertility and an aging population are attempting to utilize immigration to maintain current levels of productivity. Whether the current global pool of immigrants is capable of advancing technology and thereby increasing national prosperity is not all that clear. What to do with the underclass, low-IQ "refugees" as well as underachieving natives, has yet to be spelled out as well. Policies will need to be in place to prevent what Jones characterizes as the periodic but "worth it" Indonesian-style response to multiculturalism. It is likely that government coercion will be necessary, such as a quota system or "coerced assimilation and cultural eradication" as in early 20th century Thailand.[12] Whatever the measures and given current trends, the countries that migrants move to will likely look like the one they left.

[12] Chua, *op cit*.

About Mankind Quarterly

Mankind Quarterly was founded as a quarterly journal of anthropology, in the broadest sense of "the science of man," in 1961. This was a time when the study of man had already diversified into physical anthropology, ethnography, quantitative cross-cultural research, archaeology and other subspecialties.

These developments took place against the background of a widening gulf between the biological and social sciences. Following the leading dogma of the day, cultural and social anthropologists in academe had begun to deny the importance of biology for behavioral and cultural phenomena. Conversely, biological (physical) anthropologists aligned themselves with the "hard" sciences, many describing themselves as human biologists rather than anthropologists in an attempt to distance themselves from a social anthropology that they no longer saw as scientifically sound. In many places, these divisions persist to the present day. *Mankind Quarterly* was founded as a response to these centrifugal trends. Its founders believed in the interdependence of human biology, behavior and culture, and they understood biological and cultural diversity as the outcomes of evolutionary, ecological, and historic processes.

In short, *Mankind Quarterly* was established as a journal for those scholars who still believed in a unified "science of man" that studies the interactions between biological and cultural diversity. It was first published in Edinburgh, Scotland in 1961, and then, from 1979 to 2014, by the Council for Social and Economic Studies (chaired by Roger Pearson) in Washington, D.C. In January 2015, publication was transferred to the Ulster Institute for Social Research, a non-profit organization in London, England. Throughout its existence, *Mankind Quarterly* has maintained its character as a journal devoted to the interdisciplinary study of man. New developments in the field were reflected in the journal early on. When first sociobiology and then evolutionary psychology developed descriptions of human nature and explanations for cultural universals, the new developments found expression in the journal. The same happened with behavioral genetics, which like sociobiology saw major advances during the last three decades of the 20^{th} century.

Today the editorial board includes scholars from 12 countries who represent a wide variety of disciplines including primatology, physical anthropology, archaeology, cultural anthropology, human genetics, differential psychology, sociology, and history. Despite their varied expertise and views, the editors share a common interest in the evolutionary and historical processes that generate human diversity, and in the universal features of human nature that constrain this diversity. Because history and biological evolution are ongoing processes, this includes an interest in the social, cultural, demographic and biological changes that are taking place in modern societies.

Some of the articles the journal publishes deal with the evolutionary and historic processes that have created the racial, ethnic, linguistic and cultural diversity we see today. Others describe present-day cultural diversity and ongoing trends, especially at the psychological level. During the last years, intelligence and its change over time have been especially active research areas, and a substantial part of this work has been published in *Mankind Quarterly*. The subject is important because education and intelligence are considered the key drivers of cultural change and economic growth, not only in developing countries but also in mature postindustrial societies. Other areas of special interest are the demographic changes that are taking place in countries today and that are shaping the world of the future.

Historically, *Mankind Quarterly* has earned a reputation for publishing articles in controversial areas, including behavioral race differences and the importance of mental ability for individual outcomes and group differences. During the "Bell Curve wars" of the 1990s, it became a target of attack when opponents realized that some of the work cited by Herrnstein and Murray had first been published in *Mankind Quarterly*. However, much of this science has stood the test of time. For example, the importance of genes for individual differences in intelligence is no longer controversial, and genetic effects on individual and group differences that were merely inferred in earlier research are now studied at the molecular level. There is nothing wrong with being at the embattled forefront of new scientific developments.

Most of the research that *Mankind Quarterly* publishes today is "normal" science, but the editors still welcome controversy and new ideas. They see it as part of the journal's mission to provide a forum for the presentation and discussion of theories and empiric research that challenge entrenched beliefs. Of course, the often contradictory views that are represented in *Mankind Quarterly* are those of the individual authors, not those of the journal's publishers or editors.

Notes for Authors

As a peer-reviewed academic journal of anthropology, *Mankind Quarterly* publishes articles on all aspects of the science of man, ranging from cultural and physical anthropology, and psychology and behavioral genetics, to demography, mythology, and the history of religion.

However, the editors are especially interested in articles relating to cultural and biological evolution, and to the interaction between biology and culture. Such topics include

(1) the historical origins of present-day cultural and biological diversity using approaches from history, archaeology, linguistics, mythology, and population genetics;

(2) the study of cultural and biological trends in contemporary societies including cross-cultural studies of personality, intelligence, and culturally transmitted beliefs and values, as well as the study of demographic trends and trends in physical characters and gene frequencies over time; and

(3) the implications of current trends for future human evolution.

Included in these areas of special interest are articles dealing with the evolution of personality, its expression in varying cultural, ecological, and economic conditions, and its implications for future cultural and biological evolution. Interdisciplinary approaches that integrate findings from historically separate disciplines and subdisciplines are especially encouraged.

Mankind Quarterly publishes research reports, theoretical articles, data-driven reviews, book reviews, and short communications on new discoveries or critical comments on published papers, either in *Mankind Quarterly* or elsewhere. Because *Mankind Quarterly* is read by individuals from diverse backgrounds, the authors of highly specialized or technical articles are asked to present the background and significance of their work clearly and concisely. Book reviews should also deal with publications that will be of interest to a non-specialist audience.

Theoretical articles may be speculative or controversial or both, but must be based on solid data. Submissions are evaluated only based on scientific soundness, relevance, and interest. Manuscripts should be composed in **Microsoft Word** and submitted electronically to:

submissions@mankindquarterly.org

The editors may request a printed copy of any article which is accepted for review by the journal's referees. The review process usually takes 1-3 months. Every effort is made to publish articles within six months after final acceptance.

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