# *Smartphone addiction and its association with stress, anxiety, and neck disability among university students: a cross-sectional study*

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***DOI: 10.5281/zenodo.23999976***

## Abstract:
Smartphone use has become an integral part of university students' academic, social, and personal lives, however, excessive and problematic smartphone engagement has raised concerns regarding its potential psychological and musculoskeletal consequences. Continuous notifications, social networking, online learning, entertainment, and habitual checking behaviours may contribute to loss of control over smartphone use, increased psychological distress, reduced physical activity, and prolonged exposure to sustained cervical postures. These factors may be associated with stress, anxiety, neck pain, and limitations in daily activities among young adults. This illustrative cross-sectional study examines the association between smartphone addiction, stress, anxiety, and neck disability among 216 simulated university-student participants aged 18–30 years. Smartphone addiction was assessed using the Smartphone Addiction Scale–Short Version (SAS-SV), psychological distress was evaluated using the Depression Anxiety Stress Scales–21 (DASS-21), and functional limitations related to neck symptoms were assessed using the Neck Disability Index (NDI). A structured questionnaire was used to represent demographic characteristics, daily smartphone exposure, duration of continuous use, primary reasons for smartphone use, posture-related habits, and physical activity. The simulated dataset demonstrated a mean SAS-SV score of 34.26 ± 9.18, mean stress score of 13.64 ± 5.98, mean anxiety score of 11.57 ± 6.38, and mean NDI score of 11.83 ± 4.50. Pearson correlation analysis demonstrated positive associations between smartphone addiction and stress ($r = 0.319$, $p < 0.001$), anxiety ($r = 0.338$, $p < 0.001$), and neck disability ($r = 0.576$, $p < 0.001$). Stress and anxiety were also positively associated with neck disability. In adjusted regression models, SAS-SV scores remained associated with stress, anxiety, and neck disability, while daily smartphone-use duration was independently associated with NDI scores. These numerical findings are generated from synthetic data and do not represent observations from real students. The illustrative analysis demonstrates how problematic smartphone use may be investigated through an integrated behavioural, psychological, and musculoskeletal framework. A comprehensive preventive approach may incorporate digital-wellness education, ergonomic modification, postural variation, cervical muscle conditioning, physical activity promotion, and appropriate psychological support.

## Keywords:
Smartphone Addiction, Problematic Smartphone Use, University Students, Stress, Anxiety, Neck Disability, Cervical Pain, Musculoskeletal Health, Digital Behaviour, Physiotherapy.

## 1. Introduction:
Smartphones have transformed communication, education, information access, entertainment, and social interaction, becoming an essential part of everyday life for university students. Academic activities increasingly involve digital platforms, electronic learning resources, online assessments, educational applications, and communication with faculty members and classmates. At the same time, smartphones provide continuous access to social networking, video streaming, gaming, online shopping, and other recreational activities. Although these functions offer considerable convenience, frequent and prolonged engagement may

encourage habitual checking, difficulty regulating screen time, and continued device use despite negative consequences. Problematic smartphone use is generally understood as a pattern of excessive or poorly controlled engagement that interferes with psychological well-being, academic responsibilities, social relationships, sleep, or physical functioning. The term smartphone addiction is commonly used in research, although excessive smartphone use should not automatically be considered equivalent to a formally diagnosed behavioural addiction. Research has increasingly investigated the relationship between problematic smartphone use and mental health outcomes, including anxiety, depression, stress, sleep disturbance, and reduced subjective well-being. Meta-analytic evidence has reported associations between problematic smartphone use and psychological symptoms, although differences in study populations, measurement tools, and definitions of problematic use contribute to variation in reported estimates (Li et al., 2020, Sohn et al., 2019, Yang et al., 2020, Augner et al., 2023). University students represent an important population for investigating these associations because they frequently depend on smartphones for both academic and non-academic activities, often experience demanding academic schedules, and may have irregular sleep, physical activity, and study routines. The combination of prolonged digital exposure, academic pressure, and limited opportunities for physical recovery may increase vulnerability to psychological distress and musculoskeletal symptoms. Stress and anxiety are particularly relevant psychological outcomes in university populations. Academic deadlines, examinations, financial responsibilities, social expectations, career uncertainty, and changes in personal circumstances can contribute to perceived stress. Smartphone-related behaviours may interact with these stressors through several possible pathways. Repeated notifications, social comparison, fear of missing out, continuous information exposure, and pressure to respond immediately may increase cognitive demands and interfere with concentration. Students who repeatedly check their smartphones may experience interruptions during studying, difficulty maintaining attention, and a sense of reduced control over their daily routines. In some individuals, smartphone engagement may also become a coping behaviour used to temporarily avoid academic pressure, loneliness, boredom, or negative emotions. Although this behaviour may provide short-term distraction, it may not address the underlying stressor and can potentially reinforce repeated checking. Research among university students has reported relationships between problematic internet or smartphone use and psychological distress, including anxiety and stress symptoms (Wan Ismail et al., 2020, Al Battashi et al., 2021, Yang et al., 2019). These relationships are likely to be bidirectional: psychological distress may encourage excessive smartphone engagement, while poorly regulated use may contribute to sleep disruption, distraction, and additional distress. Therefore, the relationship should be examined as a complex behavioural and psychological association rather than a simple one-way effect. In addition to psychological concerns, prolonged smartphone use has attracted attention because of its possible relationship with neck pain and functional disability. Smartphones are commonly used while sitting, standing, walking, or lying down, and users may maintain sustained cervical flexion while looking at a screen positioned below eye level. Repeated exposure to this posture may increase the duration of loading on cervical and upper thoracic structures, particularly when device use occurs for extended periods without movement breaks. The physical demands of smartphone use may also involve sustained activity of the cervical extensor muscles, static shoulder positioning, repetitive thumb movements, and limited variation in posture. These behaviours may be associated with muscular fatigue, local discomfort, reduced movement tolerance, and symptoms affecting the neck and shoulder region. Studies involving university students have identified neck pain as a common complaint associated with mobile phone use and prolonged device exposure (Al-Hadidi et al., 2019, Chan et al., 2020, Ahmed et al., 2022). More recent research has also examined relationships among smartphone-use duration, neck muscle endurance, and neck pain, highlighting the relevance of both exposure time and physical capacity (Elvan et al., 2024). However, neck symptoms are multifactorial and may also be influenced by previous musculoskeletal conditions, workstation ergonomics, psychological distress, physical activity, sleep, academic workload, and other health behaviours. Neck disability refers to the extent to which neck-related symptoms interfere with activities such as reading, lifting, concentration, driving, sleeping, working, and personal care. Pain intensity alone does not fully represent the functional impact of a cervical complaint. Two students with similar pain intensity may experience different levels of limitation depending on their physical capacity, daily responsibilities, coping strategies, and psychological responses. The Neck Disability Index is commonly used to assess the functional consequences of neck pain through questions addressing pain and activity limitations. Its psychometric properties have been examined in different populations, and recent systematic review evidence has continued to evaluate its measurement performance (Saltychev et al., 2024). Investigating neck disability alongside smartphone addiction and psychological distress may therefore provide a broader understanding of the consequences of digital-device behaviours than measuring screen time or pain intensity alone. The relationship between smartphone addiction, stress, anxiety, and neck disability may involve interacting behavioural, psychological, and biomechanical mechanisms. Students with higher problematic-use scores may spend more time using smartphones, take fewer movement breaks, and be more

likely to use devices in sustained or awkward postures. At the same time, psychological distress may increase muscle tension, pain sensitivity, sleep disturbance, and reduced participation in physical activity. Neck pain may further contribute to stress and anxiety by interfering with studying, sleep, and daily functioning. These potential interactions support the need for an integrated investigation that considers both psychological and physical outcomes. The present study therefore examines the association between smartphone addiction, stress, anxiety, and neck disability among university students using a simulated dataset and standardized assessment instruments.

## 2. Background and Rationale:

University students are exposed to a combination of academic digital requirements and recreational smartphone activities. Unlike occupational groups in which screen exposure may be restricted to defined working hours, students may use smartphones throughout the day for lectures, study materials, messaging, social networking, entertainment, and personal communication. This overlapping exposure makes it difficult to distinguish academic use from recreational use and to determine whether total screen time alone adequately represents problematic behaviour. Two students may report similar daily smartphone duration but differ considerably in their ability to regulate use, stop checking notifications, maintain concentration, or reduce use when necessary. Consequently, assessment of smartphone addiction should include behavioural features rather than relying exclusively on the number of hours spent using a device. The Smartphone Addiction Scale–Short Version is one of the instruments used to evaluate problematic smartphone-use behaviours. Its use in different populations has been supported by psychometric research, although measurement characteristics and suggested thresholds may vary according to age, sex, culture, and study setting. A recent Indian study examined the psychometric properties of the SAS-SV among young adults and reported evidence relevant to its use in this population (Felix et al., 2025). Nevertheless, researchers should consider the scale's validation context and avoid interpreting a questionnaire score as a clinical diagnosis. For the present illustrative investigation, the SAS-SV score is treated primarily as a continuous measure of problematic smartphone-use severity. Psychological outcomes require similarly careful measurement. Stress and anxiety are related but distinct constructs. Stress refers to the perceived difficulty of coping with demands or pressures, whereas anxiety involves apprehension, worry, and physiological or cognitive symptoms associated with anticipated threat or uncertainty. The DASS-21 provides separate subscale scores for depression, anxiety, and stress. Although the present study focuses on stress and anxiety, the depression subscale may also be recorded if the complete instrument is administered, because depressive symptoms may act as a potential confounder. The DASS-21 is a screening and symptom-severity measure rather than a diagnostic instrument. Its use should therefore be accompanied by appropriate interpretation and referral procedures for participants reporting substantial distress. The musculoskeletal component is equally important because prolonged smartphone use may expose students to repeated static postures and limited movement variation. Neck disability provides a functional outcome that may be more clinically informative than smartphone-use duration alone. The present study examines whether higher smartphone addiction scores are associated with higher stress, anxiety, and NDI scores. It also considers whether psychological distress is associated with neck disability and whether the observed relationships remain after adjustment for demographic, behavioural, and ergonomic factors. The rationale is to demonstrate an integrated analytical approach that may inform university-level preventive programmes and physiotherapy-based interventions.

## 3. Statement of the Problem:

The increasing dependence on smartphones among university students has raised concerns about problematic device-use behaviours and their possible relationship with psychological distress and musculoskeletal complaints. Although previous studies have separately investigated smartphone addiction, anxiety, stress, and neck pain, the simultaneous assessment of smartphone addiction, stress, anxiety, and functional neck disability within a single student population remains important. Excessive smartphone engagement may be associated with prolonged cervical loading, reduced physical activity, sleep disruption, and repeated attentional interruptions, while academic pressure and psychological distress may influence the frequency and pattern of device use. These factors may interact and contribute to functional limitations that affect students' academic performance and daily activities. The present illustrative study examines the association between smartphone addiction and stress, anxiety, and neck disability among university students.

### 3.1. Aim of the Study:

The aim of this study is to demonstrate an analytical investigation of the association between smartphone addiction, stress, anxiety, and neck disability among university students aged 18–30 years.

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### 3.2. Objectives of the Study:

The objectives are to assess problematic smartphone use using the Smartphone Addiction Scale–Short Version, evaluate stress and anxiety symptoms using the DASS-21, determine the level of neck-related functional disability using the Neck Disability Index, examine the association between smartphone addiction and stress, assess the association between smartphone addiction and anxiety, investigate the relationship between smartphone addiction and neck disability, and explore the association between psychological distress and neck disability. The study also examines whether demographic and behavioural factors such as age, sex, academic discipline, daily smartphone-use duration, continuous-use duration, physical activity, and previous neck pain influence the observed relationships.

### 3.3. Research Hypotheses:

The null hypotheses are that there is no statistically significant association between smartphone addiction and stress among university students, no statistically significant association between smartphone addiction and anxiety, no statistically significant association between smartphone addiction and neck disability, and no statistically significant association between stress or anxiety and neck disability. The alternative hypotheses are that smartphone addiction is significantly associated with stress, anxiety, and neck disability, and that psychological distress is significantly associated with neck disability. These hypotheses are demonstrated using the simulated observations and should not be interpreted as hypotheses tested in a real participant population.

### 3.4. Conceptual Framework:

The proposed conceptual framework considers problematic smartphone use as the principal exposure variable and stress, anxiety, and neck disability as related outcomes. Smartphone addiction may be associated with increased device engagement, repeated checking, difficulty controlling use, and prolonged exposure to static cervical postures. These behaviours may contribute to psychological and physical pathways, including attentional disruption, sleep-related difficulties, reduced recovery time, sustained cervical muscle activity, and reduced movement variation. Stress and anxiety may also influence smartphone-use patterns and pain-related experiences, while neck symptoms may affect concentration, sleep, and participation in academic activities. Potential confounding variables include age, sex, academic discipline, previous neck pain, physical activity, sleep quality, study duration, workstation ergonomics, and other health conditions. Fig. 1 illustrating the proposed relationships among smartphone addiction, behavioural exposure, stress, anxiety, cervical loading, neck pain, and neck-related functional disability among university students. The framework guides variable selection and statistical analysis, it does not assume that the relationships are causal.

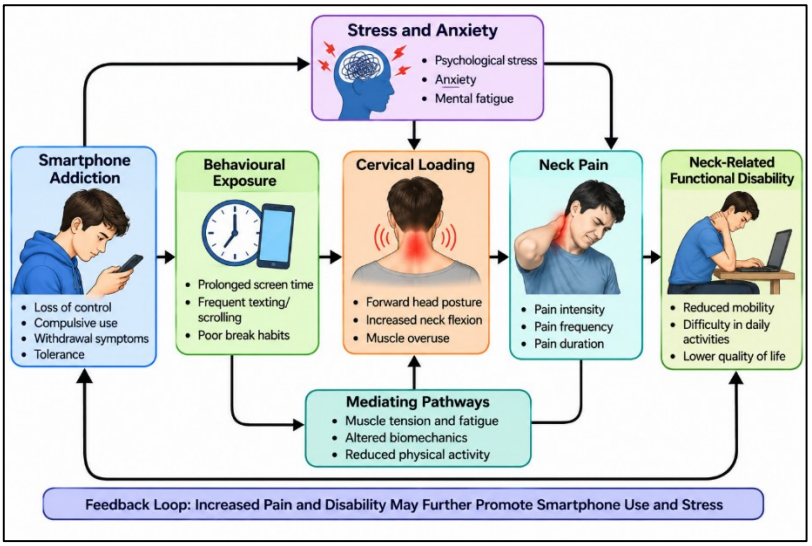



*Figure. 1: Conceptual framework linking smartphone addiction with psychological distress and neck disability*

## 4. Review of Literature:

### 4.1. Problematic Smartphone Use among University Students:

Problematic smartphone use has been investigated as a behavioural pattern characterized by excessive engagement, impaired control, preoccupation, withdrawal-like experiences, and interference with daily

responsibilities. It is important to distinguish this construct from high but purposeful smartphone use. Students may spend several hours using smartphones for lectures, reading, online assessments, or academic communication without demonstrating problematic behaviour. Conversely, a student with comparatively lower total use may experience significant difficulty controlling checking habits or may continue using a device despite negative effects on sleep, concentration, or relationships. Systematic reviews have reported that problematic smartphone use is associated with a range of psychological and behavioural outcomes, although prevalence estimates vary substantially because of differences in definitions, measurement tools, and cut-off scores (Sohn et al., 2019, Lu et al., 2024). The SAS-SV is frequently used in student research, but its interpretation should account for population-specific psychometric properties. The Indian validation study by Felix et al. (2025) is particularly relevant because it examined the scale among young adults in India and supports the importance of local psychometric evaluation.

**4.2. Smartphone Addiction and Stress:**

Stress among university students may arise from academic workload, examinations, financial pressure, social relationships, career uncertainty, and personal responsibilities. Smartphone use may interact with stress through several pathways. Frequent notifications and digital interruptions can fragment attention and increase the effort required to complete academic tasks. Social networking may expose students to social comparison, pressure to maintain online availability, and concern about missing important information. In some cases, students may use smartphones to avoid unpleasant thoughts or academic tasks, potentially contributing to procrastination and additional time pressure. Research among university students has identified relationships between problematic digital use and psychological distress, including stress-related symptoms (Wan Ismail et al., 2020, Al Battashi et al., 2021). However, the association may also operate in the opposite direction because students experiencing stress may use smartphones more frequently for distraction, reassurance, or social support. Cross-sectional research can identify whether these variables occur together but cannot determine which condition precedes the other.

**4.3. Smartphone Addiction and Anxiety:**

Anxiety may be associated with problematic smartphone use through reassurance-seeking, fear of missing out, social comparison, uncertainty, and repeated checking. Students may feel uncomfortable when unable to access their devices or may become concerned about delayed messages, missed notifications, or reduced online interaction. Such behaviours can reinforce frequent device checking and may interfere with concentration and sleep. Meta-analytic research has reported associations between problematic smartphone use and anxiety symptoms, although effect estimates vary across populations and measurement approaches (Li et al., 2020, Yang et al., 2020, Augner et al., 2023). The relationship is not necessarily uniform: smartphones may also provide social support, access to mental-health resources, educational information, and communication with family. Therefore, the focus should be on patterns of use, loss of control, and functional interference rather than assuming that smartphone ownership or ordinary use is harmful.

**4.4. Smartphone Use and Neck Pain:**

Neck pain is a common musculoskeletal complaint among young adults and university students. Prolonged smartphone use may contribute to sustained cervical flexion, static muscle activity, repetitive upper-limb movements, and limited postural variation. The amount of mechanical loading may depend on screen height, device position, sitting support, duration of uninterrupted use, and the frequency of movement breaks. Al-Hadidi et al. (2019) investigated mobile phone use and neck pain among university students, while Chan et al. (2020) examined the prevalence of neck pain and associated risk factors in undergraduate students. Ahmed et al. (2022) also investigated smartphone addiction in relation to musculoskeletal pain involving the neck and upper limb. More recent studies have examined smartphone-use duration alongside neck muscle endurance and neck pain, suggesting that exposure patterns and muscular capacity deserve attention in student populations (Elvan et al., 2024). These findings support further investigation but do not establish that smartphone use alone causes cervical pain. Neck symptoms are influenced by multiple interacting factors, including previous injury, physical activity, sleep, stress, workstation conditions, and individual pain sensitivity.

**4.5. Smartphone Addiction and Neck Disability:**

Neck disability represents the effect of cervical symptoms on everyday function. Students with neck pain may experience difficulty maintaining prolonged reading positions, using computers, carrying bags, sleeping comfortably, or concentrating during lectures. The relationship between smartphone addiction and neck disability may be influenced by both behavioural exposure and physical posture. Students with higher

addiction scores may use devices more frequently and for longer uninterrupted periods, potentially increasing exposure to static positions. However, device-use duration does not necessarily reflect the degree of cervical loading because students may use smartphones at different heights and in different positions. Recent work has specifically investigated smartphone addiction and neck-related functional disability among undergraduate students, highlighting the relevance of assessing functional outcomes rather than pain alone (John et al., 2026). Other research has examined neck pain, disability, and mobile phone use among physiotherapy students, adding to the evidence that device-use behaviours and cervical function are relevant concerns in university settings (Czępińska et al., 2024).

### 4.6. Psychological Distress and Musculoskeletal Symptoms:

Psychological and musculoskeletal health are interconnected. Stress and anxiety may influence muscle activity, sleep, attention, pain-related worry, and the interpretation of bodily sensations. Students experiencing psychological distress may report increased muscle tension or reduced ability to recover from prolonged study and device-use activities. Conversely, persistent neck pain may interfere with sleep, concentration, physical activity, and academic participation, potentially increasing psychological distress. These relationships are consistent with a biopsychosocial understanding of musculoskeletal conditions, in which biological, psychological, and social factors jointly influence symptoms and disability. The present study therefore examines stress and anxiety not only as possible correlates of smartphone addiction but also as variables associated with neck disability.

### 4.7. Evidence Gaps:

Existing research provides evidence of associations between problematic smartphone use and psychological symptoms, and between mobile phone behaviours and musculoskeletal complaints. Nevertheless, studies vary in their populations, outcome measures, definitions of addiction, and adjustment for confounding variables. Some investigations focus on total screen time, while others assess problematic-use scores. Some examine pain prevalence without measuring functional disability, and others assess psychological outcomes without considering cervical symptoms. There is therefore value in a study that uses a standardized measure of smartphone addiction, separate stress and anxiety subscales, and a validated neck-disability instrument within the same university population. The present illustrative analysis demonstrates this combined assessment approach while acknowledging that a cross-sectional design cannot establish temporal or causal relationships.

## 5. Methodology:

### 5.1. Study Design:

A quantitative, observational, analytical cross-sectional design was used to structure the illustrative analysis. The dataset contains 216 generated records representing hypothetical university students. No actual students were recruited, no questionnaires were administered, and no real participant responses were collected. The dataset was created for demonstrating statistical analysis, manuscript organization, and interpretation of possible relationships among the study variables.

### 5.2. Study Setting and Population:

The hypothetical target population consists of university students aged 18–30 years enrolled in undergraduate or postgraduate programmes. The generated dataset represents students from health sciences and non-health sciences disciplines. These categories were included to illustrate how a study might account for academic discipline and variation in digital-learning requirements. The generated sample should not be interpreted as a representative sample of any actual university, city, or country.

### 5.3. Sample Size:

A sample of 216 records was generated to correspond with the earlier illustrative sample-size estimate. That estimate assumed an expected correlation coefficient of 0.20, a two-sided significance level of 0.05, and statistical power of 80%, resulting in an approximate requirement of 194 participants before allowing for incomplete responses. The additional records were included to create a hypothetical sample of 216. This is a planning illustration and does not mean that 216 real participants were enrolled.

### 5.4. Sampling Technique:

The dataset was generated through a computer-based simulation process. Demographic characteristics and behavioural categories were assigned using predefined probability distributions, and continuous scores were

generated using a correlated multivariate model. The synthetic records were not sampled from a real university population and were not derived from any identifiable individual.

**5.5. Eligibility Criteria:**

For the hypothetical study framework, eligible participants were defined as university students aged 18–30 years who regularly used a smartphone and could complete the study questionnaires. The conceptual exclusion criteria included inability to provide informed consent, severe neurological or musculoskeletal conditions affecting cervical function, recent cervical surgery, and recent traumatic injury affecting the neck. These criteria were not applied to real individuals because no actual recruitment occurred.

**5.6. Study Variables:**

The principal exposure variable was the SAS-SV total score, representing problematic smartphone-use behaviour. The principal psychological outcomes were DASS-21 stress and anxiety scores, and the principal musculoskeletal outcome was the NDI total score. Additional generated variables included age, sex, academic discipline, year of study, daily smartphone-use duration, longest continuous-use period, and primary smartphone-use purpose, smartphone use before sleep, frequency of movement breaks, physical activity, and previous neck pain. These variables were included to demonstrate potential adjustment for demographic and behavioural confounding.

**5.7. Assessment Instruments:**

The Smartphone Addiction Scale–Short Version consists of 10 items designed to assess problematic smartphone-use behaviours. Items are rated on a Likert-type response scale, and the total score is calculated according to the instrument's scoring instructions, with higher scores indicating greater problematic use. The simulated dataset contains a total-score variable ranging from 10 to 60. The score is treated as a continuous variable rather than being used to diagnose smartphone addiction. The Depression Anxiety Stress Scales–21 is a 21-item self-report instrument containing three seven-item subscales assessing depression, anxiety, and stress symptoms. The simulated dataset includes stress and anxiety subscale totals represented on the conventional doubled 0–42 scale. These scores are illustrative values rather than responses obtained through administration of the instrument. The DASS-21 is a screening and symptom-severity measure, not a diagnostic tool. The Neck Disability Index is a 10-section questionnaire used to assess how neck pain affects activities and function. Each section is scored from 0 to 5, producing a total score from 0 to 50 when all items are completed. Higher scores indicate greater reported disability. The generated dataset contains NDI totals on this 0–50 scale. Recent systematic review evidence has examined the psychometric properties of the NDI and supports careful consideration of its measurement characteristics (Saltychev et al., 2024). A structured demographic and smartphone-use questionnaire was represented through variables for age, sex, academic discipline, year of study, daily smartphone-use duration, longest continuous-use period, primary purpose of smartphone use, use before sleep, movement breaks, physical activity, and previous neck pain. These variables were generated to demonstrate how demographic and behavioural characteristics may be incorporated into a statistical analysis.

**5.8. Data Generation and Management:**

The synthetic dataset was generated using a fixed random-number seed to ensure reproducibility. Demographic and categorical variables were generated using predefined probability distributions. Continuous smartphone-addiction, stress, anxiety, and neck-disability scores were generated using a correlated multivariate model with additional variation related to daily smartphone-use duration and previous neck pain. The generated values were constrained to the specified questionnaire score ranges. Each record was assigned a synthetic participant identifier and explicitly labelled as simulated. The resulting CSV file contains 216 records and 17 columns, including a data-status field identifying the records as synthetic. The dataset was checked for missing values, variable ranges, and consistency before descriptive and inferential analyses were performed. Figure 2 showing the proposed sequence of participant eligibility assessment, informed consent, demographic and smartphone-use assessment, SAS-SV, DASS-21 and NDI measurement, data management, statistical analysis, and interpretation. In a real study, these stages would involve actual recruitment, questionnaire administration, secure data collection, and ethics-approved procedures, in the present illustrative analysis, the records were generated computationally.

ISSN: 3108-2203; SJNTMA
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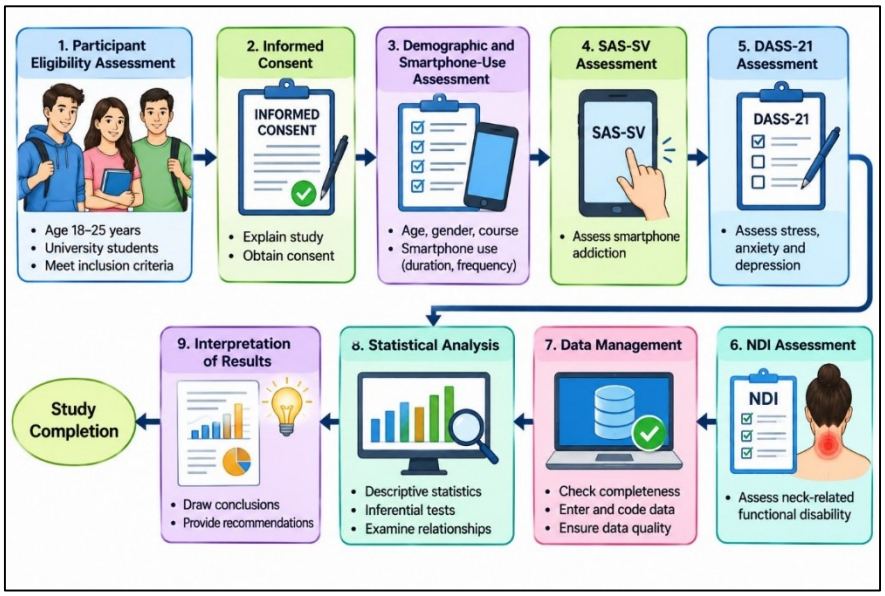



***Figure. 2: Study workflow from participant recruitment to data analysis and interpretation***

### 5.9. Ethical Considerations:

No human participants were recruited and no identifiable personal information was collected for the synthetic dataset. Therefore, the generated records do not constitute observations from an actual human-participant study. A real study using the proposed protocol would require prior approval from the appropriate Institutional Ethics Committee, informed consent, confidentiality safeguards, secure data storage, and a referral pathway for participants reporting substantial psychological distress. The simulated results must not be represented as evidence collected under an ethics approval that was not obtained.

### 5.10. Statistical Analysis:

The generated data were analysed using descriptive and inferential statistical procedures. Continuous variables were summarized using means and standard deviations, while categorical variables were summarized using frequencies and percentages. Pearson correlation coefficients were calculated to examine associations between SAS-SV, DASS-21 stress, DASS-21 anxiety, and NDI scores. Approximate 95% confidence intervals for correlation coefficients were calculated using Fisher's z transformation. Multiple linear regression models were fitted separately for stress, anxiety, and NDI scores. The principal predictor was the SAS-SV total score, with daily smartphone-use duration, age, sex, previous neck pain, and physical activity included as covariates. Statistical significance was assessed using a two-sided p-value threshold of 0.05. All reported numerical results in this manuscript are generated from the synthetic dataset and are intended solely for methodological demonstration.

## 6. Results:

### 6.1. Demographic Characteristics:

The simulated dataset consisted of 216 hypothetical university-student records. The mean age was 21.48 ± 2.00 years, with ages ranging from 18 to 26 years. Female records represented 125 participants (57.9%), while male records represented 91 (42.1%). Health sciences students accounted for 136 records (63.0%), and non-health sciences students accounted for 80 (37.0%). The distribution across academic years was relatively balanced, with 55 records (25.5%) assigned to first-year students, 56 (25.9%) to second-year students, 55 (25.5%) to third-year students, and 50 (23.1%) to students in fourth year or above. Previous neck pain was represented in 76 records (35.2%), while 140 records (64.8%) were categorized as having no previous neck pain.

***Table. 1: Simulated demographic and academic characteristics of the 216 hypothetical university-student records***

| Characteristic | Category | Simulated result |
|---|---|---|
| Total records | — | 216 |

| | | |
|---|---|---|
| Age<br>Age | Mean ± SD | 21.48 ± 2.00 years |
| | Range | 18–26 years |
| Sex | Female | 125 (57.9%) |
| | Male | 91 (42.1%) |
| Academic discipline | Health sciences | 136 (63.0%) |
| | Non-health sciences | 80 (37.0%) |
| Year of study | First | 55 (25.5%) |
| | Second | 56 (25.9%) |
| | Third | 55 (25.5%) |
| | Fourth or above | 50 (23.1%) |
| Previous neck pain | Yes | 76 (35.2%) |
| | No | 140 (64.8%) |

**6.2. Smartphone-Use Characteristics:**

The mean simulated daily smartphone-use duration was 5.16 ± 1.65 hours, with a range of 1.2–9.8 hours. Seven records (3.2%) represented less than two hours of daily use, 51 (23.6%) represented two to four hours, 97 (44.9%) represented four to six hours, and 61 (28.2%) represented more than six hours. The longest continuous-use period was represented as less than 30 minutes in 39 records (18.1%), 30–60 minutes in 104 records (48.1%), and more than 60 minutes in 73 records (33.8%). Mixed-purpose smartphone use was the most frequently assigned category, followed by social networking and communication. Smartphone use before sleep was represented in 162 records (75.0%), while 84 records (38.9%) were categorized as taking regular movement breaks.

***Table. 2: Simulated smartphone-use characteristics and behavioural patterns among the hypothetical student records***

| **Variable** | **Category** | **Simulated result** |
|---|---|---|
| Daily smartphone use<br>Daily smartphone use | Mean ± SD | 5.16 ± 1.65 hours |
| | Less than 2 hours | 7 (3.2%) |
| | 2–4 hours | 51 (23.6%) |
| | 4–6 hours | 97 (44.9%) |
| | More than 6 hours | 61 (28.2%) |
| Longest continuous use | Less than 30 minutes | 39 (18.1%) |
| | 30–60 minutes | 104 (48.1%) |

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| | | |
|---|---|---|
| | More than 60 minutes | 73 (33.8%) |
| Primary use | Academic | 43 (19.9%) |
| | Social networking/communication | 59 (27.3%) |
| | Entertainment/gaming | 37 (17.1%) |
| | Mixed use | 77 (35.6%) |
| Smartphone use before sleep | Yes | 162 (75.0%) |
| | No | 54 (25.0%) |
| Movement breaks | Regular | 84 (38.9%) |
| | Infrequent or none | 132 (61.1%) |
| Physical activity | Low | 122 (56.5%) |
| | Moderate/high | 94 (43.5%) |

### 6.3. Descriptive Scores of Smartphone Addiction, Stress, Anxiety, and Neck Disability:

The mean simulated SAS-SV score was 34.26 ± 9.18, indicating variation in problematic smartphone-use scores across the generated records. The mean DASS-21 stress score was 13.64 ± 5.98, while the mean anxiety score was 11.57 ± 6.38. The mean NDI score was 11.83 ± 4.50 out of 50. Using commonly applied NDI descriptive bands for illustration, 9 records (4.2%) fell within the no-disability range, 152 (70.4%) within the mild-disability range, 53 (24.5%) within the moderate-disability range, and 2 (0.9%) within the severe-disability range. These categories are descriptive and should not be interpreted as clinical diagnoses. The mean scores and distributions are characteristics of the generated dataset, not estimates of the actual prevalence or severity of these conditions among university students.

### 6.4. Correlation between Smartphone Addiction and Psychological Outcomes:

Pearson correlation analysis demonstrated a positive association between SAS-SV and DASS-21 stress scores ($r = 0.319$, 95% CI: 0.194–0.434, $p < 0.001$). A positive association was also observed between SAS-SV and anxiety scores ($r = 0.338$, 95% CI: 0.215–0.451, $p < 0.001$). These simulated coefficients indicate that higher problematic smartphone-use scores tended to occur alongside higher stress and anxiety scores in the generated dataset. The strength of these relationships was in the small-to-moderate range. The association between stress and anxiety was stronger ($r = 0.505$, 95% CI: 0.399–0.598, $p < 0.001$). These patterns are consistent with the relationships deliberately incorporated into the synthetic data-generation model and should not be interpreted as empirical evidence.

### 6.5. Correlation between Smartphone Addiction and Neck Disability:

A positive association was observed between SAS-SV and NDI scores ($r = 0.576$, 95% CI: 0.479–0.659, $p < 0.001$). This was the strongest correlation among the principal exposure-outcome pairs. The generated data therefore demonstrate how a higher problematic smartphone-use score may be statistically associated with greater neck-related functional limitation. Stress was also positively correlated with NDI scores ($r = 0.427$, 95% CI: 0.311–0.530, $p < 0.001$), while anxiety demonstrated a positive correlation with NDI scores ($r = 0.312$, 95% CI: 0.186–0.428, $p < 0.001$).

***Table. 3: Correlation matrix demonstrating the simulated relationships among smartphone addiction, stress, anxiety, and neck disability***

| Variables | Pearson r | 95% CI | p-value |
|---|---|---|---|

| | | | |
|---|---|---|---|
| SAS-SV and stress | 0.319 | 0.194 to 0.434 | <0.001 |
| SAS-SV and anxiety | 0.338 | 0.215 to 0.451 | <0.001 |
| SAS-SV and NDI | 0.576 | 0.479 to 0.659 | <0.001 |
| Stress and anxiety | 0.505 | 0.399 to 0.598 | <0.001 |
| Stress and NDI | 0.427 | 0.311 to 0.530 | <0.001 |
| Anxiety and NDI | 0.312 | 0.186 to 0.428 | <0.001 |

### 6.6. Multivariable Regression Analysis:

In the simulated regression model for stress, SAS-SV score remained positively associated with stress after adjustment for daily smartphone-use duration, age, sex, previous neck pain, and physical activity (unstandardized B = 0.191, 95% CI: 0.103–0.278, $p < 0.001$). The model explained approximately 12.3% of the variance in stress scores ($R^2 = 0.123$, adjusted $R^2 = 0.098$). Daily smartphone-use duration was not independently associated with stress in this generated model (B = 0.079, $p = 0.747$). For anxiety, SAS-SV score was also positively associated with anxiety (B = 0.239, 95% CI: 0.146–0.331, $p < 0.001$). The model explained approximately 14.3% of the variance in anxiety scores ($R^2 = 0.143$, adjusted $R^2 = 0.118$). Daily smartphone-use duration was not independently associated with anxiety (B = 0.130, $p = 0.617$). For neck disability, SAS-SV score remained positively associated with NDI score (B = 0.246, 95% CI: 0.193–0.299, $p < 0.001$). Daily smartphone-use duration was also independently associated with NDI score (B = 0.556, 95% CI: 0.262–0.850, $p < 0.001$), and previous neck pain was associated with higher NDI scores (B = 1.981, 95% CI: 0.996–2.965, $p < 0.001$). The model explained approximately 42.9% of the variance in NDI scores ($R^2 = 0.429$, adjusted $R^2 = 0.413$). These estimates demonstrate the interpretation of adjusted associations in the simulated dataset and should not be reported as findings from a real university sample.

### 6.7. Summary of Illustrative Findings:

The generated dataset demonstrated positive correlations between problematic smartphone-use scores and all three principal outcomes: stress, anxiety, and neck disability. The strongest correlation was observed between smartphone addiction and NDI scores. Stress and anxiety were also associated with neck disability. In adjusted analyses, SAS-SV scores remained associated with each outcome, while daily smartphone-use duration and previous neck pain were independently associated with NDI scores. These results are included to demonstrate a complete statistical reporting structure and do not establish the prevalence, magnitude, or direction of relationships in an actual student population.

## 7. Discussion:

The illustrative analysis demonstrates how smartphone addiction, stress, anxiety, and neck disability may be examined within a single cross-sectional analytical framework. The generated dataset showed positive associations between SAS-SV scores and stress, anxiety, and NDI scores. The strongest simulated association was observed between smartphone addiction and neck disability, while the relationships with stress and anxiety were smaller. These patterns were intentionally generated to provide a plausible example of the statistical relationships that a real study might investigate. They should not be interpreted as evidence that university students who use smartphones excessively necessarily experience higher psychological distress or neck disability. The simulated positive association between smartphone addiction and stress illustrates the possible relationship between poorly regulated smartphone engagement and perceived psychological pressure. Frequent notifications, digital interruptions, social comparison, academic procrastination, and pressure to remain available may contribute to cognitive demands and interfere with concentration. In some students, smartphone use may also function as a coping strategy for stress, offering temporary distraction from academic or personal concerns. However, repeated use may displace activities that support recovery, such as sleep, exercise, and face-to-face interaction. Previous research has reported associations between problematic smartphone use and psychological distress in university populations (Wan Ismail et al., 2020, Al Battashi et al., 2021). A real study would need to determine whether these associations are present in its own sample and whether they remain after adjustment for academic workload, sleep, and other relevant factors. The positive simulated association

between smartphone addiction and anxiety is also consistent with the broader hypothesis that poorly regulated smartphone use may coexist with worry, repeated checking, fear of missing out, and reassurance-seeking. Students may feel compelled to monitor notifications, maintain online availability, or remain connected to social networks. Such behaviours may interfere with concentration and may be associated with anxiety symptoms. Meta-analytic research has reported associations between problematic smartphone use and anxiety, although differences in measurement tools and study populations contribute to variation in the evidence (Li et al., 2020, Yang et al., 2020, Augner et al., 2023). Nevertheless, smartphone use may also provide social support and access to educational or mental-health resources. Therefore, it is important to distinguish problematic patterns from beneficial and purposeful digital engagement. The strongest simulated correlation was observed between smartphone addiction and neck disability. This finding illustrates the potential importance of assessing cervical function alongside smartphone-use behaviour. Prolonged device engagement may involve sustained cervical flexion, static muscle activity, limited postural variation, and inadequate movement breaks. Over time, such exposures may be associated with muscular fatigue, discomfort, and difficulty performing daily activities. Studies among university students have investigated mobile phone use and neck pain, supporting the relevance of this topic (Al-Hadidi et al., 2019, Chan et al., 2020, Ahmed et al., 2022). More recent work has examined neck muscle endurance and smartphone-use duration, suggesting that physical capacity and exposure patterns may both be important (Elvan et al., 2024). However, the generated correlation cannot establish that smartphone addiction causes neck disability. A real study should consider workstation ergonomics, previous neck symptoms, physical activity, sleep, and psychological factors.

The simulated relationship between daily smartphone-use duration and NDI scores in the adjusted model highlights the difference between total exposure time and problematic-use behaviour. Daily use duration may reflect academic requirements, recreational activity, social communication, or a combination of these purposes. A student may spend several hours on a smartphone for academic work without demonstrating impaired control, while another may report less total use but experience repeated checking and difficulty disengaging from the device. Therefore, total screen time and addiction scores should be assessed as separate constructs. If both are associated with neck disability in a real sample, this may indicate that behavioural dependence and exposure duration provide complementary information. The positive simulated relationship between stress and NDI scores is compatible with a biopsychosocial perspective on musculoskeletal symptoms. Psychological distress may influence muscle tension, sleep, pain-related attention, and coping behaviour. Persistent neck pain may also interfere with academic participation, concentration, and sleep, potentially increasing distress. The relationship between anxiety and NDI scores may similarly reflect interactions between psychological symptoms and pain-related functioning. A real study should examine these relationships with careful adjustment for previous neck pain, physical activity, sleep quality, and other relevant confounders. The adjusted regression analysis demonstrates the importance of examining associations beyond simple correlations. In the simulated stress and anxiety models, SAS-SV scores remained associated with the respective psychological outcomes after adjustment for selected covariates. In the NDI model, SAS-SV score, daily smartphone-use duration, and previous neck pain were independently associated with neck disability. These results illustrate how regression models can help distinguish the association of problematic smartphone-use scores from other measured factors. However, statistical adjustment does not eliminate all confounding, particularly when variables such as workstation ergonomics, academic pressure, sleep, and pain history are measured incompletely or not included. The findings also demonstrate why psychological and musculoskeletal outcomes should be assessed together. A narrow approach that focuses only on screen time may overlook the behavioural features of problematic use, while an approach focused only on neck pain may overlook psychological distress and functional limitations. The combination of SAS-SV, DASS-21, and NDI provides a multidimensional assessment structure that can be adapted for real university-based research. However, the instruments should be administered using their official instructions, and the results should be interpreted according to their validated scoring procedures.

## 8. Physiotherapy Implications:

Physiotherapy has an important role in the prevention and management of musculoskeletal problems associated with prolonged digital-device use. An integrated approach should address posture, movement variation, cervical muscle performance, upper-quarter function, physical activity, and self-management. Students reporting neck discomfort may benefit from individualized assessment of cervical range of motion, muscle endurance, scapular control, thoracic mobility, workstation ergonomics, and functional limitations. Exercise programmes may include progressive cervical flexor and extensor conditioning, scapular stabilizer strengthening, thoracic mobility exercises, and general physical activity. Exercise selection should be guided by symptoms, functional assessment, and individual tolerance rather than prescribed uniformly to all

smartphone users. Ergonomic education should focus on reducing prolonged static positions rather than attempting to maintain one rigid posture throughout the day. Students can be encouraged to raise the device closer to eye level when practical, support the arms, avoid prolonged neck flexion, vary sitting and standing positions, and take regular movement breaks. The frequency and duration of breaks should be realistic and adapted to academic tasks. Short periods of movement may help interrupt sustained postures and encourage postural variation. Students should also be educated about workstation setup, adequate lighting, screen distance, and the importance of alternating between devices and other study methods where possible. Digital-wellness strategies may complement physiotherapy interventions. These may include reviewing screen-time patterns, disabling non-essential notifications, setting planned periods for recreational smartphone use, avoiding unnecessary device checking during study sessions, and reducing smartphone engagement immediately before sleep. The purpose is not to discourage beneficial educational or social use but to promote intentional and controllable behaviour. Where students report significant stress or anxiety, physiotherapists should recognize the limits of their professional scope and encourage access to appropriate student counselling or mental-health services. Collaboration between physiotherapists, counsellors, university health services, and academic departments may support a more comprehensive preventive approach.

## 9. Proposed Integrated Preventive Framework:

An integrated preventive framework may combine digital-behaviour assessment, ergonomic modification, exercise-based rehabilitation, psychological support, and periodic reassessment. Initial screening would identify students with problematic smartphone-use patterns, psychological symptoms, and neck-related functional limitations. Students with elevated neck-disability scores may receive a physiotherapy assessment and individualized exercise and ergonomic advice. Students reporting substantial psychological distress may be directed toward appropriate mental-health services. Follow-up assessment may monitor changes in device-use behaviour, stress and anxiety symptoms, and neck-related function. Fig. 3 shows proposed integrated physiotherapy and digital-wellness framework combining smartphone-use screening, psychological assessment, ergonomic education, cervical and scapular exercise, movement breaks, self-management, and follow-up evaluation.

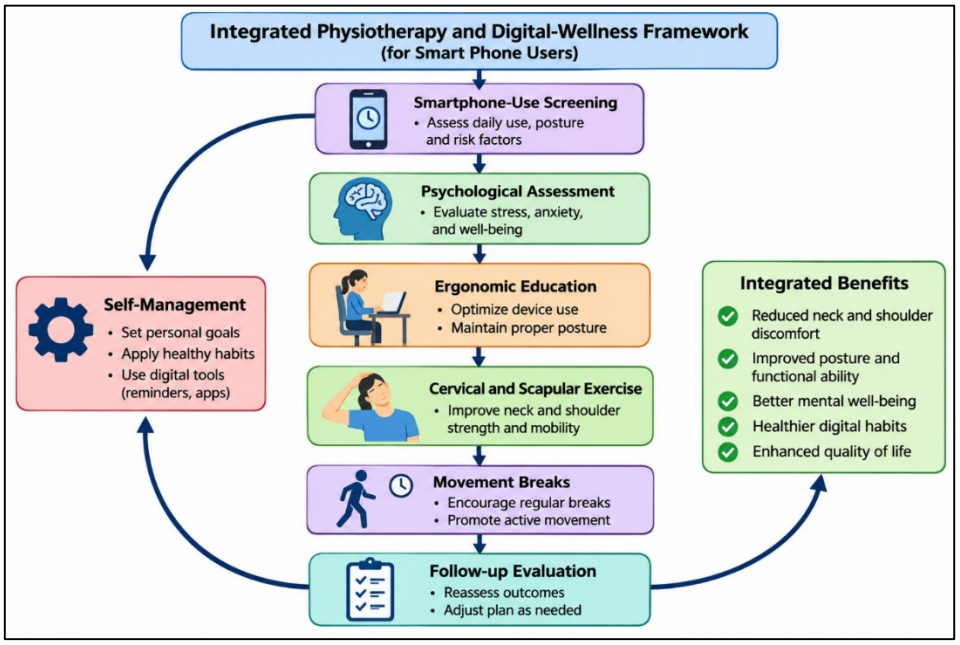



***Figure. 3: Integrated physiotherapy and digital-wellness framework for student well-being***

***Strengths of the Study Framework***

The principal strength of the proposed framework is the simultaneous assessment of smartphone addiction, stress, anxiety, and neck disability. The use of standardized questionnaires may improve consistency in measurement and allow comparison with relevant research. Including both psychological and functional musculoskeletal outcomes may provide a broader understanding of the possible health correlates of problematic smartphone use. The inclusion of daily use, continuous-use duration, academic discipline, posture-related behaviours, and physical activity also demonstrates how relevant contextual factors may be incorporated into statistical models. The synthetic dataset provides a reproducible example for learning data analysis and planning a real investigation.

## 10. Limitations:

The most important limitation is that the dataset is entirely synthetic. The records were generated using predefined assumptions and statistical relationships rather than collected from actual students. Therefore, the results cannot be generalized to any real university population, cannot establish prevalence, and cannot be used as empirical evidence. The simulated correlations and regression coefficients reflect the assumptions used in data generation and are not independent discoveries. In a real cross-sectional study, temporal relationships and causal direction would remain uncertain. Self-reported questionnaires may be affected by recall bias, social desirability, and differences in interpretation. Smartphone-use duration may be measured inaccurately unless verified through device-based screen-time records. The SAS-SV, DASS-21, and NDI are assessment instruments but do not replace clinical diagnosis or physical examination. Convenience sampling may limit generalizability, while unmeasured confounders such as sleep quality, workload, workstation ergonomics, and previous neck pain may influence observed associations. These limitations would need to be considered in an actual study and are especially important when interpreting simulated results.

## 11. Recommendations for Future Research:

Future research should use actual participant recruitment and prospective data collection to investigate whether problematic smartphone-use behaviours precede changes in psychological distress or neck disability. Longitudinal studies may help clarify temporal relationships and identify students who develop symptoms over time. Intervention studies could evaluate whether digital-wellness education, ergonomic modification, scheduled movement breaks, and physiotherapy-based exercise programmes improve neck function and reduce problematic use. Objective smartphone-use data may improve exposure measurement, while clinical assessment of cervical range of motion, endurance, posture, and functional performance may complement self-reported disability. Studies involving multiple universities and diverse academic disciplines may improve generalizability. Future investigations may also examine sleep quality, physical activity, academic stress, fear of missing out, and other psychosocial factors as potential mediators or moderators.

## 12. Conclusion:

This illustrative cross-sectional analysis demonstrates how smartphone addiction, stress, anxiety, and neck disability may be investigated together among university students. The simulated dataset of 216 records showed positive associations between smartphone addiction and stress, anxiety, and neck disability, with the strongest simulated association observed for neck disability. Daily smartphone-use duration and previous neck pain were also associated with NDI scores in the adjusted illustrative model. These numerical findings are generated from synthetic records and must not be interpreted as actual study results. The proposed framework highlights the value of assessing behavioural, psychological, and functional outcomes together and provides a structure for future empirical research. A real investigation using participant recruitment, ethics approval, validated questionnaire administration, and transparent statistical analysis is required before conclusions can be drawn about university students. Preventive strategies may incorporate digital-wellness education, ergonomic modification, postural variation, cervical and scapular strengthening, physical activity promotion, and appropriate psychological support. A multidisciplinary approach involving physiotherapists, university health services, academic departments, and mental-health professionals may help promote healthier digital habits and support the physical and psychological well-being of university students.

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