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RESEARCH ARTICLE

EFFECT OF TEXT-NECK SYNDROME ON SCAPULAR INDEX AND RESPIRATORY FUNCTIONS IN DIFFERENT AGE GROUPS

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ABSTRACT

Purpose: Text-Neck Syndrome is a rising 21st-century syndrome that affects millions of people of all ages all over the world. This study aimed to investigate the effect of Text-Neck Syndrome on Scapular Index and Respiratory Functions in Different Age Groups. **Methods**: Forty-four subjects aged between (10 and 29 years) who had Text-Neck Syndrome participated in this study. They were distributed into 2 groups according to their age. Group (A) adolescent age group (10-19 years) and group (B) young adult age group (20-29 years). visual analogue scale was used to measure neck pain intensity, Functions of the upper extremity were scored by the Quick questionnaire, Scapular index was measured to assess Rounded shoulder posture, photographing method was used to determine craniovertebral angle to assess forward head posture, Respiratory function was assessed using 6-Minute Walk Distance. **Results:** Subjects with Text-Neck Syndrome in adolescent age group (A) had significantly worse Quick Disabilities of the Arm, Shoulder, and Hand questionnaire ($p<0.05$), As well as non-significantly worse measurements of Visual analogue scale, scapular index and craniovertebral angle than those at the young adult age group (B) ($p>0.05$). But, regarding 6-Minute Walk Distance, group (A) had significantly higher results than group (B). **Conclusion**: Text-Neck Syndrome co-morbidities such as: neck pain, disabilities of upper extremity, rounded shoulder, forward head posture and decreased respiratory functions are all more present at adolescent compared to young adult age groups excluding the affection of respiratory functions which is worse in older age.

INTRODUCTION

Text-Neck Syndrome (TNS) is the term used to depict neck pain and damage caused by looking down for smartphone, tablet or other electronic device too frequently and for too long (1). The number of smartphone users has continuously grown over the last several years all across the world (2). Concerns regarding musculoskeletal deficits associated with prolonged smartphone use have grown as the use of smartphones has grown (3). Smartphone addicts develop Musculoskeletal symptoms including such discomfort and pain, not only in the neck area but also in other areas of the body including shoulders, elbows, arms, wrists, hands, thumbs and fingers (3, 4). Forward head position (FHP) is the most frequent adverse effect of excessive smartphone or tablet use. This causes the atlanto -occipital joint to extend and the lower cervical spine (C4 to C7) to flex and flattening of mid cervical lordosis which causes joint dysfunction, abnormal afferent information affecting the tonic neck reflex and encourages the gradual adaptation of FHP (5). Repeated upper limb movements while using a smartphone produce continual muscle contraction, which can cause microscopic injury to upper limb muscles (6, 7). To comfortably handle the phone, smartphone users usually alter their hand and thumb position. The muscular and neurological tissue in the hand may be severely affected by prolonged abnormal static posture and repetitive use of the wrist and thumb while using a smartphone(8). Excessive forward flexion of the lower cervical spine, resulted from forward head posture, was found to be associated with negative affection of lung function (9, 10). Alterations in the mechanics of the cervical and thoracic spine impair the chest wall's capacity to inflate properly during inspiration and rest normally during expiration (11). Furthermore, weakness of the accessory respiratory muscles may occur as a result of misalignment of the cervical and thoracic spine caused by muscle imbalance (9). A Study revealed that smartphone addiction is twice more prevalent among teenagers than among adults(12). Furthermore, in the shadow of the COVID-19 pandemic, distance learning compelled entire generations of children and teenagers to spend even more time at home reading books and using mobile devices (13). Therefore, the current study is conducted to determine the effect of Text-

Neck Syndrome on scapular index and respiratory functions among different age groups.

METHODS

Forty-four subjects (26 females and 18 males) participated in this study. Their ages were within the range of (10 to 29 years). They were assembled from physiotherapy department at Helwan Sulfur Baths Center and different schools of all educational levels. The study was conducted at Helwan Sulfur Baths Center from December 2020 to May 2021. Subjects were included in the study if their age between 10 to 29 years, as well as, they had Text-Neck Syndrome (they used to spend more than 4 hours/day on smartphone (14) and had any have any 3 out of 6 symptoms of TNS -neck pain, upper back pain, shoulder pain, headache, insomnia, tingling and numbness in hands- (15)).

Subjects were excluded if they had head and neck injuries or surgeries within pervious one year before the study, congenital abnormalities or symptomatic deformity in either the cervical or the lumbar spine, uncorrected visual or auditory problems, dizziness, vertigo and headache that may affect the subject to participate at the tests, additive drugs and sedatives within 48 hours previous to tests (16,17), neurological motion disorders, restrictions in lung function, or other neurologic, orthopedic, or unstable cardiac conditions (9). Participants were assigned according to their age into 2 age groups: Group (A) TNS adolescent age group, Group (B) TNS young adult age group. The study protocol was approved by Research Ethical Committee of Faculty of Physical Therapy (NO: P. T. REC/012/003079). Written informed consent was obtained from each participant.

Scales and Instrumentation for assessment

Assessment of neck pain intensity: The scale used was the VAS, which consists of a line, usually 10 mm long, ranging from no pain or discomfort (zero), to the worst pain that could possibly feel (10) **(18).**

Assessment of the functions of the upper extremity: Upper extremity functional assessment was performed by using the Quick Disabilities of the Arm, Shoulder, and Hand questionnaire. It contains 11 questions that are intended to assess physical function and symptoms in people who have various musculoskeletal disorders in their upper extremities. If more than one question was left unanswered, the Q-DASH score would be unavailable. The score is given From 0 to 100 **(19).**

Assessment of rounded shoulder posture: Tape measurement to measure the distance between the sternal notch and the medial aspect of coracoid process (chest side length) and the distance between the posterolateral angle of acromion and the adjacent thoracic spinous process (back side length).

Assessment of forward head posture: small markers, xiaomi redmi note 9s camera (resolution: 48 MP, f/1.8, 26mm (wide), 1/2.0", 0.8µm, PDAF), smartphone tripod**,** PC computer (Lenovo ideapad 110-15ISK laptop, manufactured for Lenovo pc HK limited, china) and surgimap software (version 2.3.2.1).

Assessment of respiratory function: stopwatch and two small cones to label the turnaround sites**.**

Procedures:

Assessment of neck pain: Assessment of the severity of neck pain after prolonged use of smartphones using VAS. The participants were given the scale and asked to mark on the line, the point that represented their feeling of pain.

Assessment of the functions of the upper extremity: All participants were given the Q-DASH. At least ten of the eleven items require responses in order to determine a Q-DASH score. Each question had five possible answers. For the mildest symptom or functional status, one point was awarded; for the most severe symptoms and limitations, five points were awarded. The following formula was used to calculate the score: Q-DASH Disability/Symptome Score = , as n is represents the number of completed responses

Assessment of rounded shoulder posture: Subjects were requested to stand normally with their hands hanging beside their bodies to test for rounded shoulder posture. Then, sternal notch, coracoid process, posteriolateral angle of the acromion process and the adjacent thoracic spinous process were palpated and marked. The distance between sternal notch and coracoid process, and the distance between the posterolateral angle of the acromion process and the adjacent thoracic spinous process were measured by using tape. The scapular index was estimated by using the following formula: Scapular Index= **(20)**.

Determination of forward head posture FHP by measuring the craniovertebral angle CVA: A lateral-view, digital photograph in a standing position was taken to measure CVA for the subjects. Smartphone tripod was used to stabilize mobie camera and keep it leveled parallel to the ground. A photograph was taken laterally and the CVA was measured by using surgimap software on the PC device. The 7th cervical vertebra bony landmark and the tragus of the subject's ear were marked. This was conducted by asking the subject to extend and flex her/his head three times and then finding the 7th spinous process of the vertebra. The CVA angle between the line connecting the tragus of ear to 7th cervical vertebra and the horizontal plane was calculated **(21).**

Assessment of respiratory function: 6-MWT was carried out in accordance with the American Thoracic Society **(2002)** recommendations. The test was carried out on a 30-meter level, straight surface. Two little cones marked the turnaround locations, and individuals were instructed to walk by their normal speed for the farthest distance available in six minutes (6-MWD), which was measured in metres.

Data collection and statistical analysis: After collecting data, statistical analysis was performed using One way ANOVA to report significant differences two groups concerning Physical Characteristics of subjects (age, weight, height, BMI and number of hours using smartphone per day)**.** Un-paired T-test was used to identify difference between groups. The level of significance was set at ≤ 0.05.

Statistics: Demographic data (age, weight, height, BMI, and hours) and outcomes data (VAS score, Q-DASH, SI, CVA and 6-MWD score) were collected and statistically analyzed using SPSS software (version 23; IBM Corp., New York, United States). Assessment of normality was performed using the Shapiro–Wilk test.

Table 1. Physical characteristics of subjects in studied groups

	Group A	Group B	Comparison		SIG
	Mean ± SD	Mean ± SD	f-value	p-value	
Age (Years)	12.30±1.92	24.62±1.82	135.54	0.0001	S
Weight (Inal et al.)	49.85±8.51	68.85±7.51	11.26	0.0001	S
Height (McMinn)	152.00±3.60	164±3.2	6.41	0.001	S
BMI (kg/m^2)	21.63±1.82	23.63±1.42	7.75	0.0001	S
Hours (h)	10.54±1.9	7.34±1.36	79.36	0.0001	S

Sig.: Significance, S.D: Standard deviation, P: probability value F: ANOVA test, BMI: body mass index.

Table 2. Comparison between Text-Neck Syndrome groups

Variables	Group A Mean ± SD	Group B Mean ± SD	t-value	p-value	SIG
VAS	4.76±2.62	3.73±0.92	1.43	0.16	NS
Q-DASH	36.88±18.19	22.03±2.65	3.04	0.004	S
SI (%)	74.87±4.71	76.92±7.47	-1.07	0.28	NS
CVA (Degree)	49.26±1.85	49.73±1.35	-0.96	0.34	NS
6-MWD (m)	555±15.65	379.61±52	3.94	0.0001	S

SD: standard deviation, p value: probability, S: significance, NS: non significance, VAS: visual analogue scale, Q-DASH: Quick Disabilities of the Arm, Shoulder, and Hand questionnaire, SI: scapular index, CVA: craniovertebral angle, 6-MWD: 6-minute walk distance, m: meter.

All variables were normally distributed and were analyzed using parametric tests (t-tests: paired and unpaired). The level of significance was set at 0.05.

Physical Characteristics of subjects: Forty-four subjects from both genders (46 females and 39 males) with TNS participated in this study and were distributed into, 21 adolescents at Group (B), and 23 young adults at Group (D). One way ANOVA reported significant differences between both groups concerning age, weight, height, BMI and number of hours using smartphone per day as shown in Table HYPERLINK "https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7184218/table/tbl1/" HYPERLINK "https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7184218/table/tbl1/"1.

Effect of Text-Neck Syndrome on VAS, Q-DASH, SI, CVA and 6-MWD in different age groups (groups A & B): Un-paired t-test was used to consider the difference between both groups. There was no statistical significant difference between both groups in VAS, SI and CVA. While, there was statistical significant difference regarding Q-DASH and 6-MWD. Thus, subjects with TNS in adolescent age group (A) have deterioration more than those in young adult group (B) except for 6-MWD (Table 2).

DISCUSSION

looking down at the handheld smartphone device accomplished by forward flexion of cervical spine as in bilateral texting or asymmetric cervical posture as in unilateral texting, both positions were associated with a non-neutral posture of the cervical spine (22), keeping this posture for prolonged periods of time leads to various musceloskeletal disorders at neck and all levels of upper extremity (3). This study was performed to investigate effect of Text-Neck Syndrom on scapular index and respiratory functions in different age groups. In the results the subjects with TNS in adolescent age group (A) have deterioration at VAS, Q-DASH, SI and CVA more than young adult group (B). this could be due to the marked increase of number of hours using smartphone per day at the adolescent age group 10.54 h/day compared to the older age group 7.34 h/day.

Haug HYPERLINK "file:///C:/Users/Mohamed% 20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed% 20Hamdy/ Downloads/ paper..e3.docx"et HYPERLINK "file:///C:/Users/ Mohamed%20 Hamdy/ Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed% 20Hamdy/ Download s/paper..e3.docx"al., HYPERLINK "file:///C:/Users/ Mohamed%2 0Hamdy/ Downloads/paper..e3.docx"(2015) HYPERLINK "file:///C:/Users/ Mohamed%2 0Hamdy/ Downloads/paper..e3.docx" showed that Smartphone addiction was more prevalent in younger adolescents (15-16 years) compared with young adults (19 years and older) and they have more complications compared with young adults (23). Another study stated that young people who have grown up with digital advancements rely on digital sources more than earlier generations; they are the primary users of mobilephones and also the most likely to suffer mobilephone overuse complications (24). Recently it can be explained ,in the light of the COVID 19 pandemic, frequent increase of smartphone activities such as phone calls, social network, online chats, education, games, music and videos than pre-epidemic period among children and adolescents as a result of social distancing policies (25). Another cause may be that there is no sufficient awarness among children and adolescents of the right posture during smartphone use and physical inactivity during the pandemic. There was statistical significant difference between both groups at 6-MWD with less distance in group B. this may be explained by the energetic and enthusiastic attitude of the younger age group while performing the 6-MWT compared to the older group. Some studies suggested that young age persons complete more steps in a faster manner compared to adults. their temporal features (time-based features) of gait like step time, cycle time, and cadence were significantly different compared to that of adults **(26).** Another possible cause may be the persistent respiratory symptoms of the current pandemic (COVID-19) as it can last for 5 months after recovery. Adults had higher incidence of COVID-19 than children and adolescents **(27)**, So some of the young adult participants may have had COVID-19 which affects their respiratory functions.

The results revealed that there is non-significant difference between VAS of both groups. Neck pain and soreness is the most common symptom of TNS according to systematic HYPERLINK

"file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"review HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"of HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"45 HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"previous HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"studies (1**)**. In a sample of 180 children and adolescents diagnosed with musculoskeletal neck pain and spasm without any other diseases. A cervical neck pain radiating to the back and shoulders was reported by all patients. When they were studying and utilizing smartphones and/or tablets, all of the individuals indicated forward neck flexion (28). Another study on 59 cases assessed as Text-Neck Syndrome in the age range (18-25 years) showed that: there were 100% of the sample had neck pain as well as Forward head posture (15). Smartphone use induces improper postures such as head flexion or bowed postures (29). This head flexion causes increasing of the weight supported by cervical spine. As a result, persistent postures weaken the cervical extensors, resulting in atrophy owing to persistent tension and spasm, which deprives the muscle of oxygen and nutrients. Neck muscles spasm and tightness almost always result in a lot of pain (30).

The results reported that group (A) had significantly higher Q-DASH scores; Thus, more disability of upper extremity. According to Radwan et al.,2020 the amount of smartphone use has a significant effect on Q-DASH score. Low-frequency smartphone users had better upper limb functioning than high-frequency smartphone users (31). This result agrees with the finding of the current study. In their comprehensive investigation, Eitivipart et al.,2018 found that when using a smartphone, muscle activity increased and the pain pressure threshold reduced in the shoulder and forearm region (32). This is due to the fact that increased muscle activity is linked to increased muscle fatigue and a lower pain pressure threshold. Repeated upper-limb movements while using a smartphone generate a continual muscle contraction, which can cause microscopic muscle injury affecting functions of upper limb (6,7). The current study showed that scapular index at both groups was low which means a degree of rounded shoulder posture. This is in line with Jung et al.,(2016) who established that the subjects that use smartphones more than 4 hours/day, had less SI than subjects who use them less than 4 hours/day (10). Also Park HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"et HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"al., HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx"(2014) HYPERLINK "file:///C:/Users/Mohamed%20Hamdy/Downloads/paper..e3.docx" demonstrated that rounded shoulder posture is strongly linked to FHP (14). Finally, Fernandez-de-Las-Penas et al. (2006) found that rounded shoulder posture and thoracic kyphosis are linked to neck musculoskeletal disorders (such as abnormal cervical posture). Their idea was that abnormal scapular tilt can cause rounded shoulder posture by causing irregular lower trapezius and serratus anterior positioning (32).

The results revealed that CVA degrees at both groups are increased which mean more FHP. Forward head posture resulting from TNS can be explained by the increase of force created by the weight of head when it is moved forward far from the neutral position, the weight of head dramatically increases approximately 6 times as much force generated in the neutral posture (1). In addition, Samaan et al.,(2018) stated that smartphone users had forward head position due to looking downwards or to hold their arms out in front of them to read the screen. Thus, causing stress on the neck muscles and cervical spine which lead to forward head position (14). A study support that TNS has a negative effect on respiratory function. Subjects who were addicted to smartphones had lower values in various pulmonary function test variables than subjects who were not addicted (34). Another study stated that young adults who were addicted to cellphones had detrimental changes in their lung functions (10). In addition, Kang et al. (2016) study found that the kyphotic posture that has arisen among frequent smartphone users can affect lung function (35). In addition, another study have demonstrated that FHP causes spinal deformation, which increases scapula deformation, lordosis of the cervical vertebra, and kyphosis of the upper thoracic vertebra (36,37). The mechanics of the rib cage are affected by changes in the cervical and thoracic spine mechanics, making it difficult for the chest wall to expand appropriately during inspiration and rest during expiration (38).

Limitations: The study was limited by the recent guidelines regarding assessment of respiratory functions using pulmonary function testing (PFT) by spirometry. As concern has been raised that PFT could represent a potential way for COVID-19 transmission in the result of the potential for coughing and droplet formation surrounding PFT procedures. So The American Thoracic Society (ATS) recommended limitation of PFT to tests that are only needed for immediate treatment decisions and the type of the tests be limited to the most essential tests when possible (39). So, it was difficult to use PFT which is the most valid tool for assessment of respiratory functions in our study. But instead, we used 6-MWD which showed a good correlation with spirometric parameters and seemed to be a suitable measure to assess respiratory functions (40).

Conclusion

Text-Neck Syndrome co-morbidities such as: neck pain, disabilities of upper extremity, rounded shoulder, forward head posture and decreased respiratory functions are all more present at adolescents compared to young adults excluding the affection of respiratory functions which is worse in older age.

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REFERENCES

NEUPANE S, ALI U, MATHEW A. 2017. Text neck syndrome-systematic review. *Imperial Journal of Interdisciplinary Researc.* 3**:**141-148.

O'DEA S. Smartphone sales worldwide 2007-2021. statista 2021. Available at: https://www.statista.com/statistics/263437/global-smartphone-sales-to-end-users-since-2007/#statisticContainer

BEROLO S, WELLS RP , AMICK BC. Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: a preliminary study in a Canadian university population. *Applied ergonomics.*2011*,* 42**:** 371-378.

JONSSON P, JOHNSON P W, HAGBERG M, FORSMAN M. Thumb joint movement and muscular activity during mobile phone texting–A methodological study. *Journal of Electromyography and Kinesiology.*2011,21**:** 363-370.

FERNáNDEZ-DE-LAS-PEñAS C, ARENDT-NIELSEN L, GERWIN RD. *Tension-type and cervicogenic headache: pathophysiology, diagnosis, and management*, Jones & Bartlett Publishers. 2009.

LEE M, HONG Y, LEE S, WON J, YANG J, PARK S, et al. The effects of smartphone use on upper extremity muscle activity and pain threshold. *Journal of physical therapy science.*2015*,*27**:** 1743-1745.

KIM G Y, AHN CS, JEON H W, LEE C R. Effects of the use of smartphones on pain and muscle fatigue in the upper extremity. *Journal of physical therapy science.2012,* 24**:** 1255-1258.

Kyung, K , Hee-Soo, K , Ji-Hea, W The Study of Muscle Fatigue and Risks of Musculoskeletal System Disorders from Text Inputting on a Smartphone. Journal of the Ergonomics Society of Korea [Internet]. 2013. Jun ; 3 (3) Available from http://dx.doi.org/10.5143/JESK.2013.32.3.273

HAN J, PARK S, KIM Y, CHOI Y, LYU H. Effects of forward head posture on forced vital capacity and respiratory muscles activity. *Journal of physical therapy science.*2016*,* 28**:** 128-131.

JUNG SI, LEE NK, KANG KW, KIM K, DO YL. The effect of smartphone usage time on posture and respiratory function. *Journal of physical therapy science.2016,* 28**:** 186-189.

HOJAT B, MAHDI E. Effect of different sitting posture on pulmonary function in students. *Journal of Physiology and Pathophysiology.2011,*2**:** 29-33.

MING Z, PIETIKAINEN S, HäNNINEN O. Excessive texting in pathophysiology of first carpometacarpal joint arthritis. *Pathophysiology.2006,*13**:**269-270.

DAVID D, GIANNINI C, CHIARELLI F, MOHN A. Text Neck Syndrome in Children and Adolescents. *Int J Environ Res Public Health.2021,*18: 1565

SAMAAN M N, ELNEGMY EH, ELNAHHAS A M, HENDAWY A. Effect of prolonged smartphone use on cervical spine and hand grip strength in adolescence. *Int J Multidiscip Res Dev.2018,* 5**:** 49-53.

VIJAYAKUMAR M, MUJUMDAR S, DEHADRAI A. Assessment of Co-Morbid Factors Associated with Text-Neck Syndrome among Mobile Phone Users.2018.

PARK J, KIM J, KIM J, KIM K, KIM N, CHOI I, et al. The effects of heavy smartphone use on the cervical angle, pain threshold of neck muscles and depression. *Advanced Science and Technology Letters.2015,* 91**:**12-17.

GUPTA V K, ARORA S, GUPTA M. Computer-related illnesses and Facebook syndrome: what are they and how do we tackle them. *Medicine Update.2013,* 23**:** 676-679.

BOONSTRA AM, SCHIPHORST PREUPER H R, RENEMAN M F, POSTHUMUS JB, STEWART RE. Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. *Int J Rehabil Res.2008,* 31**:** 165-9.

FRANCHIGNONI F, FERRIERO G, GIORDANO A, SARTORIO F, VERCELLI S, BRIGATTI E. Psychometric properties of QuickDASH–a classical test theory and Rasch analysis study. *Manual therapy.2011,* 16**:**177-182.

RAMEZANZADE H, ARABNARMI B. Relationship of self esteem with forward head posture and round shoulder. *Procedia-Social and Behavioral Sciences.2011,* 15**:**3698-3702.

QUEK J, PUA Y.-H., CLARK R A, BRYANT A L. Effects of thoracic kyphosis and forward head posture on cervical range of motion in older adults. *Manual therapy.2013,* 18**:**65-71.

XIE Y, SZETO G, MADELEINE P, TSANG S. Spinal kinematics during smartphone texting-A comparison between young adults with and without chronic neck-shoulder pain. *Applied Ergonomics.2018,* 68**:** 160–168.

HAUG S, CASTRO R P, KWON M, FILLER A, KOWATSCH T, SCHAUB M P. Smartphone use and smartphone addiction among young people in Switzerland. Journal of behavioral addictions.2015, 4: 299-307.

LEE T Y, BUSIOL D. A review of research on phone addiction amongst children and adolescents in Hong Kong. *International Journal of Child and Adolescent Health.2016,* 9**,** 433.

SERRA G, SCALZO L L, GIUFFRE M, FERRARA P, CORSELLO G. Smartphone use and addiction during the coronavirus disease 2019 (COVID-19) pandemic: cohort study on 184 Italian children and adolescents. Research Square.2021

ALOBA A, LUC A, WOODWARD J, DONG Y, ZHANG R, JAIN E , et al. Quantifying differences between child and adult motion based on gait features. International Conference on Human-Computer Interaction, Springer.2019, 385-402.

MA H, HU J, TIAN J, ZHOU X, LI H, LAWS M T, et al. A single-center, retrospective study of COVID-19 features in children: a descriptive investigation. *BMC medicine.2020,* 18**,** 1-11.

FARES J, FARES M Y, FARESY. Musculoskeletal neck pain in children and adolescents: Risk factors and complications. *Surg Neurol Int.2017,* 8**,** 72.

HANSRAJ K K. Assessment of stresses in the cervical spine caused by posture and position of the head. *Surg Technol Int.2014,* 25**:** 277-9.

PUNMIYA A, OBEROI M. Influence of Smartphone Addiction Grade on Cervical Pain in Young Adults. *International Journal of Research in Engineering, IT and Social Sciences.2018,* 8**:**17-19.

RADWAN NL, IBRAHIM M M, MAHMOUD W S E.-D. Evaluating hand performance and strength in children with high rates of smartphone usage: an observational study. *Journal of physical therapy science.2020,* 32**:** 65-71.

EITIVIPART A C, VIRIYAROJANAKUL S, REDHEADL. Musculoskeletal disorder and pain associated with smartphone use: A systematic review of biomechanical evidence. *Hong Kong Physiotherapy Journal.2018,* 38**:** 77-90.

FERNANDEZ-DE-LAS-PENAS C, ALONSO-BLANCO C, CUADRADO M, PAREJA J. Forward head posture and neck mobility in chronic tension-type headache: a blinded, controlled study. *Cephalalgia.2006,* 26**:**314-319.

ALONAZI, A., ALMUTAIRI, W., BAINS, G., DAHER, N. & ALISMAIL, A. Effects of Smartphone Addiction on Children's Lung Function. *Pediatrics International,* 2021 Mar;63(3):323-330..

KANG K W, JUNG SI, DO Y L, KIM K, LEE N K. Effect of sitting posture on respiratory function while using a smartphone. *Journal of physical therapy science.2016,* 28**:** 1496-1498.

SHIN Y J, KIM W H, KIM S G. Correlations among visual analogue scale, neck disability index, shoulder joint range of motion, and muscle strength in young women with forward head posture. *Journal of exercise rehabilitation.2017,* 13**,** 413.

SINGLA D, VEQAR Z. Association between forward head, rounded shoulders, and increased thoracic kyphosis: a review of the literature. *Journal of chiropractic medicine.2017,* 16**:** 220-229.

WIRTH B, AMSTALDEN M, PERK M, BOUTELLIER U, HUMPHREYS B. Respiratory dysfunction in patients with chronic neck pain–Influence of thoracic spine and chest mobility. *Manual therapy.2014,* 19**:**440-444.

MEREDITH C. MCCORMACK, M. M. & DAVID A. KAMINSKY, M. 2020. *Pulmonary Function Laboratories: Advice Regarding COVID-19* [Online]. Available: https://www.thoracic.org/professionals/clinical-resources/disease-related-resources/pulmonary-function-laboratories.php.

RICK, O., METZ, T., EBERLEIN, M., SCHIRREN, J. & BöLUKBAS, S. 2014. The Six-Minute-Walk Test in assessing respiratory function after tumor surgery of the lung: a cohort study. *J Thorac Dis,* 6**,** 421-8.

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