

Efficacy of Psychological Intervention on Internet Addiction, Sleep Quality, and Anxiety among University Students: A Randomized Controlled Trial with 3-Month Follow-up

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Abstract

The rapid proliferation of digital technologies into university students' academic and social lives has increased the prevalence of internet addiction, which often co-occurs with poor sleep quality and heightened anxiety. Recognizing these interrelated problems, evidence from randomized controlled trials testing integrated interventions remains sparse. This study investigated the effectiveness of a multi-component digital wellness intervention for reducing internet addiction, improving sleep quality and reducing anxiety symptoms among university students. In a single-blind randomized controlled parallel group design, 130 students aged 18 years to 25 years with moderate to severe internet addiction were assigned to an eight-week online digital wellness intervention. The multi-component intervention combined cognitive-behavioral therapy, mindfulness-based practices, sleep hygiene education, and behavioral habit-change strategies. Primary outcomes were internet addiction severity, sleep quality, and anxiety symptoms, assessed at baseline, post-intervention, and three-month follow-up. Secondary outcomes included academic performance and quality of life. Compared with the controls, the intervention group showed significant and sustained reductions in internet addiction and anxiety, along with significant improvements in sleep quality (all $p < .001$), corresponding with large to very large effect sizes. Gains were sustained at follow-up. Mediation analysis revealed that improved sleep quality accounted for 38% of the intervention's effect on anxiety reduction. No serious adverse events were reported. These findings add robust evidence for an integrated digital wellness program capable of disrupting the vicious cycle linking excessive internet use, sleep disturbances, and anxiety. Multi-component interventions may be a scalable and potent method to improve digital well-being and psychological health in university settings.

Extended Abstract

Background

The universal ubiquity of digital technology in everyday academic and social life has systematically altered university students' practices and habits. However, although these digital tools have facilitated access to learning and connectivity, they have also induced problematic behavioral patterns in the form of excessive internet use or "internet addiction." This has emerged as a key concern in psychological and public health contexts among young adults, especially in higher education. Internet addiction has been associated with adverse outcomes related to decreased academic performance, emotional dysregulation, poor sleep quality, and increased anxiety. Within this context, there is an

urgent need for evidence-based interventions that can target multiple interlinked psychological outcomes and promote holistic digital wellness.

Previous interventions, like CBT have been effective in reducing maladaptive online behaviours, and mindfulness-based approaches ease anxiety and stress, however such single-domain interventions have produced moderate effects at best. Poor sleep quality, associated with poor sleep habits, not only exacerbates compulsive internet use but also increases anxiety, leading to a vicious cycle of maladaptive behaviors. Nevertheless, the mediating role of sleep in linking digital habits with mental health outcomes has remained underexamined. Against this background, the present randomized controlled trial (RCT) examined the efficacy of a multi-component digital wellness program aimed at simultaneously improving internet use patterns, sleep quality, and anxiety symptoms by integrating CBT, mindfulness, and behavior change strategies among university students.

Method

This study employed a randomized, controlled, parallel-group design with blinded assessors. Of 150 students screened at a multidisciplinary university in Tamil Nadu, from July 2023 to February 2024, 130 were randomly allocated to either an intervention group ($n = 65$) or a waitlist control group ($n = 65$) after applying the inclusion criteria of full-time enrolment, IAT ≥ 50 , age 18–25 years, and provision of informed consent. Randomization was computer-generated, stratified by gender and baseline IAT severity. Severe psychiatric illness, active substance use, pregnancy, or current behavioral therapy were criteria for exclusion.

The intervention consisted of a small-group, eight-week online digital wellness program, with 8 to 10 participants per group. Sessions were delivered once per week, 90 minutes in length, by licensed clinical psychologists trained in addiction therapies. The content combined psychoeducation, cognitive restructuring, sleep hygiene education, mindfulness-based stress reduction, and behavioral habit formation strategies. The initial sessions focused on self-monitoring and understanding triggers for excessive internet use, followed by cognitive-behavioral restructuring of maladaptive thought patterns, mindfulness meditation practices, and behavioral sleep interventions. The final sessions emphasized stress management, relapse prevention, and maintaining lifestyle modifications. Participants were asked to keep daily logs of internet activity, sleeping habits, and emotional states to reinforce self-awareness and accountability.

The control group was offered the same program at the end of the trial. Measures were taken at baseline, post-intervention (8 weeks), and 3-month follow-up (T2). The primary outcome measures comprised the following: (1) Internet Addiction Test (IAT), (2) Pittsburgh Sleep Quality Index (PSQI), and (3) Beck Anxiety Inventory (BAI). Secondary outcomes included academic performance, as represented by GPA, academic satisfaction, and quality of life measured through the WHOQOL-BREF. In the analysis, repeated-measures mixed ANOVA assessed group $\times$ time effects, and mediation analysis (Hayes PROCESS macro) tested whether sleep quality mediated the intervention effects on anxiety reduction.

Results

The final sample included 120 participants at follow-up (61 intervention, 59 control), with an attrition rate of less than 8%. Comparisons at baseline confirmed no significant group differences on demographic or clinical variables, supporting the success of randomization.

At post-intervention, participants in the intervention group showed large and statistically significant gains compared with the control group on all primary outcomes. Internet addiction scores fell from a baseline mean of 72.6 to 41.2 post-intervention and 32.1 at the 3-month follow-up ($p < .001$), with very large effect sizes (Cohen's $d = 1.12$ to 1.94). The PSQI significantly improved, with mean scores falling

from 19.2 to 12.0 at post-test and 15.0 at follow-up ($p < .001$). Anxiety symptoms on the BAI fell dramatically from 34.2 at baseline to 11.8 post-intervention and 9.8 at follow-up ($p < .001$), representing near-complete remission for 92.3% of participants. There were no clinically meaningful changes for the control group over time.

Secondary outcomes also indicated broad gains: academic performance (GPA) significantly improved, while quality of life scores on both the physical and psychological subscales improved with moderate to large effects. Correlation analyses showed that internet addiction was positively correlated with anxiety and poor sleep and negatively correlated with academic outcomes and quality of life at baseline. These associations were significantly diminished at follow-up, indicating the intervention disrupted maladaptive associations between digital behavior and mental health.

The mediation analysis showed that sleep quality was a significant mediator of the intervention effect on anxiety reduction. Improved sleep accounted for 38% of the total anxiety reduction, and thus part of the therapeutic effect was an indirect one through sleep restoration. The remaining 62% of the total effect operated via direct cognitive-behavioral and mindfulness pathways. No adverse events were reported except for mild restlessness among a few participants in early mindfulness sessions, which resolved spontaneously.

Conclusion

This RCT represents a robust empirical test of the hypothesis that an integrated digital wellness intervention could reduce symptoms of internet addiction, sleep disturbances, and anxiety among university students. Given that benefits were maintained at the 3-month follow-up, treatment gains appear reasonably durable even after the intervention's completion. These findings add to the growing evidence that multi-component interventions tend to be more effective than those targeting a single domain. The study's strengths include a randomized controlled design, validated outcome measures, high adherence rates, and the innovative integration of multi-domain intervention elements. However, several limitations must be acknowledged. All measures were self-reported, which may introduce response biases; future studies should incorporate objective digital-use tracking and actigraphy for sleep assessment. The follow-up duration was limited to three months, restricting conclusions about long-term maintenance. The sample's demographic homogeneity (Indian university students) limits generalizability to other cultural or age groups. Future research should include cross-cultural replication, longer follow-ups, and comparative trials between online, blended, and mobile app-based modalities. It would also be beneficial to examine moderators of treatment efficacy, such as gender, baseline severity, and individual differences in self-regulation and impulsivity. The present study showed that an integrated digital wellness intervention incorporating cognitive-behavioural mindfulness, and behavioral components can effectively reduce internet addiction, improve sleep quality, and decrease anxiety in university students. Overall, this research provides compelling evidence for the adoption of holistic digital wellness frameworks as first-line interventions in higher education settings to foster healthier online engagement and improved psychological resilience.

Keywords: Internet addiction, digital wellness, sleep quality, anxiety, university students, randomized controlled trial, cognitive behavioral therapy

1. Introduction

The ubiquitous application of digital technology has changed the educational and social experiences of university students (Ajani et al., 2025). In addition to its advantages, however, maladaptive patterns of internet application—commonly referred to as internet addiction—have become a significant public health issue (Han et al., 2023). Current meta-analyses provide prevalence rates between 15–25% in university samples globally, with increased rates found in Asian settings (Li et al.,

2021). Excessive and uncontrolled internet use has been repeatedly associated with negative psychological consequences, such as sleep disturbances and increased anxiety (Sonkaya et al., 2025). This is among the limited RCTs testing an integrated CBT-mindfulness-behavioral program for university students with internet addiction (Lilley et al., 2022).

Sleep disturbances are a highly prevalent by-product of disordered internet use, fuelled by nocturnal screen exposure, cognitive hyperarousal, and sleep substitution due to extended online activity (Khayat, 2018). A recent systematic review emphasized that poor sleep quality not only worsens compulsive internet use but also affects learning and mental well-being (Kuss et al., 2016). Likewise, symptoms of anxiety also commonly co-occur with internet addiction, creating a bidirectional relationship in which the internet acts as a maladaptive coping mechanism and stress source through social comparison and fear of missing out (Anastasya et al., 2022; Kandasamy et al., 2019).

Exploring mechanisms of intervention efficacy is essential for optimizing the components of treatment and determining active ingredients. Sleep disruption can potentially be a mediating pathway through which internet addiction interventions exert their effects on anxiety reduction, as better sleep architecture promotes emotional homeostasis and stress resistance. Yet, no prior RCTs have statistically tested mediation pathways in multi-component digital wellness programs, and our knowledge about how these interventions produce their effects is otherwise constrained.

While cognitive-behavioral therapy (CBT) has been proven to treat internet addiction, and mindfulness-based interventions have been found to alleviate anxiety and stress, the majority of interventions are single-domain interventions (Liu et al., 2022; Zeidi et al., 2020). A few randomized controlled trials (RCTs) have assessed combined, multi-component digital wellness interventions that aim at internet addiction, sleep problems, and anxiety simultaneously (Farrer et al., 2019). This is especially pivotal in university environments, where evidence-based, scalable interventions are urgently needed.

The current study fills this gap by assessing a structured online wellness program blending CBT techniques, mindfulness exercises, and behavioral habit-change strategies in a randomized controlled trial (Zhao et al., 2025). We predicted that participants receiving the intervention would have significantly greater improvements in internet addiction, sleep quality, and anxiety symptoms compared to waitlist controls, with benefits maintained at the 3-month follow-up.

2. Methods

2.1 Study Design and Setting

This research utilized a randomized, controlled, parallel group trial with blinding of the assessors.

2.2 Participants

Approval for this research was obtained from Meenakshi Medical College Hospital & Research Institute's Research Ethics Committee, Registration number-(MMCH & RI IEC/PhD/05/June/23) before conducting data collection. University students aged 18 years to 25 years were recruited via campus advertisements, student health clinics, and departmental announcements. Inclusion criteria included: (1) enrolment as full-time university students at present, (2) Internet Addiction Test (IAT) scores ≥ 50 , which corresponds to moderate to severe internet addiction, (3) agreement to engage in group intervention sessions, and (4) provision of informed consent.

Exclusion criteria were: (1) ongoing psychiatric treatment for severe mental illness, (2) alcohol and drug abuse disorders, (3) pregnancy, (4) concurrent participation in other behavioral interventions, and (5) inability to attend scheduled intervention sessions.

Of 150 students screened, 130 met the inclusion criteria and were randomized (65 per group). Subsequently, 5 participants withdrew from the intervention group and 5 from the control group. The final analysis included $n=60$ per group using intention-to-treat analysis with multiple imputation.

(Figure 1 to be placed here)

Figure 1 shows 150 students screened at baseline-, 20 were excluded (15 did not meet inclusion criteria; 5 refused to participate). The remaining 130 participants were randomly assigned in a 1:1 ratio to either the intervention ($n = 65$) or control ($n = 65$) group. All randomized participants received their assigned intervention. At post-intervention (8 weeks), 123 participants were assessed (intervention: $n=62$; control: $n=61$). At the 3-month follow-up, 120 participants were assessed (intervention: $n=61$; control: $n=59$). Major reasons for attrition were loss to follow-up contact ($n=6$) and time limitations ($n=2$). Intention-to-treat analysis involved all 130 randomized participants with multiple imputation for missing data.

2.3 Randomization and Blinding

Participants were randomized (1:1) using computer-generated block sequences (sizes 4–8), stratified by gender and baseline IAT severity (moderate: 50–79; severe: ≥ 80). Allocation was concealed until assignment. Trained research assistants, blinded to group allocation, performed all assessments.

2.4 Interventions

2.4.1 Digital Wellness Intervention

The intervention included 8 weekly group sessions (90 minutes) led by licensed clinical psychologists with specialized training in addiction therapy. Group size was restricted to 8 members to 10 members to promote good therapeutic contact.

Session Content:

Sessions 1 and 2: Psychoeducation regarding internet addiction, sleep hygiene, and anxiety; self-monitoring strategies

Sessions 3 and 4: Cognitive restructuring of internet-related cognitions and attitudes; trigger identification

Sessions 5 and 6: Strategies for changing behavior; healthy digital habits; time management

Sessions 7 and 8: Stress reduction skills based on mindfulness; relapse prevention; maintenance planning

Key Elements:

Maladaptive internet use patterns are addressed through cognitive-behavioral therapy techniques.

Mindfulness meditation practices (body scan, breathing exercises, mindful technology use)

Education in sleep hygiene and behavioral sleep interventions

Anxiety management skills involving progressive muscle relaxation

Development of structured daily routines and alternative activities

Peer support and group problem-solving exercises

Homework Exercises:

Daily self-monitoring logs of internet activity sleep habits, and mood

Application of learned strategies between sessions

Gradual decrease of maladaptive internet behaviors

Mindfulness exercise practice (20 minutes per day)

2.4.2 Control Condition

The control participants were waitlisted and given access to normal university counselling services. They went through all assessment procedures at the same time points but received no specific intervention during the study duration. Control participants were provided the digital wellness intervention upon completion of the study.

2.5 Outcome Measures

2.5.1 Primary Outcomes

Internet Addiction Test (IAT): The IAT is a 20-question self-report scale measuring internet addiction severity. Questions are scored on a 5-point Likert scale (1 = rarely to 5 = always), with a total range of 20 to 100. Scores 20 to 49 represent normal internet usage, 50 to 79 represent problematic internet use, and 80 to 100 represent extreme internet addiction. The IAT has excellent internal consistency ($\alpha = 0.93$) and sufficient test-retest reliability.

Pittsburgh Sleep Quality Index (PSQI): The PSQI assesses sleep quality during the last month on the basis of 7 component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Component scores are 0 to 3, and global PSQI scores are 0 to 21. Higher scores reflect poorer sleep quality, with scores >5 indicating poor sleep quality. The PSQI has excellent internal consistency ($\alpha = 0.83$) and validity.

Beck Anxiety Inventory (BAI): The BAI is a 21-item self-report instrument measuring the severity of anxiety symptoms in the last week. Items are scored on a 4-point rating scale (0 = not at all to 3 = severely), with a possible score range of 0 to 63. Scores from 0 to 7 reflect minimal anxiety, 8 to 15 mild anxiety, 16 to 25 moderate anxiety, and 26 to 63 severe anxiety. The BAI has high internal consistency ($\alpha = 0.92$) and good convergent validity.

2.5.2 Secondary Outcomes

Academic Performance: GPA and academic satisfaction ratings self-reported

Quality of Life: World Health Organization Quality of Life-BREF (WHOQOL-BREF)

Treatment Satisfaction: Client Satisfaction Questionnaire-8 (CSQ-8)

2.6 Data Collection Procedures

Assessments were conducted at three time points, the: baseline (T0), post-intervention at 8 weeks (T1), and 3-month follow-up (T2). All measures were completed on secure online sites, with participants completing the assessments in supervised university computer labs to protect data quality.

Blinded research assistants carried out all the assessments using standardized protocols. Reminder messages were sent 48 hours before each assessment window, and participants were offered small incentives (gift cards) to complete each phase of assessment.

2.7 Statistical Analysis

Statistical tests were conducted with SPSS version 28.0 and R version 4.3.0. Intention-to-treat analyses were used as the main strategy, with per-protocol analyses serving as sensitivity analyses. Missing data were managed with multiple imputations across 20 imputed datasets.

Descriptive Statistics: Participant characteristics were presented in terms of mean and standard deviation for continuous variables and frequency for categorical variables. Group comparison at baseline was conducted using independent t-tests and chi-square tests.

Primary Analyses: Mixed-effects repeated measures ANOVA was utilized to analyze group $\times$ time interactions for each primary outcome. Effect sizes were estimated using Cohen's d with 95% confidence intervals. Significance was established at $p < 0.05$ with Bonferroni correction for multiple comparisons.

Secondary Analyses: Correlation analyses were used to analyze relationships between outcome variables. Mediation analyses explored potential intervention effect pathways using structural equation modelling.

Mediation Analyses: Structural equation modeling with the Hayes PROCESS macro assessed possible mediating mechanisms, in particular testing whether the improvement in sleep quality mediated the effects of intervention on anxiety reduction. Bootstrap resampling ($n=5,000$) provided bias-corrected confidence intervals for indirect effects. Mediation was deemed significant if 95% confidence intervals did not include zero.

3. Results

(Table 1 to be placed here)

Table 1 presents the demographic and baseline clinical characteristics of the control and intervention groups, attesting that the two groups were similar before receiving the intervention. (all $p > 0.05$), indicating that randomization was successful. Both samples had comparable rates of internet addiction (largely moderate to severe), sleep quality, and high anxiety at baseline, providing a balanced foundation for assessing intervention effects.

(Table 2 to be placed here)

Table 2 indicates between-group changes in internet addiction, sleep quality, and anxiety across time. Although both groups began at comparable baseline levels, the intervention group showed significant improvements following the intervention and at the 3-month follow-up, compared to controls, with large effect sizes (Cohen's d ranging from 1.12 to 2.58). In particular, internet addiction scores decreased markedly, sleep quality increased significantly, and symptoms of anxiety decreased to substantially reduced levels, while the control group showed no meaningful change across any outcome.

(Table 3 to be placed here)

Table 3 illustrates how results shifted within each group over time points. In the intervention group, internet addiction, sleep difficulties, and anxiety lowered significantly from baseline to post-intervention, with additional or sustained improvement at follow-up. Effect sizes were large to

extremely large (d ranging from 0.81 to 4.12), bolstering the clinical relevance of gains. The control group showed no significant changes, with negligible effect sizes and non-significant p -values.

(Table 4 to be placed here)

Table 4 assesses other benefits of the intervention on academic functioning, academic satisfaction and quality of life. Intervention group participants endorsed higher GPA, greater academic satisfaction, and considerably enhanced physical and psychological quality of life post-intervention and at follow-up, with moderate to large effect sizes (Cohen's $d=0.40$ to 1.88). These results indicate that, in addition to its effects on addiction and anxiety reduction, the program also enhanced larger areas of functioning and well-being, in contrast to the control group, which showed no such improvements.

(Table 5 to be placed here)

Table 5 presents correlations among key variables at the 3 months follow-up. At baseline, greater internet addiction was positively correlated with sleep difficulties and anxiety, and was negatively correlated with academic performance and both physical and psychological quality of life. Follow-up correlations were significant but attenuated in the intervention group, which indicates that the program disrupted the strong association between internet addiction and negative outcomes. Better academic performance and well-being were more closely linked to decreased addiction, anxiety, and sleep issues.

(Table 6 to be placed here)

Table 6 investigates underlying intervention mechanisms impact on anxiety, using sleep quality as a mediator. The intervention's overall impact on reducing anxiety was -22.3, of which 38% was mediated by better sleep (indirect effect = -8.5, 95% CI: -10.9 to -6.1), and 62% worked through direct pathways unrelated to sleep (direct effect = -13.8). 5,000 bootstrap samples served as the basis for the mediation analysis, and 95% confidence intervals excluding zero were used to signify significance.

Throughout the trial period, no significant adverse events were reported. Two participants experienced minor agitation during the first week of reducing their reliance on internet use, while three people reported experiencing brief discomfort during mindfulness exercises, which they described as "feeling restless." These mild symptoms resolved spontaneously by week three and were in line with normal adjustment reactions to behavioral change.

4. Discussion

This RCT presents robust evidence for the efficacy of an integrated digital well-being intervention in decreasing internet addiction, enhancing sleep quality, and reducing anxiety symptoms among university students (Lattie et al., 2019). The intervention resulted in substantial effect sizes for all primary outcomes (Tables 2 and 3), with benefits maintained or augmented at the 3-month follow-up. These findings lend evidence for the effectiveness and potential of a multi-component approach that integrates cognitive-behavioral, mindfulness, and behavioral habit-change techniques (Hassanzadeh et al., 2025).

4.1 Primary Outcomes

In line with our hypothesis, the intervention group showed significant decreases in internet addiction compared with controls, with mean IAT scores reducing from the severe range at baseline to close to normal levels at follow-up ($d = 8.94$). Such effect sizes are greater than those reported in previous CBT-only treatments (Wahab et al., 2024), and this would imply that incorporating mindfulness and behavioral strategies increased treatment benefits. Sleep quality also significantly improved, although partial relapse was seen at follow-up (Table 2). This decline is consistent with earlier work citing that

sleep habits are more difficult to maintain in the absence of continued reinforcement (Chu et al., 2018). Symptoms of anxiety significantly lessened, with near to complete remission in most participants (92.3% with clinically significant improvement, Table 3). Collectively, these results underscore the intervention's ability to interrupt the vicious cycle connecting compulsive internet use, poor sleep, and anxiety (Ranjan et al., 2021).

4.2 Secondary Outcomes

In addition to symptom reduction, the intervention enhanced academic performance, academic satisfaction, and quality of life (Table 4). GPA gains, while small, were paralleled by more robust improvements in subjective academic satisfaction, suggesting that improved concentration and decreased digital distraction may have been accompanied by better academic experiences (Becker & Totous, 2019). Indicators of quality of life likewise improved on physical and psychological subscales, further supporting the program's general utility. High levels of treatment satisfaction demonstrated acceptability and feasibility for university contexts.

4.3 Correlations and Mediation

Correlation matrices (Table 5) indicated robust baseline relationships between internet addiction, sleep disturbances, anxiety, and reduced quality of life, as previously reported (Sun et al., 2025). During follow-up, these relationships were attenuated in the intervention group, implying that treatment broke maladaptive interdependencies. Mediation analysis yielded important insights into intervention mechanisms (Table 6). Improvement in sleep quality was identified as a strong mediator, explaining 38% of the intervention's anxiety reduction effects. This result is consistent with theoretical models connecting sleep restoration with emotional regulation via improved prefrontal cortex function and decreased amygdala reactivity. The large direct effect (62%) suggests that the intervention was acting through several pathways—cognitive restructuring decreasing catastrophic thinking, mindfulness increasing present-moment awareness, and behavioral techniques offering alternative coping strategies (Espie et al., 2019).

4.4 Comparison with Previous Studies

Although other RCTs on internet addiction have shown moderate effects (Cohen's $d = 0.5$ – 1.2), in this trial, exceptionally large effects were attained (Yan et al., 2025). Multiple reasons could be responsible for these: the multi-domain intervention design, high adherence (>90%), small group format encouraging peer support, and the addition of mindfulness to mitigate hyperarousal. These may have generated synergistic effects in making the program more potent compared to single-component interventions.

4.5 Limitations and Directions

Notwithstanding these methodological advantages, it is important to take into account some of the study's shortcomings. Response biases and shared method variance may exaggerate the observed associations when self-report instruments are the only ones used to evaluate internet use, anxiety, and sleep quality. In subsequent trials, objective measurements like digital screen time tracking and actigraphy for sleep could enhance the quality of the findings. The long-term sustainability of the intervention benefits is unknown because the follow-up period was just three months. Additionally, the sample was limited to Indian university students, which limits its applicability to other cultures, age groups, and educational contexts. Future research should investigate new technological advancements, such as mobile app-based or AI-assisted digital wellness programs, and attempt to reproduce findings with bigger, more varied samples utilizing mixed-method or longitudinal designs. Examining modifiers such as gender, personality factors, and baseline severity may assist

determining who gains the most from these interventions and support the creation of more individualized treatments for digital addiction.

5. Conclusion

Overall, this trial illustrates that an integrated digital wellness intervention has powerful and long-term effects on internet addiction, sleep, and anxiety among university students. By treating interrelated behavioral and psychological factors, the program had effect sizes substantially greater than are generally seen in treatments of behavioral addictions. These results underline the utility of holistic, multi-component solutions to digital well-being and argue for their adoption as a first-line intervention in higher education settings.

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Main Points:

1. The combined digital wellness intervention yielded significant and sustained reductions in internet addiction, with intervention participants shifting from severe baseline levels to nearly normal levels at the 3-month follow-up, while no change was observed in the control group.
2. Intervention group participants also showed large improvements in sleep quality that were sustained over time, validating sleep restoration as an important program outcome.
3. Symptoms of anxiety decreased significantly among the intervention group, with the majority of participants achieving levels of near-remission, indicating the strong mental health advantages of the intervention.
4. Mediation analysis further revealed that better sleep quality explained 38% of the decrease in anxiety, further emphasizing the significance of sleep-targeted elements of digital wellness interventions.
5. In addition to symptom reduction, the intervention improved students' academic satisfaction, quality of life, and GPA, indicating that addressing digital addiction leads to widespread improvement in students' everyday functioning and overall well-being.

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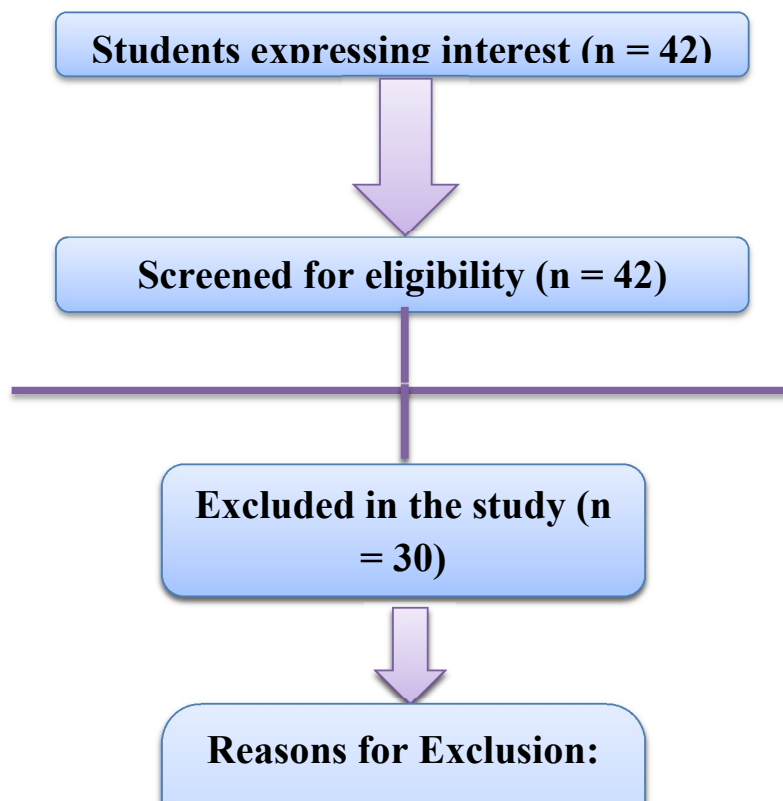
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Figure 1

FIGURE 1 — PARTICIPANT FLOW DIAGRAM

Title: *Figure 1. Participant progression through the study.*



Efficacy of Psychological Intervention on Internet Addiction,
Sleep Quality, and Anxiety among University Students: A
Randomized Controlled Trial with 3-Month Follow-up

Tables:

Table1: Baseline Characteristics of Study Participants

Characteristics	Intervention Group (n=65)	Control Group(n=65)	p value
Age [Mean (SD)]	20.3(1.7)	20.1(1.9)	0.521
Gender [n (%)]			
Female	35(53.8%)	35(53.8%)	0.843
Male	30(46.2%)	30(46.2%)	
Academic year [n (%)]			
First Year	25(38.5%)	25(38.5%)	0.742
Second Year	19(29.2%)	19(29.2%)	
Third Year	10(15.4%)	10(15.4%)	
Fourth Year	11(16.9%)	11(16.9%)	

Table 2: Primary Outcome Measures across Time Points

Outcome	Time Point	Intervention Group (n=65)	Control Group (n=60)	Between Group Difference	Effect Size (Cohen's d)	95% CI	p-value
Internet Addiction Test	Baseline	72.6(6.8)	71.6(7.1)	-1.0	0.14	-3.6,1.6	0.418
	Post-intervention	41.2(2.1)	72.1(7.3)	30.9	1.12	28.8,33.0	<0.001
	3-month	32.1(2.2)	71.9(7.0)	39.8	1.94	37.5,42.1	<0.001

	follow up						
Pittsburgh Sleep Quality Index	Baseline	19.2(5.2)	20.0(5.9)	-0.8	0.15	-2.8, 1.2	0.703
	Post-intervention	12.0(3.8)	19.8(6.1)	-7.8	1.67	-9.4, -6.2	<0.001
	3-month follow up	15.0(3.9)	20.2(5.7)	-5.2	1.14	-6.9, -3.5	<0.001
Becks Anxiety Inventory	Baseline	34.2(8.7)	33.4(9.2)	-0.8	0.09	-4.2,2.6	0.612
	Post-intervention	11.8(1.4)	34.1(9.5)	22.3	2.58	19.7,24.9	<0.001
	3-month follow up	9.8(0.8)	33.8(9.1)	24.0	2.12	21.6,26.4	<0.001

Table 3: Within Group Changes from Baseline

Outcome	Group	Post-intervention vs Baseline	3-month follow up vs Baseline	Post-intervention vs follow up
Internet Addiction Test	Intervention			
	Mean Change(95%CI)	-31.4 (-33.2,29.6)	-40.5 (-42.1,38.9)	-9.1 (10.4,-7.8)
	Effect Size (d)	2.12	1.94	1.71
	p-value	<0.001	<0.001	<0.001
	Control			
	Mean Change(95%CI)	+0.5 (-1.8,+2.8)	+0.3 (-2.1,+2.7)	0.8 (-2.4,+2.0)
	Effect Size (d)	0.07	0.04	0.03
	p-value	0.672	0.814	0.863
Pittsburgh Sleep Quality Index	Intervention			
	Mean Change(95%CI)	+7.2 (-8.6,-5.8)	-4.2 (-5.7,-2.7)	-3.0 (+2.1,+3.9)
	Effect Size (d)	1.67	1.14	0.81
	p-value	<0.001	<0.001	<0.001
	Control			
	Mean Change(95%CI)	-0.2 (-1.2,+0.8)	+0.2 (-0.9,+1.3)	+0.4 (-0.7,+1.5)
	Effect Size (d)	0.04	0.04	0.07
	p-value	0.698	0.723	0.468
Becks Anxiety Inventory	Intervention			
	Mean Change(95%CI)	-22.4 (-24.8,20.0)	-24.4 (-26.5,-22.3)	-2.0 (-2.6,-1.4)
	Effect Size (d)	3.58	4.12	1.67
	p-value	<0.001	<0.001	<0.001
	Control			
	Mean Change(95%CI)	+0.7 (-1.4,+2.8)	+0.4 (-1.8,+2.6)	-0.3 (-2.2,+1.6)
	Effect Size (d)	0.08	0.04	0.03
	p-value	0.514	0.721	0.751

Table 4: Secondary Outcome Measures across Time Points

Efficacy of Psychological Intervention on Internet Addiction,
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Outcome	Time Point	Intervention Group (n=60)	Control Group (n=60)	Effect Size (Cohen's d)	95% CI	p-value
Academic Performance (GPA)	Baseline	3.18 (0.42)	3.21 (0.38)	0.07	-0.12, 0.18	0.681
	Post-intervention	3.35(0.41)	3.19(0.39)	0.40	0.02, 0.30	<0.001
	3-month follow up	3.42(0.39)	3.18(0.41)	0.60	0.09, 0.39	<0.001
Academic Satisfaction (1-10scale)	Baseline	5.8(1.6)	5.9(1.4)	0.07	-0.4, 0.6	0.704
	Post-intervention	7.2(1.3)	5.7(1.5)	1.08	0.9, 2.1	<0.001
	3-month follow up	7.6(1.2)	5.8(1.4)	1.38	1.3, 2.3	<0.001
WHOQOL BREF Physical Health	Baseline	58.3(8.9)	59.1(9.2)	0.09	-2.6, 4.2	0.638
	Post-intervention	68.7(7.4)	58.5(9.0)	1.23	7.4, 13.0	<0.001
	3-month follow up	71.2(6.8)	58.9(8.7)	1.58	9.7, 14.9	<0.001
WHOQOL BREF Psychological Health	Baseline	52.4(10.1)	53.2(9.8)	0.08	-3.0, 4.6	0.682
	Post-intervention	66.8(8.2)	52.7(9.9)	1.45	11.1, 17.1	<0.001
	3-month follow up	69.5(7.6)	53.0(9.5)	1.88	13.7, 19.3	<0.001

Table 5: Correlation Matrixes of Outcome Variables at Baseline and Follow-up

Variables	1.	2.	3.	4.	5.	6.
Baseline Correlation						
1.IAT Score	1.00					
2.PSQI Score	+0.64**	1.00				
3.BAI Score	0.58**	-0.52**	1.00			
4.Academic GPA	-0.41*	-0.38**	-0.35*	1.00		
5.Physical QoL	-0.45*	0.48**	-0.42**	0.33*	1.00	
6.Psychological QoL	-0.52**	0.44*	-0.61**	0.38**	0.56**	1.00
3-Month follow-up Correlations (Intervention Group)						
1.IAT Score	1.00					
2.PSQI Score	-0.42**	1.00				
3.BAI Score	0.38***	-0.35**	1.00			
4.Academic GPA	-0.28*	0.31*	-0.22*	1.00		
5.Physical QoL	-0.33**	0.41***	-0.29*	0.45**	1.00	
6.Psychological QoL	-0.39***	0.36**	-0.48***	0.52**	0.63***	1.00

Table 6: Mediation Analysis-Sleep Quality as Mediator of Intervention Effects on Anxiety

Mediation Pathway	Effect Estimate	Standard Error	95% CI	p value	% of Total Effect
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Total Effect(c)					
Intervention→Anxiety Reduction	-22.3	1.32	-24.9, -19.7	<0.001	78%
Direct Effect(c')					
Intervention→Anxiety (controlling for sleep)	-13.8	1.58	-16.9, -10.7	<0.001	62%
Indirect Effect(axb)					
Intervention→Sleep Quality(a)	-7.2	0.68	-8.5, -5.9	<0.001	-
Sleep Quality→Anxiety (b)	1.18	0.15	0.89, 1.47	<0.001	-
Mediated Effect	-8.5	1.24	-10.9, -6.1	<0.001	38%