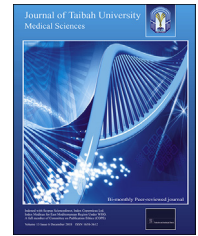




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Original Article

Correlation among smartphone addiction, craniovertebral angle, scapular dyskinesia, and selected anthropometric variables in physiotherapy undergraduates

Ashiyat K. Akodu, Ph.D.^{a,*}, Sunday R. Akinbo, Ph.D.^a and Queen O. Young, M.Sc.^b^a Department of Physiotherapy, College of Medicine, University of Lagos, Lagos, Nigeria^b National Assembly Complex, Three Arm Zone, Central Business District, Nigeria

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المخلص

أهداف البحث: أتهم إدمان الهواتف الذكية بتقليل الزاوية بين الجمجمة والعمود الفقري مما يتسبب في وضعية أمامية للرأس وزيادة في اختلال حركة عضلات عظمة اللوح الكتفي. حددت هذه الدراسة العلاقة بين مستوى الإدمان على الهواتف الذكية، والزاوية بين الجمجمة والعمود الفقري واختلال حركة عضلات عظمة اللوح الكتفي ومتغيرات قياسية بشرية مختارة بين طلاب العلاج الطبيعي الجامعيين.

طرق البحث: تم استقطاب ٧٧ مشاركاً من قسم العلاج الطبيعي بكلية الطب في جامعة لاغوس باستخدام أسلوب الأخذ الهادف للعينات. وتم تقييم مستوى إدمان الهاتف الذكي بواسطة النسخة القصيرة من مقياس إدمان الهاتف الذكي (النسخة الإنجليزية). استخدمت طريقة التصوير الفوتوغرافي لتقييم اختلال الزاوية بين الجمجمة والعمود الفقري وحركة عضلات عظمة اللوح الكتفي. تم استخدام الإحصاءات الوصفية والاستدلالية لتحليل البيانات على مستوى ألفا ٠.٠٥.

النتائج: كشفت نتائج هذه الدراسة أن عدداً أكثر من الطلاب الجامعيين مدمنين على استخدام الهواتف الذكية. لم يكن هناك اختلاف كبير في مستوى إدمان الذكور والإناث واختلال حركة عضلات عظمة اللوح الكتفي بين المشاركين. إلا أنه كان هناك فارق كبير بين الزاوية بين الجمجمة والعمود الفقري بين الذكور والإناث. كانت هناك علاقة ذات قيمة إحصائية بين إدمان الهواتف الذكية والزاوية بين الجمجمة والعمود الفقري واختلال حركة عضلات عظمة اللوح الكتفي بين المشاركين الذكور والإناث.

الاستنتاجات: يقلل المستوى العالي من إدمان الهواتف الذكية الزاوية بين الجمجمة والعمود الفقري، ويزيد اختلال حركة عضلات عظمة اللوح الكتفي. لذا

يجب تقييم مستوى إدمان الهواتف الذكية في جميع مرضى آلام الرقبة والكتف لتحديد العلاج المناسب.

الكلمات المفتاحية: الزاوية بين الجمجمة والعمود الفقري؛ اختلال حركة عضلات عظمة اللوح الكتفي؛ الهاتف الذكي؛ إدمان؛ العلاج

Abstract

Objectives: Smartphone addiction has been indicated to reduce the craniovertebral angle, thereby causing a forward head posture and increasing scapular dyskinesia. This study determined the correlation among smartphone addiction level, craniovertebral angle, scapular dyskinesia, and selected anthropometric variables in physiotherapy undergraduates.

Methods: Seventy-seven participants were recruited from the Department of Physiotherapy, College of Medicine, University of Lagos, through a purposive sampling technique. The smartphone addiction level was assessed with the short version Smartphone Addiction Scale (English version). Craniovertebral and scapular dyskinesia were assessed using the photographic method. Descriptive and inferential statistics were used to analyse the data at an alpha level of 0.05.

Results: The analysis in this study revealed that many undergraduates are addicted to using smartphones. There was no significant difference in the addiction level ($p = 0.367$) and in scapular dyskinesia ($p = 0.129$) between male and female participants. However, there was a significant difference in craniovertebral angle ($p = 0.032$) between male and female participants. There was a significant relationship among smartphone addiction, craniovertebral angle ($r = 0.306$, $p = 0.007$), and

* Corresponding address: Department of Physiotherapy, College of Medicine, University of Lagos, PMB 12003, Idi-araba, Lagos, Nigeria.

E-mail: aakodu@unilag.edu.ng (A.K. Akodu)

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scapular dyskinesis ($r = 0.363$, $p = 0.007$) in male and female participants.

Conclusion: A high level of smartphone addiction reduces the craniovertebral angle and increases scapular dyskinesis. Therefore, the smartphone addiction level should be assessed in all patients with neck and shoulder pain to plan appropriate management.

Keywords: Addiction; Craniovertebral angle; Management; Scapular dyskinesis; Smartphone

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Introduction

More than 50% of the worldwide population now uses smartphones.¹ Nigeria has been ranked 17th in a global ranking of countries with high smartphone usage. Nigerians spend 193 min every day on a mobile smartphone, compared with 131 min on a television, 80 min on a laptop computer, and 39 min on a tablet computer.² Prolonged use of smartphones is prevalent among young adults and students, including university students who spend a large amount of time on mobile devices for social, leisure, or school activities.³

Roberts et al.⁴ reported that female individuals spend significantly more time on their phones per day than male individuals, with sending text messages, sending e-mails, and using social media sites being the most time-consuming activities. Some smartphone users exhibit problematic behaviours similar to those in substance use disorders.⁵ Smartphone addiction encompasses a variety of impulse-control problems.⁶ Recently, this type of behavioural disorder has been medically accepted as a form of addiction.⁵ Smartphone addiction is often driven by an Internet overuse problem or Internet addiction disorder. It is rarely the phone itself that creates the compulsion but rather the games, applications, and online worlds it offers.⁶

The neck and shoulders are particularly vulnerable to pain due to smartphone use, with the muscles showing a high level of fatigue that results in exhaustion and pain.⁷ According to Junhyuk et al.,⁸ when the head tilts forward at 15°, the forces on the neck amount to 12 kg; at 30°, 18 kg; at 45°, 22 kg; and at 60°, 27 kg. However, at 90°, the model prediction was no longer reliable. Fatigue of the neck and shoulder muscles at different cervical flexion angles of phone usage was measured using electromyography, and the right upper trapezius and left upper trapezius showed the highest muscle fatigue at a cervical flexion angle of 50° and the lowest fatigue at an angle of 30°.⁹ Berolo et al.¹⁰ suggested that frequent smartphone use could lead to the use of a non-neutral neck posture or the development of musculoskeletal disorders.

Most individuals use smartphones with the head shifted forward and the smartphone placed close to the waist or lap

while in a sitting position.¹¹ Moreover, the maintenance of this position (head shifted forward) decreases the lordosis of the lower cervical vertebrae and creates a posterior curve in the upper thoracic vertebrae to maintain balance – known as the forward head posture.¹² A forward head posture increases external flexion torque, placing a bigger load on the extensors and some parts of the connective tissues. A forward head posture may cause many harmful symptoms such as neck pain, shoulder pain, upper back pain, chronic headaches, increased curvature of the spine, and scapular dyskinesis.¹³

Scapular dyskinesis produces alterations in the kinematics of the glenohumeral and acromioclavicular joints and interferes with the activity of the periscapular muscles and rotator cuff. It can also generate pain and reduce the functional capacity of the upper limb.¹⁴ In the long term, this poor posture can damage not only the cervical vertebra and the ligaments but also the structures around the lumbar region.¹⁵

A previous study focused on mobile phone addiction and psychological problems, such as subjective symptoms of physical problems or stress.⁸ Another study investigated posture during interactions with a computer, including posture and muscle activity during prolonged sitting.¹⁶

Only a few studies relating prolonged smartphone use to forward head posture and/or shoulder posture have been conducted in Asia, North America, and South America. This leaves a knowledge gap in this important subject matter, especially on the impact of smartphone use in young adults in Africa, precisely Lagos, Nigeria. Therefore, this study aimed to determine the correlation among smartphone addiction, craniovertebral angle, scapular dyskinesis, and selected anthropometric variables in physiotherapy undergraduates.

Materials and Methods

Study design

A cross-sectional survey design was employed.

Subjects

A purposive sampling technique was used in recruiting participants for this study. A total of 77 undergraduates (final-year students) were recruited from the Department of Physiotherapy, College of Medicine, University of Lagos, Nigeria. Undergraduates who reported a history of shoulder or neck pathology were excluded.

Procedure

Before the commencement of this study, ethical approval was sought and obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital, Idi-Araba, Lagos. The participants were informed about the nature of the study and given an informed consent form to sign. Thereafter, the preassessment and assessment procedures were carried out, and the participants who met the inclusion criteria were assessed.

First, the participants were requested to complete a demographic questionnaire (work sheet) and the short version

Smartphone Addiction Scale (SAS-SV) questionnaire (English version) to identify the excessive (score >30) and non-excessive (score ≤ 30) smartphone users.³ The participants' heights and weights were measured and recorded, then used to calculate the body mass index (BMI). The SAS-SV questionnaire (English version) is a tool for assessing smartphone addiction level.³ This 10-item self-reported scale addresses 5 content areas or domains, as follows: (i) daily-life disturbance, (ii) withdrawal, (iii) cyberspace-oriented relationships, (iv) overuse, and (v) tolerance. Participants responded on a 6-point Likert scale ranging from 1 ("strongly disagree") to 6 ("strongly agree") based on self-reporting. The total score in the SAS-SV is 60, with an average score of 30. The obtained scores were used to classify participants, as follows: those whose score was >30 were considered excessive smartphone users and those whose score was ≤ 30 were considered non-excessive smartphone users.

The craniovertebral angle was measured by instructing the participants to stand in an anatomical position with the head erect. The plumb line was set 1 m away from the participants and a tripod stand with a camera on top was set just behind it. The landmarks (the tragus of the participants' ear and the 7th cervical vertebrae) were marked clearly with adhesive markers; this was done by instructing the participants to flex and extend their neck. The plumb line was expected to fall in front or through the tragus of the ear and in front of the acromion process. The participants' photographs were taken laterally with a digital camera.¹⁷

The photographs were imported into Corel Draw X7 software version 17.0.0.491 for Windows (USA) using a Toshiba Tecra i7 laptop (USA). To measure the craniovertebral angle, a horizontal line starting from the spinous process of the 7th cervical vertebrae was drawn using the angular dimension of Corel Draw X7 software. Then, a diagonal line was drawn through the tragus of the ear to the spinous process of the 7th cervical vertebrae. The craniovertebral angle (Figure 1), which formed at the point where these 2 lines met (spinous process of the 7th cervical vertebrae), was measured and recorded.¹⁷

Scapular dyskinesia was measured with the female participants wearing tank tops and the male participants shirtless during testing, to allow access to the scapula. The participants were instructed to stand in an anatomical position with the head erect. The plumb line was set 2 m away from the participants and a tripod stand with camera on top was set just behind it. The landmarks (a vertically oriented axis passing through the intersection of the spine and medial

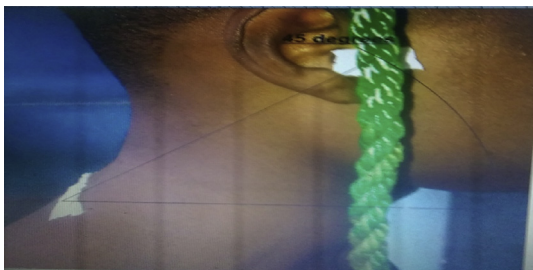


Figure 1: Measurement of the craniovertebral angle.

border of the scapula and the inferior angle of the scapula) were located using palpation and marked clearly with adhesive markers. The plumb line is expected to fall in front of the participants' cervical spine (proximal to the spinous process of C₇). The participants' photographs were taken antero-posteriorly from the back with a digital camera.¹⁸

The photographs were imported into Corel Draw X7 software version 17.0.0.491 for Windows (USA) using a Toshiba Tecra i7 laptop (USA). A horizontal line from the plumb line passing through the intersection of the spine and medial border of the scapula was drawn using the angular dimension of Corel Draw X7 software. Then, 2 diagonal lines were drawn: one through a vertically oriented axis passing through the intersection of the spine and medial border of the scapula to the inferior angle of the scapula, and the second through a vertically oriented axis passing through the intersection of the spine and medial border of the scapula to the mid plumb line. The scapular abduction angular degree was formed at the point at which these 2 lines met (superomedial scapular angle).

Scapular measurements were recorded and compared between the right and left scapulae. Scale points were awarded according to the discrepancy between the left and right scapulae, using the SICK Scapula, Static Measurements 0 to 20 Point Rating Scale. A 1.5 cm asymmetry was considered as the threshold for abnormality in each measurement.¹⁸

Statistical methods

The collected data were analysed using the Statistical Package for the Social Sciences version 21 for Windows. An independent t-test was used to determine the difference in smartphone addiction, craniovertebral angle, and scapular dyskinesia between male and female participants. Pearson correlation was used to determine the relationship of smartphone addiction level with craniovertebral angle and scapula dyskinesia, and the correlation among craniovertebral angle, scapular dyskinesia, smartphone addiction level, and selected anthropometric variables. The level of significance was set at $p \leq 0.05$.

Results

The mean height, weight, and BMI of the participants were 21.94 ± 2.386 m, 64.47 ± 9.28 kg, and 23.6 ± 3.10 kg/m², respectively. The mean craniovertebral angle, scapular dyskinesia, and smartphone addiction level of the participants were $51.83 \pm 5.7^\circ$, $15.52 \pm 5.30^\circ$, and 31.39 ± 7.82 , respectively.

Table 1 shows the comparison of demographic variables between male and female participants. There were statistically significant differences in height ($p = 0.004$), weight ($p = 0.000$), and body mass index ($p = 0.036$) between male and female participants; however, there was no significant difference in the age of all participants.

Table 2 shows that there was a significant difference in craniovertebral angle ($p = 0.032$) between male and female participants.

Table 1: Comparison of demographic variables between male and female participants.

	Male (n = 44) Mean ± SD	Female (n = 33) Mean ± SD	t-Test	p-Value
Age (years)	21.98 ± 2.50	21.88 ± 2.26	0.18	0.859
Height (m)	1.67 ± 0.09	1.62 ± 0.05	3.01	0.004*
Weight (kg)	67.86 ± 8.83	59.95 ± 7.94	4.06	0.000*
BMI (kg/m ²)	24.25 ± 3.10	22.76 ± 2.93	2.13	0.036*

*Significant at $p < 0.05$.

Key: BMI: body mass index, n: sample size, SD: standard deviation.

Table 3 shows the frequencies and percentages of the addiction level, scapular dyskinesia, and craniovertebral angle of male and female participants.

This study shows that there was no significant correlation between smartphone addiction and age (male participants: $r = 0.229$, $p = 0.134$; female participants: $r = -0.197$, $p = 0.272$) or weight (male participants: $r = -0.108$, $p = 0.484$; female participants: $r = 0.084$, $p = 0.642$) for both sexes; however, there was a significant relationship ($r = 0.483$, $p = 0.012$) between smartphone addiction level and craniovertebral angle in female participants. There was also a significant correlation ($r = 0.404$, $p = 0.006$) between smartphone addiction level and scapular dyskinesia in male participants. Overall, there was a significant relationship among smartphone addiction, craniovertebral angle ($r = 0.306$, $p = 0.007$), and scapular dyskinesia ($r = 0.363$, $p = 0.007$) in male and female participants.

Correlation among craniovertebral angle, scapular dyskinesia, and other variables in male and female participants

Table 4 shows the correlation among craniovertebral angle, scapular dyskinesia, and other variables in male and female participants. There was a significant relationship between craniovertebral angle and height ($r = 0.389$, $p = 0.009$) as well as body mass index ($r = -0.555$, $p = 0.001$) in male participants. However, there was a significant relationship but negative correlation between scapular dyskinesia and weight in male participants ($r = -0.341$, $p = 0.023$) (Table 5).

Table 2: Physical characteristics of male and female participants.

	Male (n = 44) Mean rank	Female (n = 33) Mean rank	U-test	p-Value
Addiction (level)	40.99	36.35	638.50	0.367
CVA (°)	43.73	32.70	518.00	0.032*
Sd (°)	42.33	34.56	579.50	0.129

*Significant at $p < 0.05$.

Key: Sd: scapular dyskinesia, CVA: craniovertebral angle, U-test: Mann-Whitney U-test.

Table 3: Sex distribution of addiction level, scapular dyskinesia, and craniovertebral angle.

Variable	Female n (%)	Male n (%)	Total n (%)
Addiction			
Non-excessive	15 (45.5%)	18 (40.9%)	33 (42.9%)
Excessive	18 (54.5%)	26 (59.1%)	44 (57.1%)
Total	33 (100.0%)	44 (100.0%)	77 (100.0%)
CVA (°)			
Low (abnormal)	17 (51.5%)	28 (63.6%)	45 (58.4%)
Normal	16 (48.5%)	16 (36.4%)	32 (41.6%)
Total	33 (100.0%)	44 (100.0%)	77 (100.0%)
Sd (°)			
Normal	13 (39.4%)	10 (22.7%)	23 (29.9%)
High (abnormal)	20 (60.6%)	34 (77.3%)	54 (70.1%)
Total	33 (100.0%)	44 (100.0%)	77 (100.0%)

Key: Sd: scapular dyskinesia (normal ≤ 6 , abnormal > 6), CVA: craniovertebral angle (normal ≥ 50 , abnormal < 50), Addiction: non-excessive < 30 , excessive ≥ 30 .

Discussion

This study was undertaken to determine the correlation among smartphone addiction level, craniovertebral angle, scapular dyskinesia, and selected anthropometric parameters in physiotherapy undergraduates.

As observed from the results of this study, there was no significant difference in the smartphone addiction level (excessive and non-excessive) of male and female undergraduates. This implies that both sexes use smartphones equally. This might be because of the exposure of both sexes to the same level of education and the same academic environment. The result of this study is consistent with that of Fahad et al.,¹⁹ who noted no significant difference in mobile phone addiction between male and female college students. In contrast, Rajabi et al.²⁰ observed that smartphone addiction was more prevalent in female than in male students.

This study found a significant difference in the craniovertebral angle of male and female participants; this difference might be attributed to the male participants being taller than their female counterparts. This result is in agreement with that of Hakala et al.,²¹ who noted that the high craniovertebral angle in female individuals can be

Table 4: Correlation between CVA and other variables among male and female participants.

	Total N = 77 r	p- Value	Male (n = 44) r	p- Value	Female (n = 33) r	p- Value
Age (years)	0.054	0.639	0.121	0.434	-0.063	0.729
Height (m)	0.357	0.001*	0.389	0.009*	0.071	0.696
Weight (kg)	0.033	0.776	-0.243	0.111	-0.057	0.753
BMI (kg/m ²)	0.282	0.013*	-0.555	0.001*	-0.091	0.616
Sd (°)	0.188	0.102	0.132	0.392	0.171	0.340

*Significant at $p < 0.05$.

Key: BMI: body mass index, CVA: craniovertebral angle, Sd: scapular dyskinesia, r: Pearson correlation.

Table 5: Correlation between scapular dyskinesia and other variables among male and female participants.

	Total (N = 77) R	p- Value	Male (n = 44) r	p- Value	Female (n = 33) r	p- Value
Age (years)	0.054	0.643	-0.114	0.460	0.281	0.113
Height (m)	-0.085	0.468	-0.139	0.370	-0.204	0.254
Weight (kg)	-0.154	0.181	-0.341	0.023*	-0.133	0.460
BMI (kg/m ²)	-0.083	0.473	-0.206	0.179	-0.028	0.878
CVA (°)	0.188	0.102	0.132	0.392	0.171	0.340

*Significant at $p < 0.05$.

Key: BMI: body mass index, Sd: scapular dyskinesia, r: Pearson correlation.

attributed to, or partly associated with, psychosocial issues such as stress. Nevertheless, the observation from this study is in contrast with the finding of Van et al.,²² who reported no sex differences for craniovertebral angle in adolescents and pre-adolescents and many others.

There was no significant difference in the scapular dyskinesia of male and female participants. This might be because both sexes use the same position when operating a smartphone. There was no significant difference in the age of male and female participants, which may be because all participants were in the same level of study and admitted to the university within the same age bracket. However, there were significant differences in the weight, height, and BMI of male and female participants, which may be because the male participants were taller and heavier than their female counterparts.

The percentage of participants addicted to smartphone use was higher than those who were not, as a result of the increased demand for smartphone use. This is concordant with the results of Severin et al.²³ Fahad et al.¹⁹ noted that smartphone addiction invariably results in a decrease in the craniovertebral angle and a decrease in scapular dyskinesia, in their investigation of the craniovertebral angle in Internet users. Moreover, they noted that a larger population among the subjects had a forward head posture and some degree of postural abnormality in the cervical and/or shoulder region.

A significant relationship was observed between smartphone use and craniovertebral angle: participants who were excessive smartphone users had a low (abnormal) craniovertebral angle and those who were non-excessive smartphone users had a high (normal) craniovertebral angle. This observation may be attributed to the fact that many people use smartphones with the head shifted forward and the smartphone placed near the waist or lap while in a sitting position.¹¹ Most smartphone tasks require users to stare sharply downward or to hold their arms out in front to read the screen, which makes the head move forward. Moreover, the maintenance of this head shifted forward position decreases the lordosis of the lower cervical vertebrae and creates a posterior curve in the upper thoracic vertebrae to maintain balance, which decreases the craniovertebral angle.¹²

This study revealed that there is a significant relationship between smartphone addiction level and scapular dyskinesia. Participants with excessive smartphone use were shown to have high (abnormal) scapular dyskinesia, whereas non-excessive smartphone users have low (normal) scapular dyskinesia. This may be because excessive smartphone use invariably causes a reduced craniovertebral angle.⁸ Forward head posture causes weakness of the cervical flexor muscles and the scapular retractors such as the middle trapezius.²⁴

In this study, a relationship was observed between smartphone addiction level and scapular dyskinesia in young adults. This might simply be a result of the rate of smartphone use by the participants, which may likely predispose them to developing abnormalities in the scapular region. Neumann²⁵ noted that a forward head posture causes imbalance of shoulder muscles and scapular instability. In this study, it was observed that there was a no significant relationship between scapular dyskinesia and craniovertebral angle, which implies that participants with abnormal (low) craniovertebral angle have abnormal (high) scapular dyskinesia, and this may be because an increase in craniovertebral angle causes weakness of the mid trapezius and serratus anterior muscles associated with scapular stability.²⁶ Weakness of the middle trapezius and serratus anterior muscles causes excessive activation of the upper trapezius.²⁶ An abnormal (low) craniovertebral angle may alter the length and tension of the levator scapula muscle during scapular upward rotation. Significantly increased levator scapulae activity was reported previously in the presence of reduced craniovertebral angle versus a normal head posture.²⁵ The upper trapezius is an agonist muscle for upward rotation of the scapulae, and the levator scapula is an antagonist for upward scapular rotation. Thus, increased tension of the levator scapula will prevent upward scapular rotation.

The age of an individual might be a contributing factor to smartphone addiction. However, the result of this study shows no relationship between age and smartphone addiction, which may be because the study involved young adults in their final year who entered the university within the same age range (16 years and older).

Excessive users of smartphone might exhibit a sedentary lifestyle, which predisposes them to weight gain. From the results of this study, there was no statistically significant relationship between smartphone addiction, weight, and BMI. This might be because academic stress works against weight gain in this population.

No relationship was observed among craniovertebral angle, age, and weight of participants. However, a significant relationship existed among craniovertebral angle, height, and BMI in male participants. This might be because the male participants were taller than their female counterparts, which could be a contributing factor to the low craniovertebral angle among the male participants.

This study investigated the relationship between scapular dyskinesia and age, height, weight, and BMI. No significant relationship was observed between scapular dyskinesia and age, height, and BMI in male and female participants. However, there was a significant relationship between scapular dyskinesia and weight in female participants. This might

be a result of the existence of broad shoulders among female participants who were overweight or obese.

Study limitation

This study is limited in terms of the sampling method used, which may limit the generalization of the results.

Conclusion

This study shows that undergraduates are susceptible to smartphone addiction. This can result in a decrease in craniovertebral angle, which, in turn, leads to a forward head posture that invariably causes an increase in scapular dyskinesis in young adults. Therefore, smartphone addiction has an impact on the neck and shoulder posture of male and female undergraduates, which, in the long run, may result in musculoskeletal disorders.

Recommendation

Smartphone addiction level should be assessed on all patients with neck and shoulder pain. Emphasis should also be placed on mitigating smartphone addiction and its musculoskeletal effects on undergraduates.

Practical application

The result of this study could be applied to educational programs about the correct posture when using a smartphone for extended periods. It can also help in the differential diagnosis of the causes of neck pain in the clinical setting, and inform physiotherapists to include proper neck postural information in neck care education.

Source of funding

The study did not receive any financial support.

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical approval was obtained from the Human Research Ethics Committee of Lagos University Teaching Hospital, Idi-Araba Lagos, Nigeria.

Authors' contributions

All persons designated as authors qualify for authorship and have checked the article for plagiarism. If plagiarism is detected, all authors will be held equally responsible and will bear the resulting penalty. AK was involved in the study concept and design, interpretation of data, and writing of the initial and final drafts of the paper. SR was involved in the study design and interpretation of data. QO was involved in the acquisition and analysis of data. All authors have

critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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