PREVALENCE OF SMARTPHONE ADDICTION AND ITS IMPACT ON SLEEP QUALITY AND ASSOCIATED NECK DISABILITIES AMONG UNIVERSITY STUDENTS OF OOTY, INDIA

Sankar Indira Prithika [*], Betsy Sara Biju[**], Ramakrishnan Ponnuthurai Prathipaa [**], Sivasankaran Ponnusankar[**], Hunsur Nagendra Vishwas[**]

[*] Clinical Medical Regulatory & Quality Department, Novo Nordisk, Bengaluru, Karnataka, India.
[**] Department of Pharmacy Practice, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Ooty, Nilgiris, Tamil Nadu, India.

Abstract-
Background: India experienced an enormous rise in smartphone usage since a decade. Prevalence of smartphone usage as well as internet addiction especially in young adults is increasing globally, which has various negative impact on the health and wellbeing.
Aim: Present study aimed to estimate the prevalence of smart phone addiction among the university students and to evaluate its impact on their neck health and sleep quality.
Methods: Present prospective observational study was conducted in 466 university students (Mean age: 20.04 + 1.77; 49.3% men). Information related to demographics, socio-economic status, mobile phone usage was collected from the student participants. Participants were also subjected to questionnaires like Neck Disability Index scale (NDI), Smartphone Addiction scale (SAS) and Pittsburg Sleep Quality Index scale (PSQI). Higher scores indicated higher degree of addiction, neck disability and sleep problems. Finally, all the participants were subjected for neck angle measurements using Universal Goniometer. All the responses were recorded and analyzed using Mann Whitney U test and Pearson's correlation.
Result: About 73% of the study population reported a higher degree of smart phone addiction. Around 60% of the study population reported mild-moderate degree of neck disability and 1.28% of study population reported severe neck disability. Nearly two thirds of the study population reported mild degree of sleep disturbances (318 out of 466). Analysis revealed a weak-positive correlation between SAS scores along with PQSI and NDI scores respectively. ('r'-0.287 & 0.310; $p < 0.000$).
Conclusion: Study clearly demonstrated that smart-phone addiction was associated with mild to moderate degree of sleep disturbance along with neck disability in young adults. We are in the opinion that smart phone usage in young adults should be restricted by self-motivation or else it can precipitate long-term complications.

Index Terms- Smartphone addiction, Smartphone overuse, Sleep quality, Neck disability, India

I. INTRODUCTION

Smartphones have now become an indispensable part of the modern era [1] and its overuse has become an epidemic around the globe, which demands public health concern [2]. Accessibility and handiness of a smartphone make it possible to use it anywhere, for any duration. Major proportions of youth engage in heavy smartphone use and media multitasking [3]. The adolescents who encounter more adversity in their offline lives seem most likely to experience the negative effects of using smartphones and other digital devices [4]. Smartphones have numerous purposes for which it is being used including general productivity enhancement, information seeking, social interaction, diversion, relaxation, and entertainment. Smartphones also provide enhanced educational productivity [5], but excessive and unconscious use will result in chronic sleep deprivation and negative psychological effect [6]. Studies have demonstrated that technology addiction can affect cognitive control, academic performance, physical health, and socio-emotional functioning [7]. Chronic smart phone usage is even associated with altered neck posture which further lead to development of musculoskeletal problems of the neck [8].

Smartphone addiction is defined as the lack of control to use the smartphone despite its adverse effects on users [9]. Although there is no appropriate diagnostic approach for smartphone addiction [10], the addition of gambling addiction into the International Statistical Classification of Diseases (ICD) explains the need for early intervention in Smartphone overuse [11]. Many researchers have systematically approached to explain the addiction causing effects of problematic smartphone use [12] [13]. Studies have also been done to classify nomophobia as disorder of smartphone addiction [14].

Despite smartphones being advantageous in many ways, their problematic overuse has been shown to affect the psychological as well as the physical health of an individual [15] [16] [17] [18]. Depressive and suicidal thoughts have been associated with smartphone addiction [19] [20]. On vice versa students who are depressive and lonely tend to use smartphone more than that is required to cope up with the unpleasant feelings [21] [22] [23]. A recent study has established the impact of smartphone addiction on adolescent hypertension [24]. Many young adults today are using technology within the hour before trying to fall asleep, which interferes with the potential to fall asleep and stay asleep throughout the night. Functionally, smartphone use shortly before bed has been linked to several negative outcomes. [25] The blue light emitted from smartphones can intensely pierce human retinas photoreceptors and suppress melatonin, a hormone which controls the sleep and wake cycle rate, produced by the pineal gland and it

also result in altered cerebral blood flow and brain electrical activity through electromagnetic field exposure [26]. Sleep deprivation is also associated with an increased risk of multiple metabolic disturbances like obesity, diabetes, and insulin insensitivity. Sleep loss and continuing insomnia contributes to increased blood pressure and increased risk of hypertension. It is also a noteworthy issue that lack of healthy sleep is associated with memory consolidation and encoding which in turn play a major role in the learning process [27]. Neck flexion is the most common posture smartphone users adopt when looking at display terminals for long duration of time and such postures is accounted to cause musculoskeletal problems in the neck region. [28, 29] Research study in adolescents demonstrated that continuously bending head, neck, shoulders while using smartphone could lead to increased stress on cervical spine area, leading to early wear and tear, followed by tissue degeneration [30].

Neck pain and sleep disturbance can be a source of disability and cause serious health problems among the youth. Our hypothesis is that chronic smart phone usage could lead to damage in neck muscles along with risk of sleep disturbance. Present study aimed to evaluate the smart phone usage and addiction pattern in youth who are at the risk of developing neck disability and sleep disturbances.

II. MATERIALS & METHODS

This was a single-center prospective observational study conducted over a period of six months in university students of JSS college of Pharmacy, Ooty. Students with a history of at least six months smartphone usage and those willing to participate were recruited into the study. Students who were absent/not available on the day of data collection were excluded from study. Students with medical conditions like low back pain and associated with neck pain, those with spinal cord injury, upper cervical ligamentous instability, vertebral artery compromise, acute trauma and infectious state of the cervical region were excluded from study.

DATA COLLECTION:

All the relevant data for the study was collected through a pre-designed data collection form. Data collection form included sections like demographic information, socio-economic status, mobile phone usage related information. Study team took permission from Academic In-charges and fixed a time for collection of data from students. All the students were briefed about the study and explained about the study criteria.

Student participants meeting the study criteria filled the data collection form which had demographic information, socio-economic status, and mobile phone related information. Participants also filled Neck Disability Index scale (NDI), Smartphone Addiction scale (SAS) and Pittsburg Sleep Quality Index scale (PSQI). Later all the students were subjected for neck angle measurements using Universal Goniometer followed by deep neck flexor endurance test. Research work was executed in accordance with the ethical principles of "Declaration of Helsinki' after obtaining prior voluntary consent from the study participants. Wherever required, study team aided participants in filling the data collection form.

MEASURES

A. Smartphone Addiction Scale (SAS): There are six factors and 33 items in the Smartphone addiction scale with a six-point Likert scale 1-strongly disagree and 6-strongly agree. Higher score means a higher risk of smartphone addiction. The total score can vary between 33 and 198. The six factors are daily disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance. [31]

B. Neck Disability Index (NDI): The NDI is a 10-item standard instrument for measuring self-rated disability due to neck pain. The scoring of each item is from 0-5 and the maximum score is therefore 50. A score of 0-4 indicates no disability,5-14 indicates mild disability, 15-24 indicates moderate disability, 25-34 indicates severe disability, above 34 indicates complete disability. The score in points can further be transformed in a percentage of function. [32].

C. Pittsburg Sleep Quality Index (PSQI): PSQI is 19 item self-rated questions and are combined to form seven component scores each of which has a range of 0-3 points. A score of 0-no difficulty, while a score of 3-severe difficulty. All the seven component scores are then added to yield one total score with a range of 0-21 points where 0-no difficulty and 21-severe difficulty [33].

D. G*oniometer*: A goniometer is an instrument used for measuring the body joints and angles. The most used goniometer is the universal standard goniometer made of either metal or plastic. The goniometer generally consists of a stationary arm, movable arm and a fulcrum. The circular or semi-circular portion is the centerpiece, which is the body of goniometer with a protractor printed on its face and the fulcrum of movable arm at its center. Generally, the fulcrum of the goniometer is placed over the center of a joint during measurement [34].

STATISTICAL ANALYSIS:

The collected data was imputed in the excel sheets. Data cleaning and data validation was performed before execution of the statistical tests. Normality of the data was tested using Shapiro-Wilk test. Further Mann Whitney U test was used for the comparisons of the scores in between groups. Pearson's Correlation test was applied to find the correlation between several variables like goniometer readings, neck disability scores. Level of significance was set to be <0.05.

III. RESULTS:

A total of 466 students volunteered to participate in the study. Female participants were found to be slightly higher than males (50.6%). The age of the study participants was between 17-25 years; majority of the participants belonged to 19-22 years. Majority of the students were pursuing the undergraduate Pharmacy degree. Majority of the students reported that they used the smart phones for more than 3 hours. Majority of the participants reported a head degree of 15 to 30 degree while using a smart phone. Demographic details of the study participants are given in Table-1.

Average PSQI global score among the study participants is found to be 5.96. Any scores of above '5' indicate sleep disturbance. Proportion of males with sleep disturbance was higher when

compared to that of females (73.47% & 63.13% respectively). About half of the population (50.4%) demonstrated percentage of neck disability between 10-28% as per the NDI which indicates a mild degree of neck disability. Females showed higher proportion of neck disability when compared to men. Smart phone addiction was calculated using the SAS score. Any SAS score more than 72 was considered as smart phone addicted population. Out of 466 students, 340(72.96%) students showed a SAS score more than 72. Nearly two thirds of the participants from both the sexes were found to be addicted to the smart phones (73.2% in females and 72.17% in males). Undergraduate pharmacy students in final year demonstrated more degree of addiction (78.12%) and those aged above 24 demonstrated more addiction to smart phones. The details of sleep disturbance (PSQI global scores), neck disability (extent of neck disability as per NDI scale) and smart phone addiction (SAS scores) are given in Table 2. Study population was subjected to the neck measurements using Universal goniometer. Average Cervical flexion and cervical extension in the study population was found to be 38.31 and 43.45 degrees respectively. Goniometer readings are given in Table- 3. For the comparison of the participants demographics with the scale scores Mann Whitney U test was applied. To find the correlation between the SAS, NDI, PSQI and Goniometer readings Pearson's correlation was used. The goniometer readings and the NDI scores showed a significant negative correlation ($p<0.05$) whereas the SAS scores had a significant positive correlation with the NDI scores and PSQI score ($p< 0.000$). The Mann-Whitney test results and correlation analysis data are given the tables 4,5 & 6 respectively.

IV. DISCUSSION:

With an alarming increase in the prevalence of smartphone over use especially in the growing adults [35] [36], many studies have demonstrated the various health impacts of smart phone addiction in younger adults and children [37] [38] [39] [40] [41]. This evaluated the prevalence of smart phone addiction along with its impact on the sleep quality and neck disability in college students. There is no established diagnostic criteria for identifying a person with smartphone dependence but many researches have designed various self- administered scales like Smartphone Addiction Inventory [42], Smartphone Addiction Scale [43], Mobile Phone Addiction Scale [44], Smartphone Addiction Proneness Scale [45], Mobile Phone Problem Use Scale [46], Problematic Use of Mobile Phones Scale[47], Smartphone Addiction Scale-Short Version[48],Smartphone Addiction Inventory-Short Form [49], etc. to evaluate the smartphone usage pattern of an individual based on the scores. The components of the Smartphone Addiction Scale are not complicated. Many research studies have proven the excellent validity, reliability and internal consistency of this scale; hence the study team have decided to use SAS scale in this study [31]. In a study conducted in the university students to evaluate the relationship between smart phone overuse, sleep quality, anxiety and depression, a cut off value of 72 from the SAS score to categorize the students as highly smart phone addicted group [50][51]. Several other studies have taken 72 as the cut off value to identify smart phone addicted [8] [53]. Hence, the same cut off value 72 was set in this study to identify smart phone addicted students.

Around 340 students, out of 466 students had a SAS score more 72 (72.96%). Mean SAS score of the study population was 91.66 indicating addiction behavior. On comparing the SAS scores of boys and girls, the mean score of girls were slightly higher than that of the boys (92.66 and 90.64 respectively); however, it was not statistically significant. Similar results have been demonstrated by Baifeng Chenet al [54]. Two studies conducted by Al Abdul Wahab et al and Shah et al have demonstrated that females are at increased risk for developing smart addiction when compared to males [53][55].

Duration of smart phone is having an impact of smart phone addiction. upon comparing the SAS scores among the students who used smart phone for more than 3 hours with those who used smart phones less than 3 hours, higher SAS values were seen in to students who used smart phone less than 3 hours. The research study conducted on Korean middle school students to assess smartphone addiction, game use and social networking also shown a positive correlation between duration spent on phone and SAS scores [56]. Many factors cause mechanical strain to the neck muscles resulting in neck pain. Recently smart phone over use have been considered as one of the causes for neck pain due to various reasons like poor posture during smart phone use and repetitive movement of the hands and fingers [57][58]. The NDI scale was based on Oswestry Low Back Pain Disability Index questionnaire, which is one of the best disability questionnaires of all time; hence, NDI questionnaire was used in this study. This study evaluated the impact of smart phone over use on the neck strength using both subjective (Neck Disability Index scale) and objective parameters (Goniometer readings and Deep neck endurance test). The NDI is a 10-item standard instrument for measuring self-rated disability due to neck pain. The scoring of each item is from 0-5 and the maximum score is therefore 50. The procured score can be multiplied by 2 to produce a percentage score. NDI scale was the most widely used scale to evaluate neck disability [59].

In this study, the overall mean NDI score was 14.22 and after the interpretation of the results around 182 students (39.05%) had no neck disability, 235 students (50.42%) had mild neck disability, 44 students (9.44%) had moderate neck disability and six (1.28%) students had severe neck disability. In a study conducted by Jasleen et al in the professional students of north India that evaluated the relationship between smartphone addiction and neck disability similar results have been obtained. The study showed that nearly two thirds of the study population demonstrated a mild to moderate neck disability [60].

On comparing the NDI scores of boys and girls, the mean score of boys and girls were 12.91 and 15.49 respectively. There was a significant difference in the NDI scores of boys and girls (p value 0.0016) which showed that girls had higher neck disability when compared to boys. This study has also found that females are more prone for neck disability than males. Kato et al [59] have demonstrated similar results. On comparing the NDI scores of the students with and without upper extremity pain, the mean NDI scores were 18.44 and 13.45 respectively. There was a significant difference in the NDI scores of students with and without upper extremity pain, which showed that students with upper extremity

pain had higher neck disability scores when compared to students without upper extremity pain.

NDI scores were found to be high in students who used smart phones more than 3 hours than those who used smart phones less than 3 hours (p value 0.002). A study conducted on the university students of Gachon to correlate the smart phone usage duration and neck pain showed similar results. The study also reported that continuous use of smart phone might lead to changes in the posture eventually precipitating the neck disability [61]. Academic institutions in state of Tamil Nadu does not permit the mobile phone usage during the college hours [62]. Hence, the students are forced to use the smart phone after the college hours usually in the evening and night-time.

Research studies have reported that most of the smart phone users use smart phones more at night than daytime, which is the main risk factor for decreased sleep quality mostly in the younger adults. Prolonged decrease in sleep quality may also have a direct impact on the brain function [63]. Hence, this study aimed to evaluate the impact of smart phone addiction on the sleep quality of the university students. Pittsburgh Sleep Quality Index scale was used in this study since it has demonstrated good validity, internal consistency and internal homogeneity. PSQI have also been used in graduate students of India [64]. Also, it one of the most cited scale for evaluating the sleep quality in diverse-population. PSQI is even used by neurologists and psychiatrists to evaluate sleep quality in the patients. The PSQI values range between 0 – 21. Any person demonstrating a PSQI score above 5 is considered to have sleep disturbance. Higher the PSQI score higher the sleep disturbance [65]. In this study, about two thirds of the study population reported a PSQI score more than five indicating a mild degree of sleep disturbances (Out of 466 students around 318(68.24%) students reported a PSQI score more than 5. similar results have been obtained in a study conducted by Boonluksiri et al [66]. On comparing the PSQI scores of boys and girls, the mean score of boys and girls were 6.19 and 5.75 respectively, however there was no statistically significant difference. On comparing the PSQI scores with the duration of smart phone use per day, it was found that there was a significant difference in the students who used smartphone less than 3 hours a day and in the students who used smart phones more than 3 hours a day (p value 0.002) which showed that students who used smart phones more than 3 hours a day had higher PSQI scores when compared to students who use smartphones less than 3 hours a day. A study conducted by Baitarani et al to assess the correlation between the mobile phone usage and sleep quality in medical students reported similar findings [67]

The cervical range of motion (CROM) is the common clinical outcome measure for identifying a patient with mobility deficits. [68] There are many instruments to measure the range of motion but still the manual goniometer is the most commonly used instrument. [69] Cervical flexion, Cervical extension, Cervical lateral flexion and cervical rotation are some of the possible cervical range of motion [70]. The cervical flexion and extension refer to the motion of the neck joint in which they are brought together and extended respectively. Cervical side bending is the lateral flexion of the neck muscles [71].

In this study Goniometer readings was used as an objective parameter for evaluating neck pain. On correlating the CROM measurements with the NDI scores it was found that, the value of Cervical flexion (p value< 0.000), Cervical extension (p value 0.001), Cervical lateral flexion (p value < 0.000) and cervical rotation (p value 0.021) had a significant negative correlation with the NDI scores. On correlating the CROM measurements of boys and girls with the NDI scores it showed that girls had stronger correlation than the boys (p value < 0.000, 0.001, < 0.000, < 0.000, < 0.000). In addition with CROM measurements, this study also measured the deep neck endurance of the students since in an individual with neck pain there is an significant decrease in the neck flexor endurance. In this study, there was no significant correlation between the deep neck endurance values and the NDI scores. There was a highly significant positive correlation with the scores of SAS and the scores of PSQI and NDI (p value < 0.000) which clearly indicates that smart phone over use have a positive impact on the sleep quality and neck disability. Social networking websites are attracting the youth to a greater extent and they spend most of the time in texting and internet surfing. Global presence, exciting games, affordable internet packages and social networking influence the younger adults to use smart phones more than needed. The over use of smart phones may lead to smart phone addiction which if followed various mental and physical health problems.

This study was confined to only one academic institute, which is a limitation of the study. Hence, research findings may not be generalized. This study relied on the responses provide by the students regarding the mobile phone usage and sleep pattern which may have disadvantages like behavioral and recall bias. Our study has depicted the real scenario behind the smart phone usage and its impact among the college students. In spite of these alarming results, COVID-19 pandemic has made it indispensable for each one to spend their maximum time in smart phones. It is up to one's will on how to use these smartphones wisely and not get addicted. One has to be cautious enough to make the best use of these man-made machines rather than to trapped and get suffered.

V. CONCLUSION

Smart phones have definitely brought convenience to society. However, problematic smart phone use is leading to number of negative health outcomes. The results of this study and various other researches have shown that smart phone addiction can lead to development of neck disability as well as sleep disturbances. To conclude smart phones are both effective and destructive, it is up to the individual to decide to use it in a futile manner. One should focus more on the positive aspects to avoid oneself from getting addicted. Judicial use of smart phone and short screen time are very helpful in avoiding long-term complications like neck disabilities and sleep disorder. Technology and smart phone addiction are a growing concern in college students. Interventions in raising awareness at community level may be the solution in changing the mental perception of the addicted individual.

CONFLICT OF INTEREST:

The authors declare no conflict of interest.

ETHICAL APPROVAL:

The study was approved by the Institutional Ethics Committee, JSS College of Pharmacy, Ooty. (Reference no: JSSCP/IRB/03/ 2019-20)

ACKNOWLEDGEMENT:

We acknowledge the generous research infrastructure and support from JSS College of Pharmacy, JSS Academy of Higher Education & Research, Ooty, Nilgiris, Tamil Nadu, India.

REFERENCES

[1] Rai S, Saroshe S, Khatri A, Sirohi S, Dixit S. A cross sectional study to assess the effects of excessive use of smartphones among professional college going students. International Journal of Community Medicine and Public Health. 2016 Mar;3(3):758-63.

[2] Ding D, Li J. Smartphone overuse–A growing public health issue. Journal of Psychology & Psychotherapy. 2017 Feb;7(1):289

[3] Cha SS, Seo BK. Smartphone use and smartphone addiction in middle school students in Korea: Prevalence, social networking service, and game use. Health psychology open. 2018 Feb;5(1):2055102918755046.

[4] Odgers C. Smartphones are bad for some teens, not all. Nature. 2018;554(7693):432-434.

[5] Kim MH, Min S, Ahn JS, An C, Lee J. Association between high adolescent smartphone use and academic impairment, conflicts with family members or friends, and suicide attempts. PloS one. 2019 Jul 15;14(7):e0219831.

[6] Mehrnaz M, Farahnaz M, Gholamreza K, Homa Mohseni K, Seyed Homayoon S, Majid N. Smartphone Addiction, Sleep Quality and Mechanism. International Journal of Cognition and Behaviour. 2018;1(1).

[7] Kim M, Min S, Ahn J, An C, Lee J. Association between high adolescent smartphone use and academic impairment, conflicts with family members or friends, and suicide attempts. 2020.

[8] Lee S, Shin G. Relationship between smartphone use and the severity of head flexion of college students. InProceedings of the Human Factors and Ergonomics Society Annual Meeting 2015 Sep (Vol. 59, No. 1, pp. 1788-1790). Sage CA: Los Angeles, CA: SAGE Publications

[9] Moattari M, Moattari F, Kaka G, Kouchesfahani HM, Sadraie SH, Naghdi M. Smartphone addiction, sleep quality and mechanism. Int J Cogn Behav. 2017;1(1):1-7.]

[10] Kardefelt-Winther D, Heeren A, Schimmenti A, van Rooij A, Maurage P, Carras M. y Billieux, J.(2017). How can we conceptualize behavioral addiction without pathologizing common behaviors. Addiction, avance online febrero. 2017.

[11] Grant JE, Chamberlain SR. Expanding the definition of addiction: DSM-5 vs. ICD-11. CNS spectrums. 2016 Aug;21(4):300-3.

[12] Moattari M, Moattari F, Kaka G, Kouchesfahani HM, Sadraie SH, Naghdi M. Smartphone addiction, sleep quality and mechanism. Int J Cogn Behav. 2017;1(1):1-7.

[13] Yu S, Sussman S. Does smartphone addiction fall on a continuum of addictive behaviors?. International Journal of Environmental Research and Public health. 2020 Jan;17(2):422.

[14] Tran D. Classifying nomophobia as smart-phone addiction disorder. UC Merced Undergraduate Research Journal. 2016;9(1).

[15] Matar Boumosleh J, Jaalouk D. Depression, anxiety, and smartphone addiction in university students-A cross sectional study. PLoS one. 2017 Aug 4;12(8).

[16] Kim MO, Kim H, Kim K, Ju S, Choi J, Yu M. Smartphone addiction:(focused depression, aggression and impulsion) among college students. Indian J Sci Technol. 2015 Sep 1;8(25).

[17] Demirci K, Akgönül M, Akpinar A. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. J Behav Addict. 2015 Jun;4(2):85-92.

[18] AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. Musculoskeletal care. 2017 Mar;15(1):10-2.

[19] Tamura H, Nishida T, Tsuji A, Sakakibara H. Association between excessive use of mobile phone and insomnia and depression among Japanese adolescents. Int J Environ Res Public Health. 2017 Jul;14(7):701

[20] Min-Hyuk K, Min S, Ahn JS, An C, Lee J. Association between high adolescent smartphone use and academic impairment, conflicts with family members or friends, and suicide attempts. PloS one. 2019 Jul 1;14(7):e0219831.

[21] Kim Y, Jeong JE, Cho H, Jung DJ, Kwak M, Rho MJ, Yu H, Kim DJ, Choi IY. Personality factors predicting smartphone addiction predisposition: Behavioral inhibition and activation systems, impulsivity, and self-control. PloS one. 2016 Aug 17;11(8):e0159788.

[22] Enez Darcin A, Kose S, Noyan CO, Nurmedov S, Yılmaz O, Dilbaz N. Smartphone addiction and its relationship with social anxiety and loneliness. Behav Inform Technol. 2016 Jul 2;35(7):520-5.

[23] Dikeç G, Yalnız T, Bektaş B, Turhan A, Çevik S. Relationship between smartphone addiction and loneliness among adolescents. Bagimlilik Derg. 2017;18(4):103-11.

[24] Zou Y, Xia N, Zou Y, Chen Z, Wen Y. Smartphone addiction may be associated with adolescent hypertension: a cross-sectional study among junior school students in China. BMC Pediatr. 2019 Dec 1;19(1):310.

[25] Adams SK, Daly JF, Williford DN. Article Commentary: Adolescent Sleep and Cellular Phone Use: Recent Trends and Implications for Research. Health services insights. 2013 Jan;6:HSI-S11083

[26] Mehrnaz M, Farahnaz M, Gholamreza K, Homa Mohseni K, Seyed Homayoon S, Majid N. Smartphone Addiction, Sleep Quality and Mechanism. International Journal of Cognition and Behaviour. 2018;1(1).

[27] Alshobaili FA, AlYousefi NA. The effect of smartphone usage at bedtime on sleep quality among Saudi non-medical staff at King Saud University Medical City. Journal of Family Medicine and Primary Care. 2019 Jun;8(6):1953.

[28] Eitivipart AC, Viriyarojanakul S, Redhead L. Musculoskeletal disorder and pain associated with smartphone use: A systematic review of biomechanical evidence. Hong Kong Physiotherapy Journal. 2018 Dec 14;38(02):77-90.

[29] Alsalameh AM, Harisi MJ, Alduayji MA, Almutham AA, Mahmood FM. Evaluating the relationship between smartphone addiction/overuse and musculoskeletal pain among medical students at Qassim University. Journal of family medicine and primary care. 2019 Sep;8(9):2953.

[30] Fares J, Fares MY, Fares Y. Musculoskeletal neck pain in children and adolescents: risk factors and complications. Surgical neurology international. 2017;8.

[31] Kwon M, Lee JY, Won WY, Park JW, Min JA, Hahn C, Gu X, Choi JH, Kim DJ. Development and validation of a smartphone addiction scale (SAS). PloS one. 2013 Feb 27;8(2): e56936.

[32] Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. Journal of manipulative and physiological therapeutics. 1991 Sep.

[33] Buysse DJ, Reynolds III CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry research. 1989 May 1;28(2):193-213.

[34] Goniometer [Internet]. Physiopedia.[cited 21 April 2020]. Available from: https://www.physio-pedia.com/Goniometer

[35] Soni R, Upadhyay R, Jain M. Prevalence of smart phone addiction, sleep quality and associated behaviour problems in adolescents. International Journal of Research in Medical Sciences. 2017 Jan 23;5(2):515-9.

[36] Sohn S, Rees P, Wildridge B, Kalk NJ, Carter B. Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: a systematic review, meta-analysis and GRADE of the evidence. BMC psychiatry. 2019 Dec;19(1):1-0.

[37] Kim MO, Kim H, Kim K, Ju S, Choi J, Yu M. Smartphone addiction:(focused depression, aggression and impulsion) among college students. Indian Journal of Science and Technology. 2015 Sep 1;8(25).

[38] Samaha M, Hawi NS. Relationships among smartphone addiction, stress, academic performance, and satisfaction with life. Computers in Human Behavior. 2016 Apr 1;57:321-5.

[39] Min-Hyuk K, Min S, Ahn JS, An C, Lee J. Association between high adolescent smartphone use and academic impairment, conflicts with family members or friends, and suicide attempts. PloS one. 2019 Jul 1;14(7):e0219831.

[40] Kim SE, Kim JW, Jee YS. Relationship between smartphone addiction and physical activity in Chinese international students in Korea. Journal of behavioral addictions. 2015 Sep;4(3):200-5.

[41] Zou Y, Xia N, Zou Y, Chen Z, Wen Y. Smartphone addiction may be associated with adolescent hypertension: a cross-sectional study among junior school students in China. BMC pediatrics. 2019 Dec 1;19(1):310.
[42] Lin YH, Chang LR, Lee YH, Tseng HW, Kuo TB, Chen SH. Development and validation of the Smartphone Addiction Inventory (SPAI). PloS one. 2014;9(6).
[43] Kwon M, Lee JY, Won WY, Park JW, Min JA, Hahn C, Gu X, Choi JH, Kim DJ. Development and validation of a smartphone addiction scale (SAS). PloS one. 2013 Feb 27;8(2):e56936.
[44] Chen L, Yan Z, Tang W, Yang F, Xie X, He J. Mobile phone addiction levels and negative emotions among Chinese young adults: The mediating role of interpersonal problems. Computers in Human behavior. 2016 Feb 1;55:856-66.
[45] Kim D, Lee Y, Lee J, Nam JK, Chung Y. Development of Korean smartphone addiction proneness scale for youth. PloS one. 2014 May 21;9(5):e97920.
[46] De-Sola J, Talledo H, Rodríguez de Fonseca F, Rubio G. Prevalence of problematic cell phone use in an adult population in Spain as assessed by the Mobile Phone Problem Use Scale (MPPUS). PloS one. 2017 Aug 3;12(8):e0181184.
[47] Alosaimi FD, Alyahya H, Alshahwan H, Al Mahyijari N, Shaik SA. Smartphone addiction among university students in Riyadh, Saudi Arabia. Saudi medical journal. 2016 Jun;37(6):675.
[48] Kwon M, Kim DJ, Cho H, Yang S. The smartphone addiction scale: development and validation of a short version for adolescents. PloS one. 2013;8(12).
[49] Lin YH, Pan YC, Lin SH, Chen SH. Development of short-form and screening cutoff point of the Smartphone Addiction Inventory (SPAI-SF). International journal of methods in psychiatric research. 2017 Jun;26(2):e1525.
[50] Demirci K, Orhan H, Demirdas A, Akpinar A, Sert H. Validity and reliability of the Turkish Version of the Smartphone Addiction Scale in a younger population. Klinik Psikofarmakoloji Bülteni-Bulletin of Clinical Psychopharmacology. 2014 Sep 1;24(3):226-34.
[51] Demirci K, Akgönül M, Akpinar A. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. Journal of behavioral addictions. 2015 Jun;4(2):85-92.
[52] Rao S, Sethuraman AR, Thatkar P. Comparative study of Smartphone Addiction among Arts and Medical College Students of Port Blair. Community Med. 2019;10(6):375-9.
[53] AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. Musculoskeletal care. 2017 Mar;15(1):10-2
[54] Chen B, Liu F, Ding S, Ying X, Wang L, Wen Y. Gender differences in factors associated with smartphone addiction: a cross-sectional study among medical college students. BMC psychiatry. 2017 Dec 1;17(1):341
[55] Shah PP, Sheth MS. Correlation of smartphone use addiction with text neck syndrome and SMS thumb in physiotherapy students. Int J Community Med Public Health. 2018 Jun;5:2512-6.
[56] Cha SS, Seo BK. Smartphone use and smartphone addiction in middle school students in Korea: Prevalence, social networking service, and game use. Health psychology open. 2018 Feb;5(1):2055102918755046.
[57] Namwongsa S, Puntumetakul R, Neubert MS, Boucaut R. Factors associated with neck disorders among university student smartphone users. Work. 2018 Jan 1;61(3):367-78.
[58] Sterling M, Rebbeck T. The neck disability index (NDI). Australian Journal of Physiotherapy. 2005 Jan 1;51(4):271.
[59] Kato S, Takeshita K, Matsudaira K, Tonosu J, Hara N, Chikuda H. Normative score and cut-off value of the Neck Disability Index. Journal of Orthopaedic Science. 2012 Nov 1;17(6):687-93.
[60] Jasleen K, Sadbhawna D. Smartphone addiction and its relation with neck disability among professional students of Dav Colleges Of Jalandhar.
[61] Lee JI, Song HS. The correlation analysis between hours of smartphone use and neck pain in the Gachon university students. The Acupuncture. 2014 Jun 20;31(2):99-109.
[62] Daniel Stalin J. Tamil Nadu Bans Mobile Phones In Colleges, Students Say "Regressive" Move [Internet]. NDTV.com. 2018 [cited 14 April 2020]. Available from: https://www.ndtv.com/tamil-nadu-news/tamil-nadu-bans-mobile-phones-incollegesstudentssayregressivemove 1902867#:~:text=College%20students%20will%20no%20longer,financing%20c olleges%20about%20the%20order.
[63] Medic G, Wille M, Hemels ME. Short-and long-term health consequences of sleep disruption. Nature and science of sleep. 2017;9:151.
[64] Manzar MD, Moiz JA, Zannat W, Spence DW, Pandi-Perumal SR, BaHammam AS, Hussain ME. Validity of the Pittsburgh sleep quality index in Indian university students. Oman medical journal. 2015 May;30(3):193.
[65] Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry res. 1989 May 1;28(2):193-213.
[66] Boonluksiri P. Effect of smartphone overuse on sleep problems in medical students. Asia Pacific Scholar: Medical and Health Professions Education. 2018;3(2):25-8.
[67] Bayatiani MR, Seif F, Bayati A. The correlation between cell phone use and sleep quality in medical students. Iranian Journal of Medical Physics. 2016;13(1):8-16.
[68] Childs J, Cleland J, Elliott J, Teyhen DS, Wainner RS, Whitman JM, et al. Neck pain: clinical practice guidelines linked to the international classification of functioning, disability, and health from the Orthopaedic Section of the American Physical Therapy Association. J Orthop Sports Phys Ther.2008;38(9):A1–34.
[69] Raya R, Garcia-Carmona R, Sanchez C, Urendes E, Ramirez O, Martin A, Otero A. An inexpensive and easy to use cervical range of motion measurement solution using inertial sensors. Sensors. 2018 Aug;18(8):2582.
[70] Swartz EE, Floyd RT, Cendoma M. Cervical spine functional anatomy and the biomechanics of injury due to compressive loading. Journal of athletic training. 2005 Jul;40(3):155.
[71] Norkin CC, White DJ. Measurement of joint motion: a guide to goniometry. FA Davis; 2016 Nov 18.

AUTHORS

First Author- Prithika Sankar Indira, Pharm D, Intern, Clinical Medical Regulatory & Quality Department, Novo Nordisk, Bengaluru, Karnataka, India.
E Mail:prithushankar23@gmail.com
Second Author- Betsy Sara Biju, Pharm D, Intern, Department of Pharmacy Practice, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Ooty, Nilgiris, Tamil Nadu, India.
E Mail: betsybiju2017@gmail.com
Third Author- Prathipaa Ramakrishnan Ponnuthurai**,** Pharm D, Intern, Department of Pharmacy Practice, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Ooty, Nilgiris, Tamil Nadu, India. E Mail: rpprathipaa@gmail.com
Fourth Author- Sivasankaran Ponnusankar, M Pharm, Ph D, Professor & Head, Department of Pharmacy Practice, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Ooty, Nilgiris, Tamil Nadu, India.
E Mail: drsponnusankar@jssuni.edu.in

Correspondence Author – Hunsur Nagendra Vishwas, M Pharm, (Ph D), Lecturer, Department of Pharmacy Practice, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Ooty, Nilgiris, Tamil Nadu, India. (+91 9885104372)
E Mail: vishpharm@gmail.com / vishwas@jssuni.edu.in
ORCID ID: 0000-0003-4132-3028

Table-1: Demographics of the Study participants (n=466)

Characteristic	n (%)
Gender	
Male	230(49.3%)
Female	236(50.6%)
Age(years)	
17	36(7.72%)
18	73(15.66%)
19	74(15.87%)
20	86(18.45%)
21	96(20.60%)
22	59(12.66%)
23	35(7.51%)
24	5(1.07%)
25	2(0.42%)
Course pursuing	
B Pharm	256(54.93%)
Pharm D	132(28.32%)
D Pharm	31(6.65%)
M Pharm	47(10.08%)
Family history of neck pain or arthritis	
Present	117(25.10%)
Absent	349(74.89%)
Upper extremity injury	
Present	72(15.45%)
Absent	394(84.54%)
Duration of smartphone usage	
6 months – 3 years	146(31.33%)
More than 3 years	320(68.66%)
Duration of smart phone usage for text messaging	
Rarely	66(14.16%)
Sometimes	191(40.98%)
Often	178(38.19%)
Internet usage on smartphone	
Users	457(98.06%)
Non-users	9(1.93%)
Duration of smart phone usage per day	
10minutes-30minutes	21(4.50%)
30minutes-1hour	56(12.01%)
1hour-2hours	73(15.66%)
2hours-3hours	105(22.53%)
More than 3 hours	211(45.27%)
Head posture while using smart phone*	
A (0 degree)	65(13.94%)
B (15 degree)	151(32.40%)
C (30 degree)	140(30.04%)
D (45 degree)	67(14.37%)
E (60 degree)	43(9.22%)
Interested in taking more Selfie	
Frequently take selfies	124(26.60%)
Does not take frequently selfies	342(73.39%)

Table-2: Sleep disturbance, Neck disability and Smart phone addiction in the study population

Characteristic	Total population n (%)	Male n(%)	Female n (%)
Sleep disturbance			
PSQI SCORE (<5)	148 (31.75%)	61(26.52%)	87(36.86%)
PSQI SCORE (≥5)	318 (68.24%)	169(73.47%)	149(63.13%)
Neck Disability Index			
0-4	182 (39.05%)	108 (46.95%)	74 (31.35%)
5-14	235 (50.42%)	98(42.60%)	136(57.62%)
15-24	44 (9.44%)	21(9.13%)	23(9.74%)
25-34	6 (1.28%)	3(1.30%)	3(1.27%)
35-50	0	0	0
Smart Phone addiction			
SAS SCORE (<72)	126(27.03%)	64 (27.82%)	62(26.27%)
SAS SCORE (≥72)	340(72.96%)	166 (72.17%)	174 (73.72%)

Table-3: Goniometer readings of the study population

Characteristic	Goniometer measurement in Degrees	
	Mean	Std. deviation
Cervical flexion	38.31	7.62
Cervical extension	43.45	9.65
Cervical right-side bending	39.50	7.51
Cervical left-side bending	41.14	7.00
Range of motion	152.84	15.66
Deep neck endurance test	51.64	28.66

Table 4: Mann Whitney U Test for the comparison of various scores of boys and girls

Gender	PSQI scores			NDI scores			SAS scores		
	Mean±SD	U value	*p* value	Mean ±SD	U value	*p* value	Mean±SD	U value	*p* value
Boys	6.2± 3.05	24972.5	0.136	12.9 ± 12.42	22543	0.0016*	90.64±28.8	26287.5	0.5552
Girls	5.8± 3.0			15.5 ± 11.6			92.66±28.4		

* Statistically significant *p* value

Table 5: Mann Whitney U Test for the comparison of various scores based on duration of smart phone use per day

Duration of Smartphone use per day	PSQI scores			NDI scores			SAS scores		
	Mean ± SD	U value	*p* value	Mean ±SD	U value	*p* value	Mean±SD	U value	*p* value
Less than 3 hours	5.5±2.9	22430	0.002*	12.8± 11.4	22596.5	0.0029*	83±26.45	1667	<0.0001*
More than 3 hours	6.5±3.1			16 ±12.59			102.12±27.6	8.5	

* Statistically significant *p* value

Table 6: Pearson's correlation analysis

Characteristic	Total population		Boys		Girls	
	r value	p value	r value	p value	r value	p value
Cervical flexion angle and NDI scores	-0.335	< 0.000*	-0.235	< 0.000*	-0.413	< 0.000*
Cervical extension angle and NDI scores	-0.153	0.001*	-0.073	0.273	-0.223	0.001*
Cervical range of motion angle and NDI Scores	-0.107	0.021*	0.016	0.805	-0.236	< 0.000*
Cervical right side bending angle and NDI scores	-0.285	< 0.000*	-0.327	< 0.000*	-0.227	< 0.000*
Cervical left side bending angle and NDI scores	-0.237	< 0.000*	-0.191	0.004*	-0.271	< 0.000*
Deep neck endurance test values and NDI Scores	-0.011	0.806	-0.013	0.847	0.016	0.801
SAS score and NDI scores	0.287	< 0.000*	0.311	< 0.000*	0.258	< 0.000*
SAS score and PSQI score	0.310	< 0.000*	0.336	< 0.000*	0.292	< 0.000*

* Statistically significant *p* value