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Assessment of Smartphone Usage and Neck Pain among Undergraduate Students

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Abstract— Smartphones have become an everyday academic and social tool for undergraduate students, and the sustained head-down posture associated with their use has raised concern about neck pain in this age group. This cross-sectional study assessed the association between daily smartphone use and neck pain among 400 undergraduate students selected by stratified random sampling. Daily screen time was recorded over seven days and categorised as low (<3 h), moderate (3–5 h) or high (>5 h). Neck pain in the previous three months was recorded with the Nordic Musculoskeletal Questionnaire, disability with the Neck Disability Index, smartphone dependence with the short Smartphone Addiction Scale, and head posture with the craniovertebral angle (CVA) measured from lateral photographs. Neck pain was reported by 194 students (48.5%). Prevalence rose from 28.3% in the low-use group to 51.2% in the moderate-use group and 65.0% in the high-use group ($\chi^2 = 33.10$, $p < 0.001$). Mean CVA fell from 51.2° to 45.9° across the same categories ($F = 32.34$, $p < 0.001$). After adjustment for sex, posture, exercise and laptop use, high use remained independently associated with neck pain (adjusted OR 4.18, 95% CI 2.32–7.52). Longer daily smartphone use is associated with a higher burden of neck pain and a more forward head posture. Posture education and screen-time guidance should be built into student health programmes.

Keywords: smartphone use; neck pain; undergraduate students; craniovertebral angle; forward head posture; musculoskeletal disorders

Introduction

Neck pain is among the most common musculoskeletal complaints worldwide. The Global Burden of Disease 2010 study placed it fourth in disability burden among all conditions, with a point prevalence of about 5% and a clear predominance in women (Hoy et al., 2014). Its causes are rarely a single injury. They are more often the accumulated effect of sustained postures, repetitive loading, psychosocial strain and low physical activity (Hoy et al., 2010). Until recently these exposures were studied mainly in office workers, drivers and manual labourers. Young adults were assumed to be at low risk.

That assumption is now harder to defend. Smartphone ownership among university students is close to universal, and daily use of several hours is routine. Reading, messaging, video, social networks, banking and coursework all happen on the same small screen, usually held below eye level. To look at it the user flexes the neck forward, and the head, which weighs roughly 4.5–5 kg in a neutral position, is carried at a mechanical disadvantage. Biomechanical modelling suggests that the load on the cervical spine rises steeply with the angle of flexion (Hansraj, 2014), and measurements of real users show flexion angles that frequently exceed 40° during texting and reading (Lee et al., 2015).

Evidence from different countries suggests that this exposure is reflected in symptoms, although the findings are not uniform. In India, students spend long hours on phones during and after classes, often in bed or on a sofa, where support for the back and neck is poor. Local data on the dose–response relationship between hours of use and neck pain, on the posture that mediates it, and on the role of other habits are limited. This study addresses that gap among undergraduate students. It estimates the prevalence of neck pain, compares it across categories of daily smartphone use, examines head posture, and tests whether smartphone use remains associated with neck pain after other factors are taken into account.

Literature Review

The link between head posture and neck pain has been examined repeatedly. Silva et al. (2009) found that adults with chronic non-traumatic neck pain held their heads further

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forward than pain-free controls. A later systematic review and meta-analysis concluded that forward head posture is associated with neck pain, though the strength of the association depends on how posture is measured (Mahmoud et al., 2019). The craniovertebral angle, taken between the horizontal and the line from the tragus of the ear to the seventh cervical vertebra, is the most widely used photographic measure, and smaller angles denote a more forward head.

Several reviews have collected the evidence on handheld devices. Xie et al. (2017) reviewed musculoskeletal complaints among users of mobile handheld devices and reported that the neck and the upper limbs were the regions most often affected, with longer duration of use and certain postures increasing risk. Toh et al. (2017) examined the associations of touch-screen device use with symptoms and exposures and judged the evidence to be limited by the quality of exposure measurement, since most studies relied on self-report. These reviews motivated the choice in the present study of a seven-day recorded screen-time measure, in place of a recalled estimate.

Primary studies point in the same direction. Kim and Kim (2015) found that university students who used smartphones for longer reported more musculoskeletal symptoms, with the neck and shoulders prominent. In a five-year cohort of young adults, Gustafsson et al. (2017) showed that frequent texting was associated with later neck and upper-limb symptoms, which gave some temporal support to the relationship. Namwongsa et al. (2018) assessed smartphone users with the Rapid Upper Limb Assessment and found that a large proportion adopted postures of elevated ergonomic risk, with the neck being among the most strained regions.

Behavioural dependence adds another dimension. People who score high on smartphone addiction scales tend to use their devices for longer and in worse postures, and the short version of the Smartphone Addiction Scale has been validated for this purpose (Kwon et al., 2013). Dependence is therefore both a marker of exposure and a possible confounder in any study of hours of use.

The reviewed work leaves three gaps that this study tries to fill. First, exposure was often self-reported. Second, few studies combined symptoms with an objective postural measure in the same students. Third, adjusted analyses that include posture during use, exercise and other device use are uncommon. The present study responds with recorded screen time, a photographic craniovertebral angle and multivariable logistic regression.

Objectives and Hypotheses

The objectives were to estimate the prevalence of neck pain among undergraduate students; to compare prevalence and neck disability across categories of daily smartphone use; to compare craniovertebral angle across those categories; and to determine whether smartphone use is independently associated with neck pain. The hypotheses are listed in Table 1.

Table 1. Study hypotheses and the tests used

Hypothesis	Statement	Test
H1	Prevalence of neck pain differs across smartphone-use categories	Chi-square test; odds ratio
H2	Mean craniovertebral angle differs across smartphone-use categories	One-way ANOVA
H3	Smartphone-use category predicts neck pain after adjustment for other factors	Multivariable logistic regression

Methodology

Design and setting

A cross-sectional survey with a physical examination component was carried out among undergraduate students enrolled at a multi-faculty university campus. Data were collected over eight weeks during the regular academic term, and not during examinations, to avoid the stress effect on pain reports.

Sample size and sampling

The sample size was computed for a comparison of proportions between the highest and lowest use categories. Assuming a medium effect (Cohen, 1988), 80% power, a two-sided alpha of 0.05 and an expected prevalence of 30% in the low-use group, about 110 students per group were needed. Allowing for non-response and incomplete data, 400 students were enrolled. Students were stratified by programme and year of study, and participants were drawn from each stratum by simple random sampling from enrolment lists. Students were eligible if aged 18–24 years and enrolled full time. Students with a history of cervical trauma or surgery, known spinal deformity, rheumatological disease, pregnancy, or neck pain with neurological deficit that preceded smartphone ownership

Vol. 15, Issue: 11, November 2026
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were excluded. Written informed consent was obtained and the institutional ethics committee approved the protocol.

Instruments and measures

Smartphone use was taken from the built-in screen-time record on each participant's phone, averaged over the previous seven days and checked by the investigator. Students were classified as low (<3 h/day), moderate (3–5 h/day) or high (>5 h/day) users. Smartphone dependence was measured with the short version of the Smartphone Addiction Scale (Kwon et al., 2013). Neck pain in the previous three months was recorded with the neck item of the Nordic Musculoskeletal Questionnaire (Kuorinka et al., 1987), and pain-related disability with the Neck Disability Index (Vernon & Mior, 1991), scored from 0 to 50. Participants also recorded sex, age, year and programme, habitual posture during phone use (upright and supported, or bent/lying), weekly exercise days and daily laptop use.

Head posture was assessed by the craniovertebral angle. With the participant standing in a relaxed position, a reflective marker was placed over the C7 spinous process and a lateral photograph was taken from a fixed distance of 1.5 m with the camera at shoulder height. The angle was measured with image analysis software by a single trained examiner who was unaware of the use category. A subset of 40 photographs was measured twice, a week apart, to check repeatability.

Statistical analysis

Categorical variables are shown as counts and percentages with Wilson 95% confidence intervals for prevalence. Differences in prevalence were tested with the chi-square test and expressed as Cramér's V and odds ratios with Woolf confidence intervals. Craniovertebral angle was compared across categories by one-way analysis of variance with Bonferroni-adjusted pairwise comparisons. Multivariable logistic regression was used to estimate adjusted odds ratios of neck pain, entering use category, sex, posture, exercise and laptop use. A p value below 0.05 was taken as significant.

Results

Participant profile

All 400 selected students completed the assessment. Their characteristics are shown in Table 2. Women formed 57.0% of the sample, and nearly three-quarters of participants were 20 years of age or older.

Table 2. Characteristics of participants (N = 400)

Characteristic	Category	n	%
Sex	Female	228	57.0
	Male	172	43.0
Age group	18–19 years	118	29.5
	20–21 years	164	41.0
	22–24 years	118	29.5
Year of study	First	104	26.0
	Second	112	28.0
	Third	98	24.5
	Fourth	86	21.5
Programme	Engineering and technology	124	31.0
	Science	96	24.0
	Commerce and arts	108	27.0
	Health sciences	72	18.0

Prevalence of neck pain by smartphone use

Neck pain in the previous three months was reported by 194 of 400 students (48.5%, 95% CI 43.6–53.4). Prevalence increased steadily with daily use (Table 3 and Figure 1). The difference across the three categories was statistically significant (χ^2 = 33.10, df = 2, p <0.001), with a moderate effect size (Cramér's V = 0.29). Compared with low users, moderate users had 2.66 times the odds of neck pain (95% CI 1.61–4.40) and high users had 4.70 times the odds (95% CI 2.72–8.11). H1 is therefore supported.

Table 3. Prevalence of neck pain by daily smartphone use

Use category	n	With neck pain	% (95% CI)	Crude OR (95% CI)
Low use (<3 h/day)	120	34	28.3 (21.0–37.0)	1.00 (reference)
Moderate use (3–5 h/day)	160	82	51.2 (43.6–58.9)	2.66 (1.61–4.40)
High use (>5 h/day)	120	78	65.0 (56.1–72.9)	4.70 (2.72–8.11)
Total	400	194	48.5 (43.6–53.4)	

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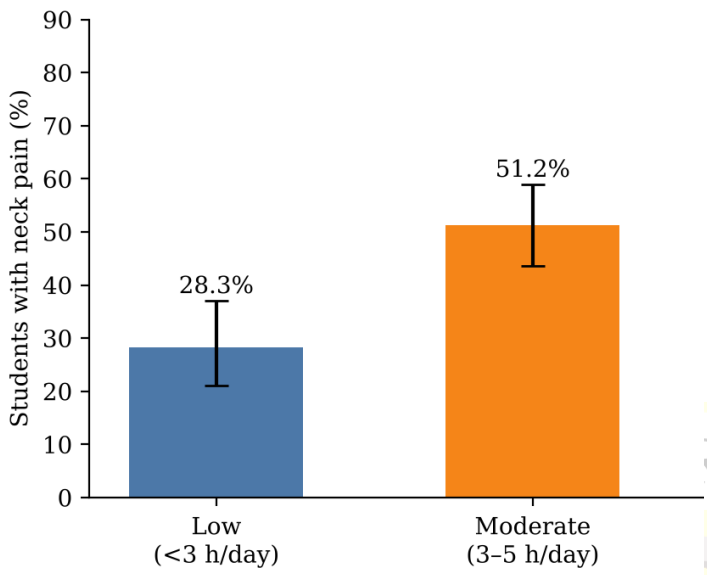


Figure 1. Prevalence of neck pain (with 95% confidence intervals) by daily smartphone use.

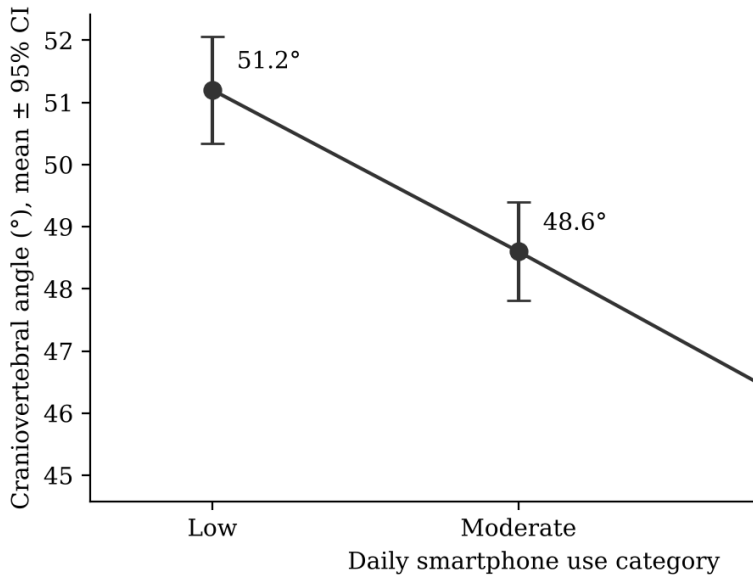


Figure 2. Mean craniovertebral angle (with 95% confidence intervals) by daily smartphone use.

Head posture

Craniovertebral angle fell progressively across use categories (Table 4, Figure 2). One-way ANOVA showed a significant difference ($F(2, 397) = 32.34$, $p < 0.001$, $\eta^2 = 0.140$). Bonferroni-adjusted comparisons showed that the angle in the low-use group exceeded that in the moderate-use group by 2.6° ($p < 0.001$) and the high-use group by 5.3° ($p < 0.001$), and the moderate-use group exceeded the high-use group by 2.7° ($p < 0.001$). H2 is supported. Intra-examiner repeatability on the 40 repeated photographs was good (intraclass correlation coefficient 0.91).

Table 4. Craniovertebral angle by daily smartphone use

Use category	n	Mean CVA (°)	SD
Low use (<3 h/day)	120	51.2	4.8
Moderate use (3–5 h/day)	160	48.6	5.1
High use (>5 h/day)	120	45.9	5.4
Overall	400	48.6	5.5

Adjusted association

In the multivariable model (Table 5, Figure 3), high use remained strongly associated with neck pain (adjusted OR 4.18, 95% CI 2.32–7.52), as did moderate use (adjusted OR 2.59, 95% CI 1.49–4.48). Bent or lying posture during use increased the odds (adjusted OR 1.86), whereas exercising three or more days a week was protective (adjusted OR 0.62). Female sex and laptop hours showed positive but statistically non-significant associations. H3 is supported.

Table 5. Multivariable logistic regression of neck pain (N = 400)

Variable	Adjusted OR	95% CI	p value
Moderate vs low use	2.59	1.49–4.48	<0.001
High vs low use	4.18	2.32–7.52	<0.001
Female vs male	1.40	0.91–2.16	0.122
Bent/lying posture vs upright	1.86	1.18–2.92	0.007
Exercise ≥3 days/week vs less	0.62	0.40–0.95	0.029
Laptop use (per h/day)	1.07	0.99–1.16	0.080

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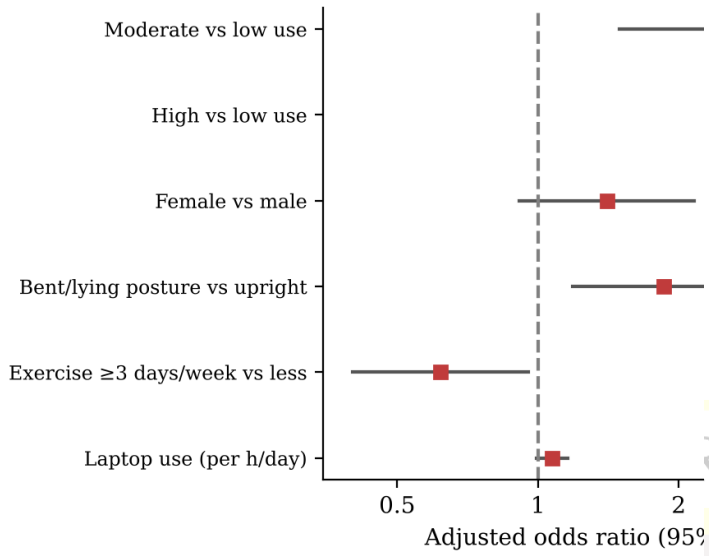


Figure 3. Adjusted odds ratios for neck pain from the multivariable logistic regression.

Symptoms among students with neck pain

Among the 194 students with neck pain, stiffness and pain on prolonged sitting were the most frequent complaints (Table 6). Median Neck Disability Index scores were higher in the high-use group than in the low-use group, although most disability was in the mild range.

Table 6. Associated symptoms among students with neck pain (n = 194)

Symptom	n	%
Neck stiffness	138	71.1
Pain during prolonged sitting	121	62.4
Shoulder pain	94	48.5
Headache	89	45.9
Upper back pain	72	37.1
Restricted neck movement	66	34.0
Arm tingling/numbness	31	16.0

Discussion

Nearly one in two undergraduate students in this sample reported neck pain in the previous three months. That figure is well above the global point prevalence of about 5% for the general population (Hoy et al., 2014), although the two numbers are not directly comparable because the present study used a three-month recall window and a younger group. The result is consistent with other work among university students, in whom musculoskeletal symptoms of the neck and shoulders are common (Kim & Kim, 2015; Xie et al., 2017).

The gradient across categories is the main finding. Prevalence was 28.3% among low users and 65.0% among high users, and the adjusted analysis retained a large effect after other factors were considered. This dose–response pattern supports a causal reading, though a cross-sectional design cannot settle direction. The temporal evidence from the cohort of Gustafsson et al. (2017) makes the exposure-to-symptom direction more plausible. The craniovertebral angle results add a mechanism: heavier users held their heads 5.3° further forward on average, in line with the forward head posture associated with neck pain by Silva et al. (2009) and Mahmoud et al. (2019). The sustained neck flexion measured during smartphone use by Lee et al. (2015), and the loading estimates of Hansraj (2014), offer a biomechanical explanation for why longer use would be followed by pain.

The posture and exercise findings are of practical interest. Students who typically used the phone in a bent or lying position had higher odds of pain regardless of hours, which agrees with the elevated ergonomic risk scores found among smartphone users by Namwongsa et al. (2018). Regular exercise was protective, which suggests that muscular conditioning of the neck and shoulder girdle may offset part of the load. Neither factor can be changed by telling students to use their phones less, so campus advice should emphasise raising the screen to eye level, supporting the elbows, taking breaks, and building strengthening routines into physical education.

Taken together, the results suggest a pathway from screen time to posture to pain. They also show that hours of use are not the only target. Because smartphone dependence tracks usage, brief screening with the Smartphone Addiction Scale (Kwon et al., 2013) could help identify students whose use is likely to be heavy, and who may benefit from earlier counselling.

Limitations

The design is cross-sectional, so temporal order cannot be established, and students with neck pain may use their phones differently. Neck pain was self-reported with a three-month recall window, which may introduce recall error. Screen-time records do not separate use with the head down from use at eye level, and some phone use occurs on other devices. The photographic craniovertebral angle is a static measure taken in standing, and may differ from posture during real use. The

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study was conducted on one campus, which limits generalisability. Finally, unmeasured factors such as psychological stress and sleep could confound the association.

Conclusion

Neck pain was common among undergraduate students and increased with daily smartphone use, from 28.3% in low users to 65.0% in high users. Heavier users also held their heads further forward, and the association with neck pain persisted after adjustment for posture, exercise, sex and laptop use. Institutions should give students practical ergonomic guidance, encourage regular movement and exercise, and include musculoskeletal health in routine student health checks. Prospective studies with objective posture monitoring are needed to confirm the direction of the association and to test whether interventions on posture and screen time reduce neck pain.

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