Original Article

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Effect of Smartphone Usage Time on Scapular Position and Respiratory Function: A Cross-sectional Study

Physiotherapy Section

JYOTI DUBEY[1], JYOTI KATARIA[2], RICHA HIRENDRA RAI[3]

ABSTRACT

Introduction: In recent times, the number of smartphone users has increased all over the world. The prolonged use of smartphone also shown increase in the musculoskeletal problems among the smartphone users. Smartphone usage become exceptionally desired by most of undergraduate students. Several studies are performed to asses the effect of smartphone usage among students. It has been suggested by many studies that the duration of smartphone usage is the better indicator of the addiction than the frequency of use.

Aim: To study effect of smartphone addiction on respiratory function and position of scapula among undergraduate students.

Materials and Methods: This cross-sectional study was conducted at School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, Delhi, India, from February 2020 to July 2020 on 110 undergraduate students of Delhi and National Capital Region (NCR). Smartphone usage duration along with scapula position and respiratory function was studied. Respiratory function testing was done by using Pulmonary Function Tests (PFT) Machine by RMS, Helios-401 Model. Scapula protraction was assessed by using keibers method of scapula assessment. Data was further analysed using t-test and Analysis of Variance (ANOVA) to find out variation among study population.

Results: The mean age of study population was 22±3.35 years and majority of study population fall under healthy group as per Body Mass Index Body Mass Index (BMI). There was no statistically significant change in the scapular position at rest (p-value=0.334), at 45° abduction (p-value=0.840) and at 90° abduction (p-value=0.595) of addicted subjects. There was no significance (p-value=0.083) change in Forced Expiratory Flow (FEF) 25-75%, also other parameters p-value do not show any statistical significance difference between the smartphone users less than 4 years, 4-6 years, >6-8 years, more than 8 years.

Conclusion: No significant changes observed in pulmonary function tests and altered scapula positioning among the smartphone addicted users.

Keywords: Altered position, Neck pain, Text neck syndrome, Vital capacity

INTRODUCTION

In today's time usage of smartphone has been increased all over the world [1,2]. Prolonged usage leads to inflation of various musculoskeletal problems [3]. This will have great possibilities towards inflation in risk of developing musculoskeletal problems among smartphone users [4,5]. In present time, smartphone have highly predominant role in everybody's life from college going students, to geriatrics population. Physiotherapy students have also developed various mobile applications for online consultations, research work, and assignments submissions [6].

As there is inflation in smartphone users in global population which includes 70% of total population. It is also observed that most of smartphone users are from younger population who are mostly addicted to smartphone [7]. Addicted usually described as 1) Bodily response towards certain food or toxins of pharmaceutical origins. 2) A specific state of mind where nothing helps until certain drug or alcohol infused; 3) The situation of not able to differentiate because of few ideas or objects [8]. Excessive smartphones usage among young generation leads to increase in sedentary lifestyle which causes various types of musculoskeletal problems [9]. The addiction of smartphone is excessive in younger population as it makes immediate connect with people on social media, gets continuous information from social platform's, also students can share study materials, information for work or pleasure [10]. Koseki T et al., found that females spends significantly more time on their smartphone screens per day than male population [11].

Forward head position enhances the force over supporting soft tissues of cervical spine. Recent evidence suggestive of several symptoms which commonly encountered such as cervical spine pain, headache, temporomandibular dysfunction/joint pain, headache, and other various musculoskeletal disorders are related to rounded/forward head posture [12]. This wrong posture cause muscle imbalance in cervical region which further affects the loading of cervical spine, such alteration in loading at cervical spine affects thoracic spine and scapula musculature [13].

Prolonged utilisation of smartphone exhibits repositioning of head and neck of smartphone users as they have maintain a certain position and have to hold that position for long which leads to increased anterior curvature in vertebrae of lower cervical spine and posterior curvature of thoracic spine to manage the load present on the cervical spine and neck muscles [14]. Changes in curvature of cervical spine and imbalance in cervical muscle results in the upper crossed syndrome which further leads to rounded shoulder. Rounded shoulder causes reduction in expansion of the chest wall during normal respiratory cycle and it affects both inspiration and expiration as well [14]. Respiratory function is very much influenced by position of body [15-17]. Kim YG et al, suggested when small repetitive movements were performed like texting they were primarily associated with maintenance of static head down posture for long duration, which ultimately reduces the blood circulation to the supporting muscles hence if not managed may lead to development of fatigue and localised pain [18-21].

In addition, this also have been noticed that changes of cervical spine mechanics along with thoracic spine has ability to alter ability of chest wall during respiratory cycle [21]. Several other postural disorders of spine like scoliosis, has ability to affect function of the respiratory muscle and hence can have negative impact on the respiratory function [22]. Therefore, aim of the research was to study effect of smartphone addiction on respiratory function and position of scapula among undergraduate students.

MATERIALS AND METHODS

This cross-sectional study was conducted at School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, Delhi, India, from February 2020 to July 2020 on 110 undergraduate students of Delhi and National Capital Region (NCR). Ethical clearance was obtained after approval from Departmental Research Committee (DRC) of School of Physiotherapy, DPSR University, Government of NCT of Delhi. Duly filled consent form was obtained from all participants prior to data collection.

Inclusion criteria: Male and female population, age range between 18 to 35 years, also subjects who use smartphone for more than 4 hours per day and less than 4 hours per day were included in the study.

Exclusion criteria: Participants who were having scoliosis, diagnosed case of congenital defect in the spine (Klippel-feil, Scheuermann's disease), respiratory disorders like asthma, deformity of scapula or any history of trauma of rib cage, spine or shoulder girdle were excluded from the study. Subjects who were operated for any heart or cardiac surgery were also excluded from the research.

Sample size calculation: The sample size was calculated using the following formula: $(n)=4pq/l^2$.

Sample size was estimated as 110 undergraduate students keeping 5% absolute precision and 95% confidence interval [7]. All subjects were selected using convenience sampling.

Subjects were divided into two groups,

- Smartphone addicted group (N=60) and
- Smartphone non addicted group (N=50).

However smartphone addicted group further divided into four group depending upon usage of smartphone on daily basis:

- First group who are using smartphone less than four years (<4 years),
- Second group who are using smartphone between 4-6 years,
- Third group more than 6-8 years and
- Fourth group more than eight years (>8 years).

Also, a total number of years of using smartphone was also studied on the basis of addiction and non addiction criteria.

Procedure

Duration of smartphone usage, scapula position, and respiratory function testing was done.

- Respiratory function testing was done by using Pulmonary Function Test (PFT) Machine by RMS, Helios-401 Model. Forced Vital Capacity (FVC), Forced expiratory volume in one second/ Forced Vital Capacity (FEV1/FVC), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow (FEF) 25-75% were assessed by using PFT Machine.
- Scapula protraction was assessed by using keibers method of scapula assessment [14].
- Body Mass Index (BMI) was calculated by using the following formula,

  $BMI=weight(kg)/(height\ in\ meters)^2$.

Respiratory Function

Subjects were seated and asked to look straight ahead. Spirometer was utilised for assessment of respiratory function. Then the subjects were first assessed for:

- Forced Vital Capacity (FVC)- subject was asked to take two tidal breaths in the mouth piece, then subject was asked to inspire maximally and then forcefully expire in the mouthpiece with as much effort as possible for as long as he/she can.
- Slow vital capacity- subject was asked to take 1 tidal breath that includes both inspiration and expiration, at the end of expiration, with full effort take the air in maximally and with full effort but slowly and hold till it is possible, then expire maximally and slowly through mouth. This is followed by another tidal inspiration.
- Maximum voluntary ventilation- subject was asked to inhale and exhale in the mouth piece as forcefully as possible with maximal effort possible and upto her/his maximum lung capacity. This was done for 15 seconds continuously at a stretch. The same assessor performed measurements throughout the entire experiment and respiratory function was recorded [23].

Scapular Position

Position of scapula was assessed by technique devised by kibler known as 'Lateral Scapula Slide Test (LSST)' where scapula assessed in three different positions.

Examiner first demonstrates the positions to the participants of the study. Participants were asked to maintain relaxed position in standing measurements were recorded in three different positions: First position 'At rest', Second position keeping 'Hands on hip joint', Third position keeping 'glenohumeral abduction at 90°'.

- Measurement of first position- participants standing in relaxed position, inferior border of scapula marked and distance recorded from its respective spinous process [23].
- Second position hands were placed at hip joint keeping shoulder joint in medial rotation and at 45° abduction. Distance was recoded for both sides and recorded [24,25].
- For third position participants maintained glenohumeral joint in 90° abduction along with internal rotation. Examiner recorded distance both sides to assess the difference. All scapula measurements were taken three times and average was calculated for data analysis [26,27]. Measurements were recorded by subtracting the value from dominant side to non dominant side, further absolute value was used for data analysis [28,29]. As per LSST a difference obtained as 1.5 cm or more may be considered as altered scapula position obtained from all three positions [30-32].

STATISTICAL ANALYSIS

The data was analysed using descriptive test in terms of mean and standard deviation. The t-test and Analysis of Variance (ANOVA) was used for comparison of variables. Analysis was performed using Statistical Package for the Social Sciences (SPSS) version 24.0. The p-value <0.05 was considered as statistically significant.

RESULTS

A total of 110 undergraduate students were assessed for their static scapula position and pulmonary function. Results shows there was no statistical significant difference in scapular positioning among smartphone addicted and non addicted group however results exhibits alterations in positioning of scapula [Table/Fig-1].

Scapula position	Non addicted			Addicted		
	Left (Mean±SD)	Right (Mean±SD)	p-value	Left (Mean±SD)	Right (Mean±SD)	p-value
Rest	9.14±1.41	9.31±1.47	0.614	9.39±1.59	9.69±1.81	0.334
45° abduction	9.34±1.53	9.53±1.39	0.586	9.69±1.80	9.76±1.85	0.840
90° abduction	9.75±1.45	9.84±1.30	0.762	9.87±2.02	10.05±1.74	0.595

[Table/Fig-1]: Descriptive data of the mean and Standard Deviation (SD) and p-value of scapular position in addicted and non addicted population.

[Table/Fig-2] shows descriptive data of the mean, SD, and p-value of pulmonary function testing in smartphone addicted and non addicted. [Table/Fig-3] exhibits descriptive data of the mean, standard deviation of height, weight, BMI and age in population using smartphone less than 4 years, 4-6 year, >6-8 years and

more 8 than years. The mean age of study population was 22±3.35 years and majority of study population fall under healthy group as per BMI [Table/Fig-3].

Pulmonary function test	Addicted Mean±Standard deviation	Non addicted Mean±Standard deviation	t-value	p-value
FEV1 (L)	2.89±0.60	2.79±0.79	0.701	0.485
FVC (L)	3.01±0.89	3.36±0.85	-1.922	0.058
FEV1/FVC%	81.12±10.40	80.58±9.11	0.263	0.793
PERF (L/s)	5.94±1.49	6.05±1.25	-0.399	0.691
FEF 25-75% (L/s)	3.50±0.86	3.70±1.04	-1.056	0.294

[Table/Fig-2]: Descriptive data of the mean and standard deviation and p-value of pulmonary function testing in addicted and non addicted population Pulmonary Function Testing.
FVC: Forced vital capacity; FEV1/FVC: Forced expiratory volume in one second/Forced vital capacity; PEFR: Peak expiratory flow rate; PEFR: Peak expiratory flow rate

Variable	Less than 4 years (Mean±SD)	4-6 years (Mean±SD)	>6-8 years (Mean±SD)	More than 8 years (Mean±SD)
Age (years)	21.63±2.90	22.77±2.87	21.91±3.11	22.18±2.70
Height (cms)	161.38±8.65	161.23±8.01	161.30±8.930	161.36±7.76
Weight (kg)	59.18±11.21	61.97±11.11	59.50±10.60	61.00±11.99
Body mass index (kg/m^2)	22.63±3.35	23.74±3.44	22.80±3.28	23.30±3.58

[Table/Fig-3]: Descriptive data of the mean and standard deviation of height, weight, Body mass index and age in population.

[Table/Fig-4] exhibits descriptive data of the mean, standard deviation, t-value and p-value of scapular position in population using smartphone at varying time frame (<4 years, 4-6 years, >6-8 years and >8 years). There was no statistical significant difference found at varying period of time among scapular position in the study population [Table/Fig-4].

There was no statistical significant difference found at varying period of time in pulmonary function testing among population using smartphone [Table/Fig-5]. Parameters (p-value) do not show any statistical significance difference between the smartphone users less than 4 years, 4-6 years, >6-8 years, more than 8 years.

that there was slight significant in p-value seen in FVC (L) with the p-value of 0.058 in respiratory reading among college students on the basis of addiction and non addiction data and other values are non significant (p-value >0.05). Results were not statistically significant enough to display changes in FEF 25-75% (L/s) in respiratory reading among college students with respect to years (since when students were using smartphone). And no significance found in the scapular reading of these subjects. This study showed no significant change in the scapular position or the respiratory function with the usage of the smartphone among college students in relation to time of smartphone usage (hour per day). Present research exhibits that the all the subjects are college student and young population between the age of 18-35 year. Also some of the students who participated are in sports science course, so they have chances of having musculoskeletal changes which is rare in them. So, it can be stated that the data showing non significant results may be due the above reason.

The previous studies done by Koseki T et al., revealed that many undergraduate students were addicted to smartphones but they have not observed statistically significant difference in the addiction level and in scapular dyskinesis between male and female participants. However, results exhibits there was a significant difference in craniovertebral angle among male and female population which is typical characteristic of forward head posture and further leads to altered position of scapula. Hence, results suggest excessive usage of smartphones produces alterations in spinal curvature and respiratory functions [11].

Alonazi A revealed that there were no significant differences in the mean age (years), height (m), weight (kg), BMI (kg/m^2), and number of hours of smartphone use per day between the addicted and non addicted boys and girls (p-value >0.05) [7].

Findings by Kang KW et al., states that there were no differences between both groups in gender, age, height, or weight. And they include 15 subjects in each group, but 4 participants were excluded due to deterioration of their conditions (control group, 3; smartphone group, 1). There were statistically significant differences in FVC and FEV1 between the control group and smartphone group (p-value <0.05) which is possible due to continuous looking on smartphone screen in forward head posture which is further related with rounded

Scapula position	Less than 4 years Left (Mean±SD)	Right (Mean±SD)	p-value	4-6 years Left (Mean±SD)	Right (Mean±SD)	p-value	>6-8 years Left (Mean±SD)	Right (Mean±SD)	p-value	More than 8 years Left (Mean±SD)	Right (Mean±SD)	p-value
At rest	9.20±1.62	9.51±1.79	0.303	9.49±1.32	9.63±1.53	0.696	9.09±1.28	9.28±1.36	0.438	9.57±1.77	9.88±2.01	0.434
45° abduction	9.50±1.78	9.58±1.64	0.784	9.68±1.58	9.85±1.79	0.689	9.39±1.54	9.35±1.31	0.872	9.78±1.90	10.09±2.02	0.465
90° abduction	9.86±1.81	9.94±1.52	0.794	9.75±1.86	10.03±1.71	0.512	9.65±1.67	9.75±1.41	0.729	10.04±1.99	10.25±1.76	0.604

[Table/Fig-4]: Descriptive data of the mean and standard deviation and p-value of Scapular position in population using smartphone.

Variable	Less than 4 years (Mean±SD) (A)	4-6 years (Mean±SD) (B)	>6-8 hours (Mean±SD) (C)	More than 8 years (Mean±SD) (D)	p-values A and B	A and C	A and D	B and C	B and D	C and D
FEV1 (L)	2.84±0.66	2.87±0.71	2.85±0.64	2.86±0.72	0.814	0.933	0.874	0.871	0.939	0.969
FVC (L)	3.21±0.86	3.01±0.94	3.20±0.85	3.07±0.93	0.299	0.951	0.391	0.812	0.273	0.470
FEV1/FVC%	81.13±10.0	80.53±9.86	80.85±9.53	81.01±10.47	0.775	0.741	0.875	0.856	0.796	0.936
PERF(L/s)	6.03±1.38	5.88±1.46	6.09±1.31	5.84±1.51	0.613	0.807	0.473	0.563	0.652	0.382
FEF: 25-75% (L/s)	3.69±0.92	3.35±0.92	3.66±0.96	3.46±0.88	0.083	0.394	0.865	0.652	0.456	0.267

[Table/Fig-5]: Descriptive data of the mean and standard deviation and p-value of Pulmonary function testing in population using smartphone.

DISCUSSION

The present research was conducted to study the association between the smartphone usage time with the scapular position and respiratory functions among college students. A total of 110 college students were recruited in the research as per study criteria. In present study, authors have compared the static scapula position and respiratory function with respect to smartphone usage time (hours per day). After observations from present study, it can be said shoulder and affects the expansion of thorax during respiratory movements and results in altered respiratory function [15].

However, there are other studies contrary to the results of current study. Lee NK et al., conducted a study in 2017 suggested that there is statistically significant differences were noted in the craniovertebral angle, FVC, Forced Expiratory Volume in 1 second (FEV1), FEV1/FVC ratio, peak expiratory flow, maximal inspiratory pressure, and maximal expiratory pressure of the two groups (p-value <0.05) [16].

Limitation(s)

In the present study, certain confounding factors like size of smartphone, weight of smartphone, eye sight as in usage of spectacles etc., were not considered.

CONCLUSION(S)

Present study does not exhibit significant changes in respiratory functions among smartphone users both in addicted and non addicted population. Smartphone usage time also does not exhibit changes on scapula position among college students. In future, research may be performed on larger scale among students from different sections such as graduate, postgraduate, and postdoctorate.

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PARTICULARS OF CONTRIBUTORS:
1. Student, School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, Delhi, India.
2. Assistant Professor, School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, Delhi, India.
3. Professor, School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, Delhi, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Jyoti Kataria,
Assistant Professor, School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, Delhi, India.
E-mail: dahiya.jyoti25@gmail.com

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