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Effect of a Yoga Intervention on Well-being and Life Satisfaction among Late Adolescents: A Quasi-Experimental Study

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Abstract

Late adolescents face intense academic and social pressures, yet educational institutions often lack scalable, evidence-based programmes that build durable coping skills. Yoga offers a promising, low-cost solution. This study examines the effect of a structured yoga intervention on late adolescents' psychological well-being (PWB) and multidimensional life satisfaction (MLS). Two hundred participants aged 16–19 years were assigned to a 45-day yoga program (Sūryanamaskāra, Āsana, Prāṇāyāma) or a wait-list control group (50 males and 50 females per group). Participants completed the MLS and PWB questions before and after the intervention. A 2 (Group) × 2 (Time) repeated-measures ANOVA revealed significant interaction effects, with greater improvements in the yoga group for both PWB ($F(1,198) = 123.31$, $p < .001$) and MLS ($F(1,198) = 142.28$, $p < .001$). ANCOVA confirmed higher adjusted post-test scores in the intervention group (PWB $\eta^2 = .18$; MLS $\eta^2 = .09$; both $p < .001$). This 45-day yoga protocol significantly improved late adolescents' well-being and life satisfaction, beyond changes attributable to maturation or test repetition. These findings imply the promotion of structured mind–body sessions within college initiatives and call for future randomized, multi-site trials including physiological measures and follow-up assessments.

Keywords: Psychological well-being, Multidimensional life satisfaction, Sūryanamaskāra, Asanas, Prāṇāyāma

1 Introduction

Adolescence is a crucial developmental phase marked by biological maturation, shifting social roles, and heightened emotional reactivity. Late adolescence (15–19 years), in particular, represents a period when young people confront critical transitions such as the emergence of self-concept, growing autonomy from parents, and intense identity exploration (Erikson, 1956; Jung, 2014). Globally, one in seven adolescents experiences mental health conditions, yet many remain undiagnosed, facing stigma, exclusion, and academic or behavioural difficulties (World Health Organization, 2024).

1.1 Mental health challenges in Indian adolescents

In India, similar patterns are seen. Large-scale reviews confirm that emotional and behavioural problems are both common and wide-ranging. A systematic review of 31 studies conducted between 2013 and 2023 identified depression as the most common difficulty, followed by social-behavioural problems, anxiety, technology addiction, stress, and attention-deficit/hyperactivity disorder among adolescents (Balamurugan et al., 2024). A similar conclusion had been drawn by earlier research that examined 52 studies published between 2001 and 2015 and documented risk behaviors like alcohol and tobacco use, sexually transmitted infections, and interpersonal violence in addition to elevated depressive symptoms (Bej, 2015).

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Furthermore, a recent socio-ecological review (Gadgil et al., 2025) shows that layered forces shape help-seeking behavior among adolescents. At the family level, parental awareness and a willingness to seek care are positives, yet limited mental-health literacy and deep-rooted belief systems often hold adolescents back. At the school and policy level, vigilant teachers and policy moves toward youth-friendly services are promising, but staffing shortages, tight budgets, and persistent stigma remain significant barriers. Given these multi-level gaps and opportunities, brief low-cost programmes such as yoga, which can be embedded directly into the educational curriculum, offer a potential solution to improve well-being where formal services are scarce.

These concerns are equally salient for late adolescents in residential colleges, where adjustment to academic rigor, peer competition, and separation from family can diminish well-being and heighten vulnerability to stress (Beri et al., 2024; Patil & Kalmath, 2016). Notably, most students in such contexts do not seek formal mental health services, underscoring the need for proactive, embedded, and accessible interventions that strengthen resilience and coping skills in students before problems arise, thereby reducing the need for crisis intervention later on.

1.2 Positive indicators: Psychological well-being and life satisfaction

Recent scholarship emphasizes that adolescent mental health initiatives must go beyond symptom reduction to foster strengths and values that support life-long thriving (Bundick et al., 2010). Psychological well-being (PWB) and multidimensional life satisfaction (MLS) are two factors that come to aid. PWB is a eudaimonic construct consisting of emotional balance, autonomy, and a sense of purpose (Ryff, 2013), while MLS reflects hedonic evaluations of satisfaction with self, family, peers, school, and the broader environment (Huebner, 1994).

Research indicates that eudaimonic motives, like personal growth, increase life satisfaction by promoting active engagement, while relaxation-oriented motives may decrease it by promoting disengagement and avoidance (Choi et al., 2025). In this context, relaxation-oriented motives may be understood as escapist responses to life stresses, in which individuals avoid active engagement with problems rather than attempting to resolve them. Therefore, effective interventions must cultivate eudaimonic growth and broad life satisfaction to support lasting adolescent well-being.

Global research indicates that life satisfaction declines most rapidly during adolescence in nearly all regions, except South Asia and the Middle East–North Africa, where satisfaction levels are already low (Handa et al., 2023). These regions and sub-Saharan Africa also show the most significant gaps in life satisfaction between wealthier and poorer adolescents, highlighting unequal living conditions and the early burden of adult responsibilities. These regional disparities underscore the urgency of culturally grounded approaches to strengthen well-being and everyday satisfaction among late adolescents.

1.3 Interventions promoting well-being and life satisfaction

Indian adolescents' well-being and life satisfaction are shown to be promoted by a wide range of well-designed school-based programmes. Mindfulness-based cognitive behavioural therapy in Sikkim reduced depression and suicidal ideation while promoting life satisfaction (Raj et al., 2019); a 12-week hope curriculum in Jharkhand enhanced hope, self-worth, and life satisfaction (Alam & Mohanty, 2024). Brief gratitude and "best possible selves" exercises in Delhi increased life satisfaction and subjective well-being (Iqbal & Dar, 2022), and a 24-session "Strengths Gym" raised happiness, well-being, and life satisfaction scores in middle-school students (Khanna et al., 2021). Even large-scale studies such as the "Girls First Resilience Curriculum" for 2,300 rural girls improved emotional resilience and PWB (Leventhal et al., 2022). A recent scoping review confirms that multi-component, school-wide interventions are the most consistently effective (Mehra et al., 2022).

These trials confirm that well-structured psychological programs can lift adolescents' well-being and life satisfaction. However, comparison across studies is hindered by inconsistent outcome measures and considering life satisfaction as a secondary variable (Iqbal & Dar, 2022; Khanna et al., 2021). In addition, most programmes depend on resources that many educational institutions cannot easily afford, such as

specialist clinicians and extensive classroom time. Within this landscape, yoga emerges as a culturally rooted, low-cost alternative, readily delivered by campus instructors and specifically endorsed in India's National Education Policy for routine student-wellness provision (Ministry of Human Resource Development, 2020).

1.4 Yoga: A culturally rooted remedy

According to early Indian sources, yoga is a discipline based on spiritual devotion and inner mastery. The Katha Upaniṡad (VI.11) describes yoga as the firm restraint of the senses, performed with reverence to the Lord, who is the ultimate source and end of all things (Vasu, 1905). The Śvetāśvatara Upaniṡad (II.12–15) describes that by focusing on the five elements, the yogin achieves physical vitality, mental clarity, and ultimately oneness with the eternal self, which leads to liberation from suffering (Gambhirananda, 1986). While Patañjali's Yoga Sūtra (2nd century BCE) lays out the eight-limbed path aimed at calming the mind (Madhvācārya, 2007), later texts like the Yogatattva Upaniṡad (Ayyangar, 1952) provide concise practice guides, and the medieval haṭha texts (Muktibodhananda, 1998) emphasize bodily techniques and the awakening of kuṅḍalinī̄ energy. Building on this rich heritage, contemporary yoga combines posture, breath regulation, and meditation to promote psychological and physical balance.

Existing Indian studies offer a promising but uneven picture of yoga's impact on adolescent mental health. Randomised and quasi-experimental trials have shown that diverse yogic formats such as daily 60–minute āsana–prāṅāyāma classes (Verma et al., 2025), thrice-weekly Yoga-nidra sessions (Vaishnav et al., 2018), a one-month integrated programme of postures, breathing, and meditation (Bilagi et al., 2025), and the Sudarshan Kriya Yoga breathing protocol with 40 days of home practice (Subramanian et al., 2025) have consistently been shown to reduce depression, anxiety and stress while elevating well-being in its various forms, such as general, cognitive, and emotional. However, only the Verma study included a validated life-satisfaction measure, and it was treated as a secondary outcome. Across studies, breathing practices and seated or supine techniques receive strong emphasis, whereas dynamic sequences such as Sūryanamaskāra are rarely incorporated and never evaluated as part of a structured module.

1.5 Theoretical framework

The expected impact of yoga on PWB and MLS can be understood using a combination of psychological and yogic theories. Self-determination theory (Ryan & Deci, 2000) proposes that when needs for autonomy, competence, and relatedness are supported, it leads to enhanced well-being. Yoga practices are shown to promote self-regulation through breathing techniques and mindful movements (Gard et al., 2014), enhance competence as individuals learn to master postures and attention (Kwasky & Serowoky, 2018), and foster relatedness when practiced in a group setting (Ross et al., 2014). Together, these processes can lead to greater overall well-being.

The broaden-and-build theory (Fredrickson, 2001) suggests that experiences resulting in positive emotional states enhance cognitive and attentional processes, enabling individuals to build lasting psychological resources. Yoga-based regulation of physiological arousal is therefore expected to contribute to more adaptive appraisals of one's life circumstances, which supports higher life satisfaction. These psychological mechanisms are consistent with the Pancha Kosha model (Gambhirananda, 1958). Through combined engagement of the physical body, breath, emotions and attention, yoga practices may stabilise affective responses and promote clarity and balance in day-to-day functioning.

Together, these frameworks relate to the view that yoga strengthens self-regulation, enhances cognitive–emotional balance, and improves social and internal experiences, providing a theoretical basis for expecting improvements in psychological well-being and life satisfaction.

1.6 Research gaps and present study

Despite the earlier studies, substantive gaps remain in the adolescent yoga literature. First, very few trials have treated MLS as a primary outcome, so very little is known about how yoga influences late

adolescents' appraisals of family, friends, school, and self. Second, most studies combine practices in broad "integrated" packages or single-technique protocols; none have evaluated a pre-specified sequence that pairs Sūryanamaskāra with selected standing–balance āsanas and follows these with breath-regulation, even though classical sources (Haṭ ha Yoga Pradīpikā 2.1) advise mastering postures before beginning prāṅāyāma (Digambaraji & Gharote, 1978; Muktibodhananda, 1998). Third, existing evidence is drawn mainly from school settings or on a special population (e.g., adolescents with depression, suicidal ideation, or in institutional care), leaving everyday college environments, where most of the late adolescents are present, understudied.

The present quasi-experimental study addresses these gaps by implementing a 45-day, residential college-based programme that follows the classical posture-then-breath progression: beginning with Sūryanamaskāra, and followed by five standing/balance āsanas and three well-defined prāṅāyāma techniques. Outcomes are assessed using validated, multidimensional measures of PWB and MLS, providing a focused examination of yoga's potential to enhance positive mental health indicators among late adolescents in a semi-urban Indian college.

1.7 Study objectives

1. To assess whether participation in a yoga-based intervention leads to improvements in PWB and MLS compared to a control group.
2. To compare changes over time between the experimental and control groups to determine whether observed effects are attributable to the intervention.

2 Material and methods

2.1 Hypothesis

Based on the study objectives, the following one-tailed hypotheses were developed. All hypotheses were directional (one-tailed) and guided by prior evidence suggesting a beneficial effect of yoga interventions on psychological outcomes.

H1: After controlling for pre-test scores, participants in the experimental group will report significantly higher post-test PWB compared to participants in the control group.

H2: After controlling for pre-test scores, participants in the experimental group will report significantly higher post-test MLS compared to participants in the control group.

H3: The experimental group will exhibit significantly greater positive change over time in PWB and MLS compared to the control group.

2.2 Pilot study

A pilot study was carried out using the eight-domain framework (Bowen et al., 2009) to assess the viability of the yoga-based intervention. Eight residential college students participated in feasibility sessions: 6:30 AM–7:00 AM (4 members), and 6:00 PM–6:30 PM (4 members), one week to ensure that the intervention's timing, content, and delivery were appropriate and feasible. A sample of 30 students was used to evaluate the internal consistency of the two scales; Cronbach's alpha coefficients for both scales (overall) ranged from .72 to .84, indicating acceptable reliability (Taber, 2018). Two hundred twenty-one students showed interest in participating in the study upon attending a recruitment orientation session. Students reported no major difficulties, suggesting the intervention was feasible and encouraging us to proceed with the full-scale study.

2.3 Study design and setting

An *open-label, two-arm, parallel-group, superiority, quasi-experimental design* was used in this study. After receiving the necessary administrative and ethical approval, the study was conducted in a government residential junior college (anonymized to maintain confidentiality) among 12th-standard and vocational course (post-10th-standard) students in Visakhapatnam, Andhra Pradesh, from July to August 2024, with a pilot study carried out in February 2024. Using G*Power software, an a priori power analysis for ANCOVA (with two groups and two covariates) indicated that a minimum of 147 participants was required to detect a medium effect size (f = 0.30) with α = 0.05 and 95% power. However, to strengthen statistical validity and maintain balanced group sizes, we enrolled 200 participants (100 per group), based on students' interest and availability. This study adhered to the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines (Des Jarlais et al., 2004) to ensure comprehensive and transparent reporting of behavioral intervention research.

Inclusion criteria

- No prior yoga experience
- No diagnosed psychological or physiological disorders
- Ages between 15 and 19 years
- Willingness to participate in the study
- Received consent from parents/guardians to participate in the study

Exclusion criteria

- Unwillingness to participate
- Less than 15 years or more than 19 years
- Presence of diagnosed psychological or physical conditions
- Lack of parental or guardian consent

2.4 Participants

The mean age of participants was 16.99 years (SD = 0.95) in the experimental group and 16.87 years (SD = 0.86) in the control group. As shown in Figure 1, following an initial orientation session, 221 students showed interest. Among these, 205 met the eligibility criteria. Using a non-random, purposive sampling approach, the first 100 eligible students were assigned to the experimental group and the next 100 to the control group. To minimize gender-related biases, both groups were matched for gender (50 males and 50 females), helping to ensure group equivalence despite the absence of randomization. Following the completion of the study, the intervention was made available to the five remaining eligible students. Throughout the 45-day intervention period, regular check-ins and coordination with college staff maintained participant engagement and motivation. As a result, no participants withdrew from the study, ensuring a complete dataset at post-test.

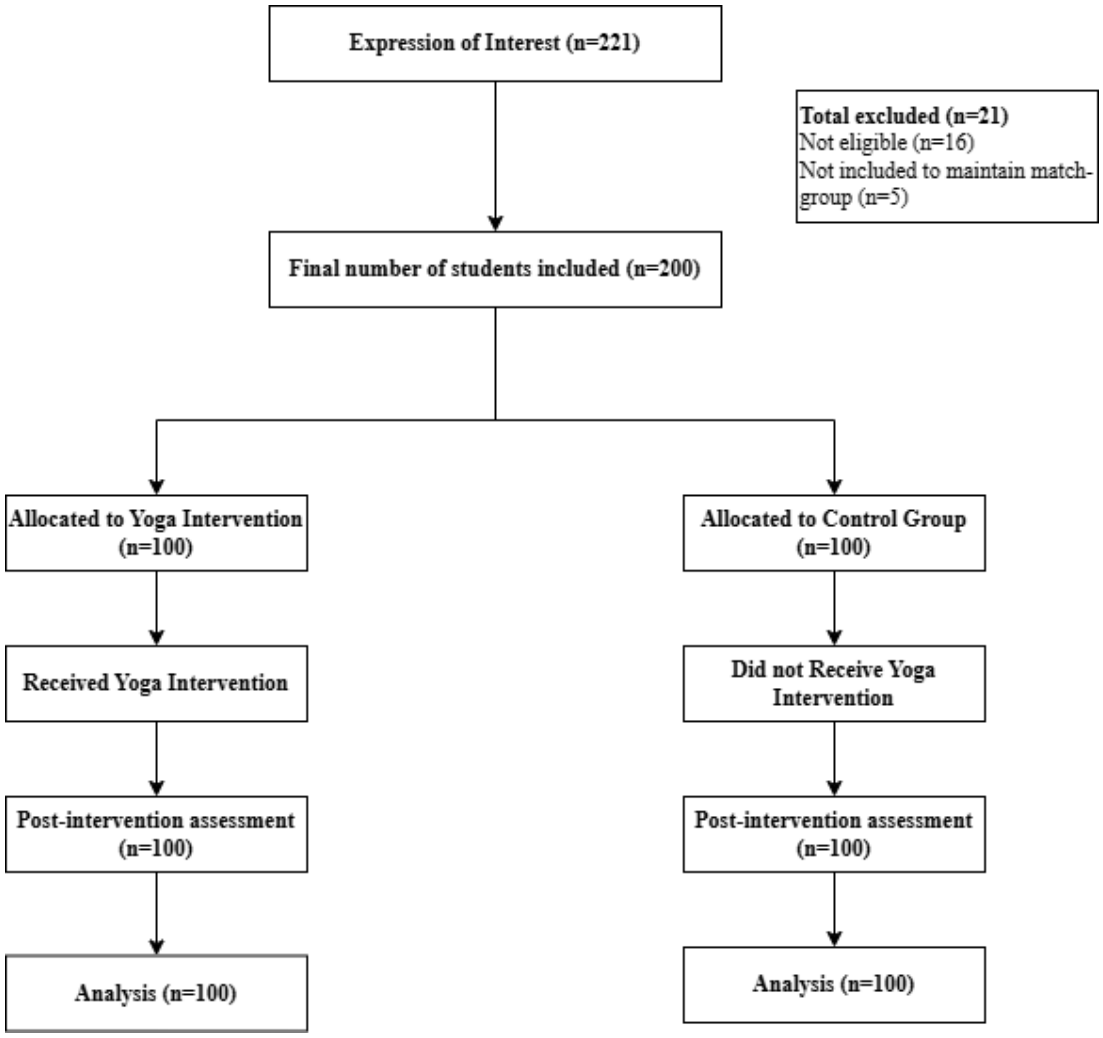

Figure 1. Flow diagram depicting participant recruitment, allocation, intervention, and analysis

Table 1. Daily practice structure

Segment	Activity
Centering	Seated posture, silent breath awareness Activity time: 2 min Week plan: Same throughout the intervention
Warm-Up	Neck rolls, shoulder rolls, ankle rotations Activity time: 5 min Week plan: Same throughout the intervention
Sūryanamaskāra	3 rounds of 12 poses (moderate pace); start slow, gradually increase (10–12 minutes) 12 poses: Pranāmāsana (Prayer Pose), Hasta Uttānāsana (Raised Arms Pose), Pādahastasana (Hand to Foot Pose), Aśva Sañcālanāsana (Equestrian Pose / Low Lunge), Parvatasana (Mountain Pose / Downward Dog), Aṣṭāṅga Namaskāra (Salute with Eight Parts or Points), Bhujangāsana (Cobra Pose), Parvatasana (Mountain Pose / Downward Dog), Aśva Sañcālanāsana (Equestrian Pose / Low Lunge), Pādahastasana (Hand to Foot Pose), Hasta Uttānāsana (Raised Arms Pose), Pranāmāsana (Prayer Pose). Activity time: 10–12 min Week Plan: – Week 1–2: 3 rounds, slow pace – Week 3–4: 5 rounds, low-medium pace – Week 5–6: 7 rounds, medium pace

Āsana	Paścimottānāsana (seated forward bend), Vŕkṣāsana (tree pose), Śaśāṅkāsana (the pose of the moon or hare pose), Uṣṭrāsana (camel pose), Utthān Pādasana (raised legs pose) Activity time: 4–5 min Week Plan: – Week 1–2: 3 rounds, hold the pose for 10–15 sec – Week 3–4: 3 rounds, hold the pose for 15–20 sec – Week 5–6: 3 rounds, hold the pose for 20–30 sec
Prānāyāma	Nāḍíśodhana (alternate nostril breathing), Bhastrikā (bellows breath), Ujjāyī (victorious or ocean breath) Week plan: – Week 1–2: Activity time: 3–5 minutes – Week 3–4: Activity time: 5–7 minutes – Week 5–6: Activity time: 7–10 minutes
Cool Down	Śavāsana Activity time: 5 minutes Week plan: Same throughout the intervention

2.5 Yoga intervention and the experimental group

The yoga intervention was designed specifically for late adolescents, emphasizing postures and breath control. The intervention plan (as shown in Table 1) was developed with the help of classical yoga texts and refined through pilot testing and expert (yoga and psychology) feedback to ensure relevance and feasibility within a residential college setting. Sessions were led by a certified yoga instructor with over five years of experience in group yoga teaching. Each session involved 50 students and was conducted in two daily batches, morning (6:30 AM–7:00 AM) and evening (6:00 PM–6:30 PM). The lead trainer was supported by three assistant facilitators who were trained in yoga instruction to ensure consistent supervision and postural correction and provide support throughout the practice. Due to the nature of the intervention, blinding of participants and facilitators was not feasible. However, efforts were made to minimize potential bias by maintaining uniform scheduling and consistent facilitator-led instructions across both groups.

2.6 Control group

A wait-list design, commonly used in mind-body research despite its limitations in addressing expectancy or placebo effects (Karri et al., 2023), was adopted in this study to ensure control group participants had access to the yoga intervention after the 45-day study period to maintain ethical parity. To reduce attrition-related bias, participants were not exposed to intervention content during the frequent follow-ups (once every 15 days), and these interactions were limited to scheduling assessments and attendance. They were reminded of their importance to the study and cautioned against discussing the intervention with their peers. These actions increased retention without affecting the potential post-intervention outcomes.

2.7 Measures

Psychological Well-being

The 20-item Brief Scale of Psychological Well-being for Adolescents (BSPWB-A) (Viejo et al., 2018) was used to measure PWB. Four dimensions, autonomy, positive interpersonal relationships, self-acceptance and life development, are assessed (for coding and scoring, see Viejo et al., 2018) using a 6-point Likert scale (1-completely disagree and 6-completely agree). The English version of the scale provided by the authors was utilized in this study, even though it was initially created in Spanish. Both the pilot and final study samples showed satisfactory internal consistency despite the scale's lack of formal validation in the Indian context. Cronbach's alpha values for the pre-test were .76 (experimental) and .79 (control), and for the post-test were .72 (experimental) and .75 (control).

Multidimensional Life Satisfaction

Multidimensional life satisfaction was assessed using the Multidimensional Students' Life Satisfaction Scale (MSLSS) (Huebner, 1994), a 40-item scale rated on a 6-point Likert scale (1 = strongly disagree to 6 = strongly agree). The scale measures satisfaction across five domains: self, friends, school, family, and living environment (for coding and scoring, see Huebner, 1994). In addition to demonstrating good internal consistency in both the pilot and main study, the MSLSS has previously shown good reliability among Indian adolescents (Antaramian et al., 2016). Cronbach's alpha values for the current sample at pre-test were .81 (experimental) and .85 (control), and at post-test were .82 (experimental) and .85 (control).

Given the significant conceptual and empirical overlap among life satisfaction, happiness, and mental health measures, which are often described as reflecting a general factor of well-being (Longo et al., 2016), the use of two robust scales (PWB and MLS) was considered sufficient to capture the broader construct while avoiding redundancy.

2.8 Data collection

The researcher personally administered the questionnaire and collected the data in the college in a quiet and closely monitored classroom setting. All the groups finished the pre-test one day prior to the start of the intervention, and the post-test was completed right after the forty-five days. To minimize measurement error, standardized instructions were given. The questionnaire format was the same for both groups. No missing data were recorded, and each session lasted approximately 15-20 minutes. A control group and significant group × time interactions helped control for possible practice effects. Before participation, student and parental consent were obtained.

2.9 Statistical analysis

Prior to conducting the main analyses, assumption checks were performed for ANCOVA and repeated-measures ANOVA (RMANOVA) to ensure statistical validity. For ANCOVA, assumptions were evaluated, including the continuous nature of the variables, the absence of outliers (as determined by boxplots and standardized z-scores), normality, linearity between covariates and outcomes, homogeneity of regression slopes, and equality of variances (as assessed by Levene's test). RMANOVA assumptions, such as normality of repeated measures, absence of extreme outliers, homogeneity of variances, and sphericity, were also verified.

Chi-square tests were conducted to evaluate the comparability of baseline characteristics between the experimental and control groups in terms of categorical sociodemographic, health, and academic variables. Additionally, independent-samples t-tests were performed to assess differences between morning and evening intervention schedules. The analysis was performed using IBM SPSS 27. Effect sizes were reported using partial η^2, which indicates the proportion of variance explained by each effect after accounting for other factors in the model. Since there were no dropouts or protocol deviations, all 200 participants were included in the final analyses. Therefore, the analysis reflects both intention-to-treat and per-protocol approaches.

2.10 Ethical considerations

The study received ethical approval from the Institutional Review Board and permission from the college principal. Because most of the participants were under 18 years of age, written informed consent was obtained from the participants' parents or legal guardians along with the participants. The researchers explained the study's purpose, procedures, and voluntary nature to the participants and assured them of confidentiality and their right to withdraw at any point in time during or after the study. The collected data were stored in a secure, password-protected digital repository accessible only to the researchers. Identifiable information was separated from response data, and the latter was anonymized to ensure participant confidentiality.

3 Results

This section presents the outcomes of the intervention on late adolescents' mental health indicators. As shown in Table 2, the chi-square test results indicated that the experimental and control groups were largely comparable and had baseline equivalency in sociodemographic and health factors. Most participants came from smaller families and lived with their parents, indicating strong family support. Diagnosed health issues were rare and similarly distributed across groups. Sleep patterns were healthy and consistent, with most getting eight or more hours nightly on weekdays and weekends.

However, academic performance differed significantly between the groups: The experimental group had a higher proportion of top grades (A1 and A2), while the control group had a higher proportion of mid-level grades. This difference suggests a potential baseline difference in academic achievement that may influence the study outcomes and should be considered when interpreting the study's results.

Furthermore, independent-samples t-tests were conducted to compare the morning (n = 50) and evening (n = 50) yoga cohorts on all outcome variables at both pre- and post-intervention time points. Results indicated no statistically significant differences across any of the measures ($|t| \leq 1.86$, df = 98, all $p \geq .067$), suggesting equivalence between the two subgroups. Given this comparability at both baseline and post-test, the cohorts were combined into a single experimental group for subsequent analyses using repeated-measures ANOVA and ANCOVA to evaluate the overall impact of the yoga intervention.

Table 2. Relationship between experimental and control groups across sociodemographic, academic, and health variables

Variables	Experimental group (n=100)	Control group (n=100)	χ^2	*p*
Family size				
Below 4	58	65	1.07	.31
4 and above	42	35		
Living				
with parents	70	66	.37	.54
In hostel	30	34		
Diagnosed health issue				
Yes	14	8	1.8	.18
No	86	92		
Sleep hours (weekdays)				
4 to 5 hours	5	7	.39	.82
6 to 7 hours	37	35		
8 or more hours	58	58		
Sleep hours (weekend)				
4 to 5 hours	6	6	.09	.95
6 to 7 hours	42	44		
8 or more hours	52	50		
Academic Performance				
A1 Grade	6	2	**15.5**	**.02**
A2 Grade	28	10		
B1 Grade	8	6		
B2 Grade	35	53		
C1 Grade	5	8		
C2 Grade	15	17		
D/Fail	3	4		

Note. χ^2: Chi-square. Gender is not mentioned in the table, as they are divided equally.

To examine the effects of the intervention on psychological well-being and life satisfaction, both ANCOVA and RMANOVA were performed. Before analysis, key statistical assumptions were assessed. Normality was evaluated using the Shapiro-Wilk test, as well as skewness and kurtosis values, and histograms (Tabachnick & Fidell, 2013, p. 113). The variables were found to be normally distributed. One univariate outlier ($z > \pm 3.29$) was identified and retained due to negligible influence. For ANCOVA, the assumptions of linearity and homogeneity of regression slopes (p-value for IV * Covariate > .05) were met. Despite Levene's test (not violated for RMANOVA) indicating a violation of the homogeneity of variance assumption, analyses proceeded due to equal group sizes (n = 100), which helps minimize bias (Tabachnick & Fidell, 2013, pp. 241-242). A more stringent alpha level ($p < .025$) was applied to ensure a conservative interpretation of the results (Tabachnick & Fidell, 2013, p. 120). As repeated measures involved only two time points, sphericity was not applicable (Tabachnick & Fidell, 2013, p.870). Furthermore, Box's M test was significant for all variables, indicating a violation of the equality of covariance matrices; however, because group sizes are equal, this test can be ignored, as Pillai's Trace is robust to this violation (Tabachnick & Fidell, 2013, p. 294).

A 2 (Category: Experimental vs. Control) $\times$ 2 (Time: Pre-test vs. Post-test) repeated-measures ANOVA was conducted to examine changes in PWB and MLS (see Table 3). Results indicated a statistically significant main effect of time, F (1, 198) = 154.60, $p < .001$, partial $\eta^2 = .44$, indicating that there is an overall improvement in PWB across both groups from pre-test to post-test. More importantly, a significant time $\times$ group interaction was observed, F (1, 198) = 123.31, $p < .001$, partial $\eta^2 = .38$, indicating that the increase in PWB was primarily driven by participants in the experimental group (see Figure 2). This effect size falls within the moderate-to-large range (Cohen, 2013; Richardson, 2011), indicating that the intervention produced a significant change in PWB. In contrast, the between-groups main effect was not statistically significant, F(1, 198) = 2.29, $p = .13$, partial $\eta^2 = .01$, suggesting minimal baseline differences between the experimental and control groups. These findings suggest that the observed changes in PWB were due to the intervention's impact over time, rather than pre-existing group differences.

Table 3. Results of 2 × 2 mixed-design repeated-measures ANOVA examining the effects of group and time on psychological well-being (PWB) and multidimensional life satisfaction (MLS)

Variable	Effect	F(1, 198)*	*p*	Partial η^2
PWB	Time	154.60	$<$ .001	.44
	Group × Time	123.31	$<$ .001	.38
	Between-groups	2.29	.13	.01
MLS	Time	32.73	$<$ .001	.14
	Group × Time	142.28	$<$ .001	.42
	Between-groups	0.16	.69	.001

* Pillai's Trace values
Note. Experimental – Control (Mean Differences): PWB: 1.85; MLS: 1.22. Post–Pre (Mean Differences): PWB: 2.245; MLS: 1.41. All the mean differences are significant at the .05 level.

Complementing this, after controlling for pre-intervention PWB scores, the ANCOVA results (see Table 4) demonstrated a significant main effect of group membership on post-intervention PWB scores, F (1, 196) = 43.87, $p < .001$, partial $\eta^2 = .18$. Estimated marginal means showed that the experimental group had significantly higher adjusted post-test PWB scores (M = 83.74, SE = 0.21) compared to the control group (M = 79.76, SE = 0.21), with a mean difference of 3.98 (95% CI [3.40, 4.56], $p < .001$). These findings indicate that the intervention had a positive effect on participants' PWB, beyond what could be attributed to baseline differences, thereby supporting Hypothesis 1.

Table 4. ANCOVA results for post-intervention PWB and MLS scores, controlling for pre-test scores

Effect	Sum of squares	F	*p*	Partial η^2
Differences in Psychological Well-being scores				
Pre-PWB (covariate)	11933.11	2758.49	$<$.001	.93
Group (experimental vs control)	189.79	43.87	$<$.001	.18
Group × Pre-score	113.65	26.27	$<$.001	.12
Error	847.89	Mean square = 4.33		
Differences in Life Satisfaction scores				
Pre-MLS (covariate)	87346.72	8035.03	$<$.001	.98
Group (experimental vs control)	233.51	21.48	$<$.001	.10
Group × Pre-score	113.27	10.42	.001	.05
Error	2130.66	Mean square = 10.87		

Note. Degrees of freedom: 1, 196; dependent variable: post-test scores.

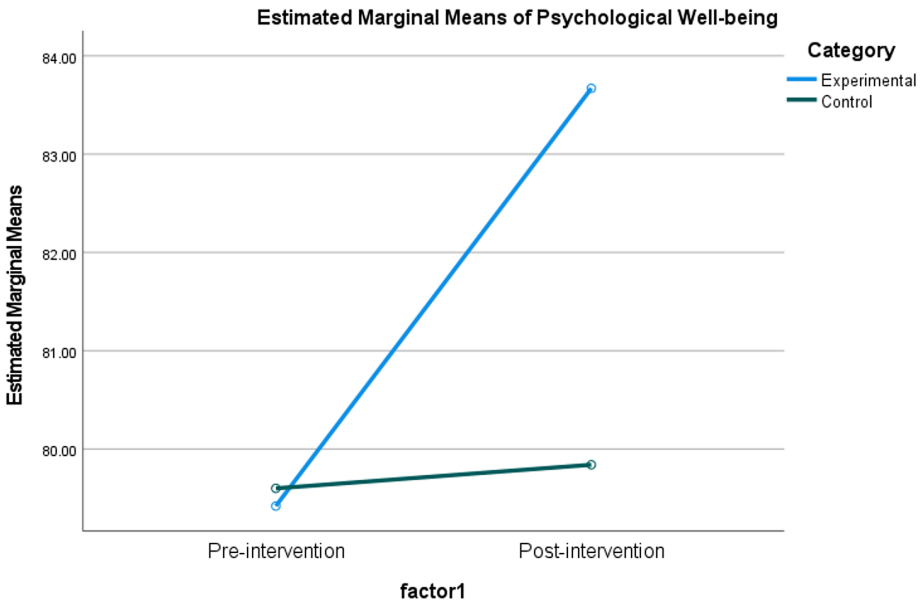

Figure 2. Estimated marginal means of Psychological Well-Being by group and time

For MLS, RMANOVA revealed significant changes over time, F (1, 198) = 32.73, $p < .001$, partial $\eta^2 = .14$, indicating a positive change throughout the study period. This was supported by a significant interaction effect, F (1, 198) = 142.28, $p < .001$, partial $\eta^2 = .41$, indicating that the experimental group experienced greater improvements relative to the controls (see Figure 3). This interaction effect reflects a moderate-to-large magnitude of change, suggesting a substantial practical impact of the intervention on MLS. The between-group differences were nonsignificant, F (1, 198) = 0.16, $p = .69$, partial $\eta^2 = .001$, suggesting that both groups began with comparable levels of MLS. These results suggest that the observed changes in MLS were primarily attributed to the intervention, rather than pre-existing differences between the groups.

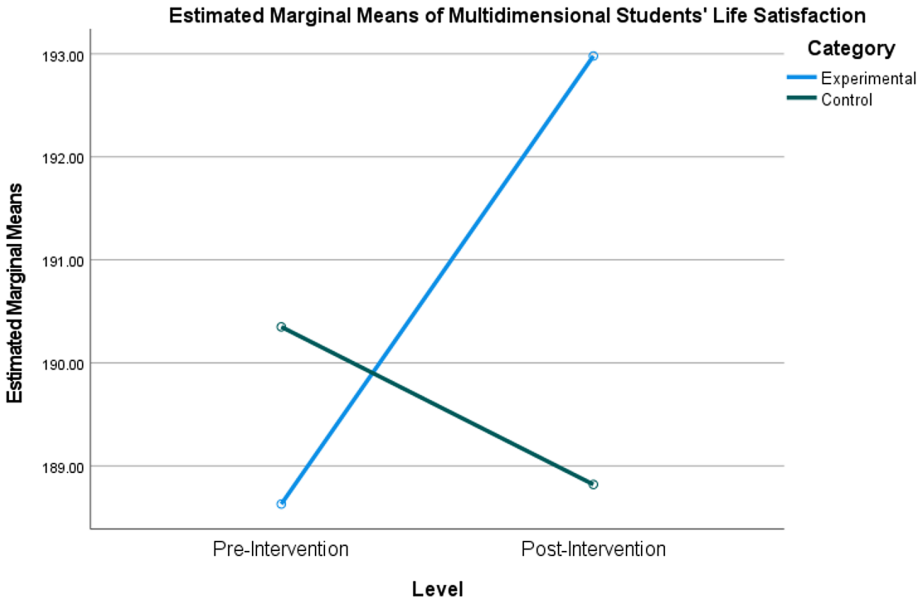

Figure 3. Estimated marginal means of Multidimensional Life Satisfaction by group and time

Supporting this, after controlling for pre-intervention MLS scores, the ANCOVA results demonstrated a significant main effect of group membership on post-intervention MLS scores, F (1, 196) = 21.48, $p < .001$, partial $\eta^2 = .09$. Estimated marginal means indicated that the experimental group had significantly higher adjusted post-test MLS scores (M = 193.77, SE = 0.33) compared to the control group (M = 187.97, SE = 0.33), with a mean difference of 5.81 (95% CI [4.88, 6.73], $p < .001$). These findings suggest that the intervention effectively enhanced participants' overall life satisfaction, supporting Hypothesis 2.

In summary, the combined RMANOVA and ANCOVA findings provide evidence that the intervention significantly improved multiple psychological outcomes. Participants in the experimental group showed significant improvements in PWB and MLS compared to the controls. The consistent presence of significant time $\times$ group interactions across measures highlights that these benefits were predominantly driven by the intervention rather than natural changes over time or baseline differences, further supporting Hypothesis 3. Although the mean differences between groups appeared modest, they correspond to small to moderate effect sizes. Given the wide ranges of these scales (PWB: 20–120; MLS: 40–240), even small point shifts reflect meaningful changes in adolescents' functioning.

In line with prevention science, the observed modest yet reliable gains are particularly valuable in population-based programs, where participants are not clinically distressed at baseline, and large improvements are unlikely. At the same time, these small effect sizes also highlight the need for further refinement of the program, for example, by adjusting session content or duration, and such modifications should be systematically tested in future studies. Taken together, these findings suggest that the yoga-based program may represent a promising and pragmatic approach for supporting adolescent well-being in educational settings.

4 Discussion

The current study provides evidence that a structured yoga intervention can significantly improve late adolescents' PWB and MLS. Notably, the strong time $\times$ group interaction effects across both outcomes indicate that the improvements were likely due to the intervention rather than general developmental changes or repeated testing (Baltes, 1968; Schaie, 1965). Since adolescence is characterized by greater neural plasticity, intense academic demands, and an evolving self-identity, even modest well-being enhancements can help individuals cope better, build resilience, and adopt a healthier lifestyle (Steinberg, 2015; Weare & Nind, 2011). Therefore, integrating mind-body programs such as yoga into adolescents' daily routines offers a promising approach to support their psychological growth during this crucial developmental stage.

The most notable effects of the intervention were observed in PWB. PWB broadly reflects an individual's emotional balance, mental clarity, and resilience (Ryff, 2013). The study's yoga intervention offers several avenues for promoting this holistic sense of well-being. While Sūryanamaskāra sequences encourage mindfulness and self-control (Parajuli et al., 2023), Prāṅāyāma techniques, especially Bhastrikā and Ujjāyī, help regulate the autonomic nervous system, reduce stress responses, and may enhance neuroplasticity (Jerath et al., 2006; Zope & Zope, 2013). Furthermore, literature highly acknowledges that standing and grounded postures improve emotional control and body awareness, which helps people remain composed under pressure. Additionally, by stimulating the parasympathetic nervous system, these poses promote a balanced emotional state (Schmalzl et al., 2015). Taken together, the study's intervention can support the basic components that promote PWB in late adolescence.

Improvements in MLS imply that yoga's advantages go beyond internal states and positively impact adolescents' everyday lives. Higher life satisfaction is strongly linked to peer connectedness and valuable social support, both of which were probably improved by practicing in a group environment with encouraging facilitators (Azpiazu Izaguirre et al., 2021; Gempp & González-Carrasco, 2021). Furthermore, Sūryanamaskāra's structured flow stimulates the energy centers, promotes emotional control, and improves mental flexibility (Saraswati, 1996), all of which can facilitate more fulfilling and engaged involvement in daily life. While Prāṅāyāma was shown to promote social bonding, balance-oriented āsanas (sthira sukham āsanam, Yoga Sūtra II:46) (Madhvācārya, 2007) may encourage motivation that supports academic engagement. These elements align with the broaden-and-build theory (Fredrickson, 2001), highlighting that positive emotions go beyond cognitive and social capacities, leading to greater life satisfaction. However, given the quasi-experimental design and absence of an active control, these mechanisms should be considered plausible rather than causal interpretations.

In summary, the three intervention pillars, Sūryanamaskāra, Āsana, and Prāṅāyāma, delivered in a supportive group setting, offer a plausible biopsychosocial explanation for the improvements seen in both PWB and MLS. The Sūryanamaskāra sequences probably created a more stable physiological baseline by increasing vagal tone and positive affect. The prāṅāyāma then improved moment-to-moment control of arousal, while static standing and balance poses developed confidence and sustained attention. Additionally, group delivery under skilled supervision may have increased modeling and social reinforcement. These factors reflect the pancha-kosha model (Gambhirananda, 1958), which states that the integrated cultivation of the physical, energetic, mental, and relational layers leads to flourishing. Although physiological markers were not recorded and individual components were not separated, the results suggest that the intervention components may have worked together, each strengthening the effect of the other, thereby producing the observed improvements.

4.1 Limitations and future directions

Despite the promising results, certain limitations constrain the strength and generalisability of the conclusions. First, the group assignment was quasi-experimental, based on enrolment order with gender matching rather than randomisation. Because the groups differed in baseline academic grades and these ordinal data were unsuitable for statistical adjustment, academic achievement may partly be responsible for the observed effects. It is also possible that students who enrolled at the beginning (i.e., those allocated to the experimental group) were more motivated, more health-oriented, or more engaged during the activities, which may have introduced an additional selection bias. Therefore, the influence of baseline academic performance and enrolment-related motivation on outcomes cannot be entirely ruled out.

Second, reliance on self-reported data introduces potential social desirability and expectancy biases, which are particularly relevant in a yoga-based intervention. Additionally, the PWB scale used in the study has not been previously validated among Indian adolescents, which may affect measurement precision despite the satisfactory reliability observed in the current sample. Furthermore, no physiological or behavioural markers were collected to support the survey findings. Third, outcomes were assessed only once, immediately after the 45-day intervention, so the durability of benefits remains unknown. Fourth, the full intervention was delivered as a single package at one residential college, limiting the identification of its most active components and the extent to which results can be applied to other educational or cultural contexts.

Fifth, the facilitation styles and supportive interactions of yoga instructors may also have contributed to participant engagement, making it difficult to separate the instructor's influence from the effects of the yoga protocol itself. Lastly, the absence of a placebo or active comparison group reduces the capacity to rule out alternative explanations and fully attribute observed changes to the intervention itself. Because the control group did not receive an activity of comparable structure or social engagement, placebo, peer-interaction, and instructor-attention effects cannot be ruled out.

Numerous directions for further research emerge from the study's limitations and findings. Determining what influences the results would be possible by randomly allocating participants to several comparison conditions, such as an active physical education control, a posture-only arm, and a breath-only arm. The addition of objective indicators, such as heart rate variability, stress hormones, attendance, and academic engagement, would support the self-reports. To determine whether benefits continue, follow-up evaluations must be conducted at three, six, and twelve months. It would be clearer how the intervention functions and for whom it is most helpful to measure potential mediators, such as self-compassion, mindfulness, and perceived peer support. Lastly, repeating the study in different educational institutions and cultures, including studies employing qualitative or mixed methods, would enhance external validity and provide practical guidance for broader implementation.

4.2 Implications

The study findings have several practical implications. A residential-college yoga program offers researchers a useful framework for studying the mind-body processes in late adolescence. In addition to standard fitness programs, higher education policy makers could include brief, low-cost yoga classes in their requirements for campus well-being. Parents can support their children's well-being by adopting an evidence-based practice. Furthermore, including guided yoga in the weekly schedule is an easy way for colleges and students to create a more resilient and peaceful campus environment. However, it is necessary to note that designing such programs would require a trained yoga instructor and institutional commitment to routine implementation.

4.3 Conclusion

The rising reports of adolescent depression, suicide, and impulsive violence in Visakhapatnam, such as nine student suicides linked to exam results (Sudhir, 2023) and a 19-year-old engineering student with a history of bipolar illness fatally assaulting his mother after an online-gaming quarrel (Babu, 2025), indicate the urgent need for campus-based mental-health solutions. In response, the Government of Andhra Pradesh has integrated well-being modules into youth employment training through the State Skill Development Corporation, and the School Education Department has appointed dedicated mental health counsellors in government schools. At the national level, the NEP 2020 identifies yoga and social–emotional learning as core wellness activities, complemented by the Government of India's promotion of yoga through International Yoga Day.

The impact of these policy moves has been limited. The present study offers a pragmatic advance, as the institution involved in the study has formally committed to incorporating the yoga programme into its regular curriculum, demonstrating that teachers can effectively deliver it during routine class periods. By carefully conducting the Sūryanamaskāra, Āsana, and Prāṅāyāma in a peer-supportive environment, the yoga intervention provided substantial practical benefits. By incorporating similar yoga programmes into college health initiatives and curricula, the service gap highlighted by regional news reports can be addressed, and support can be provided to the state's skill-building and national wellness policies.

Authors' Contribution

Kavya Siripuram and Nidhi Mishra: Conceptualization, methodology, formal analysis
Kavya Siripuram: Data curation, investigation, validation, visualization, writing – original draft
Nidhi Mishra: Supervision, project administration, writing – review & editing

Statements and Declarations

Data Availability

The data that supports the findings of this study will be made available upon reasonable request.

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Conflict of Interest

None

Ethical approval

The study received ethical approval from the department research committee of GITAM School of Humanities and Social Sciences in June 2023 (DRC/06/2023/0036).

Informed consent

Permission to conduct the study was obtained from the college authorities, and informed consent was obtained from all participants and their parents/guardians prior to their participation in the study.

Generative AI usage statement

During the preparation of this work, the authors used Quillbot, Grammarly, and ChatGPT for language editing and grammar checks. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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