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ORIGINAL ARTICLE

Does Smartphone Addiction have an Effect on Neck Proprioception?

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Main Points

- Smartphone addiction might be widely seen in young adults.
- Even if smartphone addiction does not cause pain or any symptoms, it might negatively affect musculoskeletal performance.
- Young adults that were addicted to smartphones had a poorer neck proprioception sense than those without this addiction.
- Poorer neck proprioception sense may lead performance deficiencies in individuals, especially during sports activities. Therefore, preventive measures should be taken for smartphone-addicted young adults.

Abstract

This study aimed to examine whether there was a difference in neck proprioception abilities between individuals with and without smartphone addiction. Healthy young adults aged 18 – 24 years and who volunteered to participate in the study were included in the sample. After obtaining the demographic information of all the participants, neck joint position errors were evaluated using the Tracker Laser system. Then, the Smartphone Addiction Scale-Short Form was administered to the participants to evaluate the degree of smartphone addiction. According to the results, the individuals were divided into two groups as smartphone-addicted and non-addicted. This study was concluded with a total of 176 individuals, including 40 (22.7%) smartphone-addicted and 136 (67.3%) non-addicted participants. A statistically positive moderate correlation was found between the Smartphone Addiction Scale-Short Form total scores and smartphone use frequency ($p < .001$, $r = .481$). The joint position error distances of neck flexion ($p < .001$), neck extension ($p < .001$), and left neck rotation ($p = .002$) were higher in the smartphone-addicted group than in the non-addicted group. This study showed that as the duration of smartphone use increased in young adults, the degree of smartphone addiction also increased. In addition, young adults addicted to smartphone use had poorer neck proprioception ability than non-addicted adults.

Keywords: Neck, position sense, proprioception, smartphone, technology addiction, young adult

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Introduction

Developments in information technologies, especially in recent years, have led to changes in people's habits (Salehan & Negahban, 2013). Among the most preferred information technology tools in use are tablets, computers, internet-supported education devices, and smartphones. Smartphones are widely used in daily life with their many favorable features, such as portability due to their small size, capabilities of playing media, taking photos and videos, using the global positioning system for navigation, internet and social media access, and easy accessibility due to affordability (Montag et al., 2015). However, the use of smartphones involves the risk of developing addictive behavior and triggers addiction, especially in young people (Kwon et al., 2013; Walsh et al., 2010).

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Smartphone addiction, which starts with the increasing duration of smartphone use and then turns into an addiction, has many negative effects on people's health, as well as social and cultural effects. Disturbance of sleep, physical inactivity, musculoskeletal pain, impairment of mental functioning, and poor posture are among the most common adverse effects (Kaya et al., 2021; Chen et al., 2017; Cheever et al., 2014; Clayton et al., 2015; Demirci et al., 2015; Kaya et al., 2021; Kim et al., 2015). In addition, smartphone addiction negatively affects the quality of life in physical, mental, and social aspects (Shahrestanaki et al., 2020)

Proprioception, also known as the sixth sense, facilitates body stability and orientation during static and dynamic activities by providing a connection between the afferent and efferent systems of the body (Ergen et al., 2007). This establishes the position and motion perception of a part of the body in space (Borghuis et al., 2008). The impairment of proprioception can weaken a person's ability to control movement in a joint and may pave the way for a number of musculoskeletal problems and injuries, especially postural defects (Beinert & Taube, 2013).

During smartphone use, individuals usually have a posture dominated by excessive and prolonged neck flexion and shoulder protraction. It has been proven that this poor posture has long-term effects on the position of the head, neck, and shoulder (Park et al., 2015; Szeto et al., 2002). It is considered that this poor posture habit may especially affect neck proprioception due to its effect on the muscles and anatomical structures in the neck region (Yong et al., 2016). However, there is a gap in the literature concerning the effects of smartphone addiction on neck proprioception. Therefore, this study was planned to examine whether there was a difference in neck proprioception abilities between individuals with and without smartphone addiction.

Methods

This cross-sectional study was conducted at the Social and Cultural Welfare Association of Eskişehir İnönü İsmetpasa Neighborhood between August and November 2021. The study was approved by the Non-interventional Ethics Committee of Kütahya Health Sciences University (2021/11-26). Written and verbal consent was obtained from all participants before starting the study. G*Power software, version 3.1.9.4 (Heinrich-Heine-Universität Düsseldorf, Germany) was used to determine the sample size required for the study (Faul et al., 2007). In accordance with a similar article (Alshahrani et al., 2018) and calculations performed with the two-sample *t*-test, the sample size was determined as a total of 176 individuals with the power ratio of $\beta = 90\%$ and type I error rate of $\alpha = 0.05$.

The study consisted of individuals aged 18 – 24 years, who were receiving training at the above-mentioned association, were smart phone users, and who volunteered to participate in the study. Individuals with a neuromusculoskeletal problem related to the cervical spine, neck and back pain complaints within the last 3 months, neurological and neurodevelopmental disorders (e.g., multiple sclerosis), or systemic disorders (diabetes mellitus, hypertension, etc.), those with a body mass index of >30 kg/m^2, those with hearing or vision problems, and those with confirmed or suspected pregnancy were excluded from the study. A total of 190 participants were interviewed to question whether they met the inclusion criteria. Fourteen participants were excluded from the study because they did not meet the inclusion criteria, and the study was completed with a total of 176 participants (Figure 1). Data on the age, height, body weight, body mass index, age, education level, mean daily frequency of smartphone use within the last month, and dominant side were recorded in the prepared evaluation form with the face-to-face interview method. Then, the neck proprioception sense of the individuals was assessed. Finally, it was evaluated whether the individuals were addicted to smartphones.

In this study, the Tracker Laser device (3Fellows LLC, Minneapolis, USA) was used to evaluate neck proprioception (Figure 2). This system consists of a laser headband attached to the head of the subject being tested and 60 × 60 cm target paper. In a study by Michiels et al. (2013), the CI of the measurement technique applied in our study was found to be 0.35 – 0.87 with the test – retest method. The participant wearing the laser headband was seated directly opposite the target paper at a distance of 90 cm. Care was taken to ensure that the feet of the tested person were on the ground and the position of his/her back was adjusted appropriately. The incidence angle of the laser beam was adjusted, and the tested subject was kept in a relaxed and neutral head position. The laser head was placed as close to the eye as possible over the nasal root. The room where the test was conducted was large and arranged in a way to allow for adequate lighting so that the laser beam falling on the target paper could

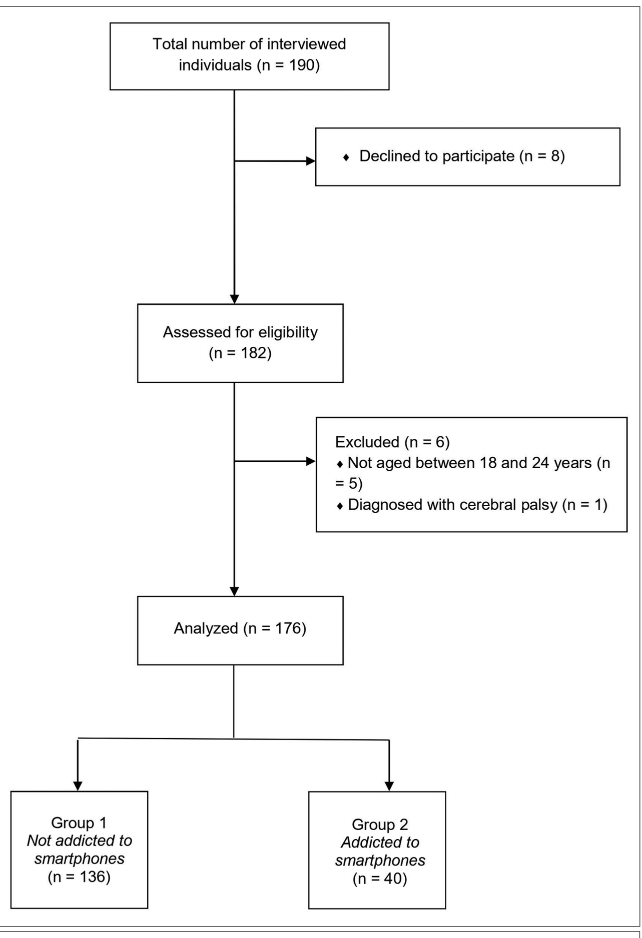

Figure 1. Study Sample Flow Diagram.

Figure 2. Neck Proprioception Assessments.

be clearly seen. The assessment area was free of factors, such as noise, loud conversations, and excessive lighting, that could hinder focus on the task. Before starting the test, it was confirmed that the participant did not feel tired or had not recently engaged in any activity that could affect muscle fatigue, since muscle fatigue could adversely affect the accuracy of the test procedure (Nasr Awad et al., 2020; Pinsault & Vuillerme, 2010). The participant was then asked to put on the laser headband. When the participant's neck was in the neutral position, the point indicated by the laser was determined as the center point, and the paper was placed in the middle of the target paper. With eyes open, the participant was asked to move his/her neck as far to the left in the direction of rotation as possible and return to the starting point, that is, the neutral position of the head. After trying this movement a total of six times, the participant was asked to test the same movement with his/her eyes closed and bring his/her head to the starting position and find the center point with the laser light (Figure 2).

In order for the participant to familiarize with the test procedure, the first test was performed as an experiment during which no measurement was taken. After making sure that the participant understood what to do, the actual test was conducted, and the point indicated by the participant using the laser was marked. Care was taken to represent each sign in a different color. At the end of the test, the distance between the point reported by the patient and the true center point was measured with a tape measure and recorded. The same test procedure was repeated for the right rotation, flexion, and extension movements. Considering that the participants' natural desire was to achieve a result as close to the center of the target as possible, in order to avoid the inadvertent correction of the head, and thus the laser, the participant was asked to wait with their eyes closed until the cue was given after completing each movement trial (Torbé et al., 2017). The whole evaluation procedure was undertaken under the same room conditions by the same researcher (F.Ç.) blinded to the groups of the participants.

After the neck proprioception evaluation, the Smartphone Addiction Scale-Short Form (SAS-SF) was administered to the participants to determine whether they were addicted to smartphones. This scale was developed to assess the risk of smartphone addiction in adolescents (Kwon et al., 2013). The item-total score correlation coefficients of the scale, which were evaluated as evidence for content validity, were found to range from .64 to .82. When the Cronbach α and McDonald ω values were analyzed for the reliability level of the scale, they were reported to be .90 and .94, respectively (Şata & Karip, 2017). The scale consists of ten items rated on a six-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = partially disagree, 4 = partially agree, 5 = agree, and 6 = strongly agree. The scale score varies between 10 and 60. As the total score on the scale increases, the risk for addiction increases. In a study conducted in Korea, the cut-off score was determined as 33 for women and 31 for men (Kwon et al., 2013).

Statistical Analysis

Statistical analyses were performed using International Business Machines® Statistical Package for the Social Sciences software© v. 24 (IBM SPSS Corp., Armonk, NY, USA). The compliance of numerical variables with a normal distribution was checked using visual (histogram and probability graphs) and analytical methods (Kolmogorov – Smirnov test). Descriptive statistics for normally distributed numerical variables were expressed as mean and standard deviation values and those of categorical variables as numbers and percentages. The Pearson's correlation test was used to examine the relationship for normally distributed data, while correlation coefficients and statistical significance were calculated using Spearman's test if at least one of the variables was non-normally distributed or ordinal. The degree of correlation was interpreted as low if the correlation coefficient was 0.05 – 0.4, moderate if 0.4 – 0.7, and high if 0.7 – 1.0 (Hayran, 2011). The independent samples *t*-test (Student's *t*-test) was used to compare two normally distributed independent groups. The statistical significance level was accepted as $p < .05$ (Hayran, 2011).

Results

The study was completed with a total of 176 participants, 113 (64.2%) women and 63 (35.8%) men. It was found that 40 participants (22.7%) were smartphone addicts and 136 participants (77.3%) were not addicted to smartphone use. The individuals with and without smartphone addiction had similar demographic characteristics. The detailed demographic data of the participants are given in Table 1. As expected, the smartphone use frequency ($p < .001$) and SAS-SF total score ($p < .001$) significantly differed between the individuals with and without smartphone addiction. In addition, there was a positive moderate statistical correlation between the SAS-SF total score and smartphone use frequency among all the participants ($p < .001$, $r = .481$).

When the proprioception evaluations of the smartphone-addicted and non-addicted groups were compared, statistically significant differences were foundff in relation to the joint position errors (JPEs) in neck flexion, ($p < .001$), neck extension ($p < .001$), and left neck rotation ($p = .002$). The smartphone-addicted individuals had poorer neck flexion, extension, and left rotation proprioception senses than those that were not addicted to smartphones. Table 2 presents the detailed data on the comparison of neck proprioception parameters between the smartphone-addicted and non-addicted groups.

Table 1.
Demographic Characteristics of the Participants with and without Smartphone Addiction

Variable	Non-addicted (*n* = 136)	Addicted (*n* = 40)	*p*
Age (years, X ± SD)	20.07 ± 2.60	19.70 ± 2.38	.494
BMI (kg/m², X ± SD)	23.57 ± 3.61	22.88 ± 3.44	.238
Smartphone use frequency (hours/day)	3.59 ± 2.16	5.43 ± 2.53	<.001*
SAS-SF total score	20.97 ± 5.84	39.53 ± 5.22	<.001*
Dominant side (n, %)			
Right	116 (85.3%)	36 (90%)	.603
Left	20 (14.7)	4 (10%)	
Gender (n, %)			
Female	88 (64.7%)	25 (62.5%)	.852
Male	48 (35.3%)	15 (37.5%)	
Education level (n, %)			
Primary school	2 (1.5%)	0	.801
High school	89 (65.4%)	27 (67.5%)	
Associate degree	8 (5.9%)	4 (10.0%)	
Undergraduate degree	37 (27.2%)	9 (22.5%)	

SAS-SF = Smartphone Addiction Scale-Short Form; X = mean; SD = standard deviation; BMI = body mass index; n = number of picipants. *$p < .05$.

Discussion

It was determined that 22.7% of the young adult individuals included in this study were addicted to smartphones, and the degree of smartphone addiction increased as the daily phone use frequency increased. Furthermore, it was concluded that the individuals who were addicted to smartphones had a poorer sense of neck proprioception than those without this addiction.

Studies in the literature have shown that smartphone addiction can lead to musculoskeletal problems, functional disorders on the neck, and a decrease in cervical proprioception ability (İnal & Arslan, 2021; Alshahrani et al., 2018). In a study investigating the effect of smartphone use on cervical proprioception and balance in 30 healthy adults, Alshahrani et al. (2018) divided the participants into 2 groups: light-use (smartphone use of less than 4 h/day) and heavy-use (more than 4 h/day). When neck proprioception was evaluated, it was observed that the JPE distances in right and left rotation were higher in the heavy-use group compared to the light-use group. The authors concluded that long-term smartphone use negatively affected cervical proprioception. Similarly, in a study by Portelli and Reid (2018) evaluating 44 participants aged 18 – 35 years, the participants were divided into 2 groups as those who used electronic devices for 4 hours or longer a day and those who used these devices less frequently. The JPE distances were found to be higher in neck flexion in the group that spent 4 hours or longer a day on electronic devices compared to the other group. However, no significant difference was found in relation to the JPE distances in extension, right rotation, and left rotation. In our study, when the neck proprioception evaluations of the smartphone-addicted and non-addicted individuals were compared, statistically significant differences were found in all JPE distances except right neck rotation. One of the reasons for there being no significant difference in right neck rotation might be due to the fact that majority of young adults were right-sided. Accordingly, it can be stated that people that are addicted to smartphones have a poorer neck proprioception sense than those without this addiction. In previous studies on the effects of smartphone use on proprioception, positioning errors in neck flexion similarly showed significant differences between the groups with high and low smartphone use frequency. This can be attributed to the prolongated static poor posture of the cervical spine due to the increasing use of smartphones (Ha & Sung 2020).

Yoon et al. (2015) showed that smartphone use negatively affected proprioception abilities in the lumbar spine and the cervical spine. In that study, the effect of smartphone use on positioning errors in the lumbar vertebrae was examined in 20 participants. As a result, it was observed that the lumbar positioning errors increased immediately after walking for 20 minutes while using a smartphone. Besides, Kee et al. (2016) stated that smartphone-addicted teenagers may be more frequently subjected to muscular disturbance in the craniocervical area. Similarly, Elserty et al. (2020) found a significant correlation between musculoskeletal discomfort and smartphone using. Evaluating our findings in light of these results, we can state that smartphone use may adversely affect not only cervical region proprioception but also lumbar region proprioception. Future studies can be planned to examine the effects of smartphone use on proprioception abilities in other spinal or body regions.

Table 2.
Comparison of the Neck Proprioception Ability Between the Participants with and without Smartphone Addiction

	Non-addicted (n = 136)		Addicted (n = 40)				
Variable	X⁻ ± SD	Min-Max	X⁻ ± SD	Min-Max	*t*-value	*p*	95% CI
Neck flexion error distance (cm)	7.37 ± 4.21	0.00 ± 20.00	11.31 ± 4.94	2.50 ± 28.00	−4.98	<.001*	−5.49; −2.37
Neck extension error distance (cm)	6.74 ± 3.55	0.00 ± 19.50	9.77 ± 4.16	1.50 ± 19.50	−4.56	<.001*	−4.35; −1.72
Neck right rotation error distance (cm)	6.40 ± 2.96	0.00 ± 18.00	7.19 ± 3.68	2.00 ± 16.00	−1.39	.164	−1.90; 0.32
Neck left rotation error distance (cm)	6.84 ± 3.00	1.00 ± 20.00	8.55 ± 3.12	3.80 ± 16.10	−3.13	.002*	−2.78; −0.63

*Independent *t*-test, $p < .05$.
n = number of participants; t = difference in mean values between the two groups; SD = standard deviation; min = minimum; max = maximum; X⁻ = mean.

Reduced sense of proprioception in the cervical region in individuals with smartphone addiction may pose significant risks for these individuals. It has been suggested that the decrease in proprioceptive abilities may lead to important functional changes, and these changes in clinical position or movement may cause performance deficiencies in individuals, especially during sports activities (Ogard, 2011). Decreased long-term intense proprioceptive input from neck muscles may also have lasting effects on self-motion perception and cognitive body representation, which will make individuals more prone to spinal injuries, especially in the neck region (Pettorossi & Schieppati, 2014). Therefore, today when smartphone use is widespread, preventive measures should be taken not to deteriorate cervical proprioception. Many preventive approaches such as reducing the time spent using smartphones a day, increasing the level of physical activity, and adopting a more active lifestyle can reduce the negative effects of smartphone use on proprioception (Portelli & Reid, 2018; Sarig-Bahat, 2003).

Limitations and Directions/Suggestions for Future Research

There are certain limitations to this study. Although the physical activity and fatigue levels of the participants are important factors that may affect neck proprioception, we did not evaluate these levels among our participants. Another limitation is that although we assessed joint position and repositioning, we did not investigate the sense of kinesthesia, which constitutes neck proprioception. Besides, the device for measuring proprioception is a new; therefore, the validation of measurement with this device has not been conducted yet. However, these methods of proprioception measurement with similar devices are valid and reliable in the literature. It is recommended that future studies examine the effects of smartphone use on the sense of proprioception in different age groups and different body parts, taking into account the parameters of physical activity and fatigue.

This cross-sectional study showed that young adult individuals who were addicted to smartphones had a poorer neck proprioception sense than those without this addiction. Although the weakening of the neck proprioception sense does not cause any pain or loss of function, it may be recommended that individuals increase their physical activity levels by reducing the time they use smartphones since this habit may pave the way for future musculoskeletal problems in the spine, especially in the neck region.

Ethics Committee Approval: Ethical committee approval was received from the Noninterventional Ethics Committee of Kütahya Health Sciences University (Approval no: 2021/11-26).

Informed Consent: Written and verbal consent was obtained from all participants who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - F.N.Y.; Design - F.N.Y.; Supervision - İ.S.; Materials - F.N.Y., İ.S.; Data Collection and/or Processing - F.N.Y.; Analysis and/or Interpretation - F.N.Y., İ.S.; Literature Review - F.N.Y.; Writing - F.N.Y., İ.S.; Critical Review - İ.S.

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References

Alshahrani, A., M Aly, S. M., Abdrabo, M. S., & Asiri, F. Y. (2018). Impact of smartphone usage on cervical proprioception and balance in healthy adults. *Biomedical Research*, *29*(12), 2547 – 2552. [CrossRef]

Beinert, K., & Taube, W. (2013). The effect of balance training on cervical sensorimotor function and neck pain. *Journal of Motor Behavior*, *45*(3), 271 – 278. [CrossRef]

Borghuis, J., Hof, A. L., & Lemmink, K. A. P. M. (2008). The importance of sensory-motor control in providing core stability: Implications for measurement and training. *Sports Medicine (Auckland, NZ)*, *38*(11), 893 – 916. [CrossRef]

Cheever, N. A., Rosen, L. D., Carrier, L. M., & Chavez, A. (2014). Out of sight is not out of mind: The impact of restricting wireless mobile device use on anxiety levels among low, moderate and high users. *Computers in Human Behavior*, *37*, 290 – 297. [CrossRef]

Chen, B., Liu, F., Ding, S., Ying, X., Wang, L., & Wen, Y. (2017). Gender differences in factors associated with smartphone addiction: A cross-sectional study among medical college students. *BMC Psychiatry*, *17*(1), 341. [CrossRef]

Clayton, R. B., Leshner, G., & Almond, A. (2015). The extended ISelf: The impact of IPhone separation on cognition, emotion, and physiology. *Journal of Computer-Mediated Communication*, *20*(2), 119 – 135. [CrossRef]

Demirci, K., Akgönül, M., & Akpinar, A. (2015). Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *Journal of Behavioral Addictions*, *4*(2), 85 – 92. [CrossRef]

Ergen, E., Ülkar, B., & Erarslan, A. (2007). Derleme: Proprioriyosepsiyon ve Koordinasyon. *Spor Hekimlği Dergisi*, *42*(2), 57 – 83.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175 – 191. [CrossRef]

Ha, S. Y., & Sung, Y. H. (2020). A temporary forward head posture decreases function of cervical proprioception. *Journal of Exercise Rehabilitation*, *16*(2), 168 – 174. [CrossRef]

Hayran, M. (2011). Sağlık Araştırmaları için Temel İstatistik (*1*. Basım). Art Ofset Matbaacılık Yayıncılık Organizasyon.

İnal, Ö., & Serel Arslan, S. S. (2021). Investigating the effect of smartphone addiction on musculoskeletal system problems and cognitive flexibility in university students. *Work (Reading, Mass.)*, *68*(1), 107 – 113. [CrossRef]

Kaya, F., Bostanci Daştan, N. B., & Durar, E. (2021). Smart phone usage, sleep quality and depression in university students. *International Journal of Social Psychiatry*, *67*(5), 407 – 414. [CrossRef]

Kee, I. K., Byun, J. S., Jung, J. K., & Choi, J. K. (2016). The presence of altered craniocervical posture and mobility in smartphone-addicted teenagers with temporomandibular disorders. *Journal of Physical Therapy Science*, *28*(2), 339 – 346. [CrossRef]

Kim, J. H., Seo, M., & David, P. (2015). Alleviating depression only to become problematic mobile phone users: Can face-to-face communication be the antidote? *Computers in Human Behavior*, *51*, 440 – 447. [CrossRef]

Kwon, M., Kim, D. J., Cho, H., & Yang, S. (2013). The smartphone addiction scale: Development and validation of a short version for adolescents. *PLOS ONE*, *8*(12), e83558. [CrossRef]

Michiels, S., De Hertogh, W., Truijen, S., November, D., Wuyts, F., & Van de Heyning, P. (2013). The assessment of cervical sensory motor control: A systematic review focusing on measuring methods and their clinimetric characteristics. *Gait and Posture*, *38*(1), 1 – 7. [CrossRef]

Montag, C., Błaszkiewicz, K., Sariyska, R., Lachmann, B., Andone, I., Trendafilov, B., Eibes, M., & Markowetz, A. (2015). Smartphone usage in the 21st century: Who is active on WhatsApp? *BMC Research Notes*, *8*(1), 331. [CrossRef]

Nasr Awad, A., Alaa Yousri, M., Nadia Abdelazim, F., and Lama Saad El-Din, M. 2015. Decreased Neck Proprioception & Postural Stability after Induced Cervical Flexor Muscles Fatigue. *Journal of Musculoskeletal & Neuronal Interactions*, *20*(3), 421. [CrossRef]

Ogard, W. K. (2011). Proprioception in sports medicine and athletic conditioning. *Strength and Conditioning Journal*, *33*(3), 111 – 118. [CrossRef]

Park, J., Kim, K., Kim, N., Choi, I., Lee, S., Tak, S., & Yim, J. (2015). A comparison of cervical flexion, pain, and clinical depression in frequency of smartphone use. *International Journal of Bio-Science and Bio-Technology*, *7*(3), 183 – 190. [CrossRef]

Pettorossi, V. E., & Schieppati, M. (2014). Neck proprioception shapes body orientation and perception of motion. *Frontiers in Human Neuroscience*, *8*, 895. [CrossRef]

Pinsault, N., & Vuillerme, N. (2010). Degradation of cervical joint position sense following muscular fatigue in humans. *Spine*, *35*(3), 294 – 297. [CrossRef]

Portelli, A., & Reid, S. A. (2018). Cervical proprioception in a young population who spend long periods on mobile devices: A 2-group comparative observational study. *Journal of Manipulative and Physiological Therapeutics*, *41*(2), 123 – 128. [CrossRef]

Salehan, M., & Negahban, A. (2013). Social networking on smartphones: When mobile phones become addictive. *Computers in Human Behavior*, *29*(6), 2632 – 2639. [CrossRef]

Sarig-Bahat, H. (2003). Evidence for exercise therapy in mechanical neck disorders. *Manual Therapy*, *8*(1), 10 – 20. [CrossRef]

Şata, M., & Karip, F. (2017). Akıllı telefon bağımlılığı Ölçeği-Kısa Versiyonunun Ergenler İçin Türk Kültürüne Uyarlanması. *Cumhuriyet Uluslararası Eğitim Dergisi*, *6*(4), 426 – 440

Shahrestanaki, E., Maajani, K., Safarpour, M., Ghahremanlou, H. M., Tiyuri, A., & Sahebkar, M. (2020). The relationship between smartphone addiction and quality of life among students at Tehran University of Medical Sciences. *Turkish Journal on Addictions*, *7*(1), 61 – 66.

Soliman Elserty, N., Ahmed Helmy, N., & Mohmed Mounir, K. (2020). Smartphone addiction and its relation to musculoskeletal pain in Egyptian physical therapy students. *European Journal of Physiotherapy*, *22*(2), 70 – 78. [CrossRef]

Szeto, G. P. Y., Straker, L., & Raine, S. (2002). A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers. *Applied Ergonomics*, *33*(1), 75 – 84. [CrossRef]

Torbé, D., Torbé, A., & Lubkowska, A. (2017). Laser Tracker - A handy device that verify proprioception of neck and head. *Journal of Education, Health and Sport*, *7*(9), 155 – 166

Walsh, S. P., White, K. M., & McD Young, R. (2010) Needing to connect: The effect of self and others on young people's involvement with their mobile phones. *Australian Journal of Psychology*, *62*(4), 194 – 203. [CrossRef]

Yong, M. S., Lee, H. Y., & Lee, M. Y. (2016). Correlation between head posture and proprioceptive function in the cervical region. *Journal of Physical Therapy Science*, *28*(3), 857 – 860. [CrossRef]

Yoon, J. O., BHSc, Kang, M. H., Kim, J. S., BHSc, & Oh, J. S. (2015). The effects of gait with use of smartphone on repositioning error and curvature of the lumbar spine. *Journal of Physical Therapy Science*, *27*(8), 2507 – 2508. [CrossRef]