EVALUATION OF EFFECT OF SMARTPHONE OVERUSE ON CERVICOFACIAL MUSCLES AND CERVICAL SPINE

Dissertation submitted to
Maharashtra University of Health Sciences, Nashik
in the partial fulfillment of regulations
for the award of the degree of

MDS

IN

DEPARTMENT OF ORAL MEDICINE & RADIOLOGY

BRANCH IX

2021

CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF FIGURES

LIST OF COLOUR PLATES

ABBREVATIONS

TMD	Temporomandibular joints
SAS-SV	Smartphone Addiction Scale-Short Version
NSL	Nasion- Sella Line
SAS	Smartphone addiction scale
SAPS	Smartphone Addiction Proneness Scale
KS-scale	Korean self-reporting internet addiction scale
ROC	Receiver operating characteristics analysis
AUC	Area under a curve
ROM	Range of motion
CVA	Craniovertebral Angle
FHP	Forward Head Posture
CROM	Cervical range of motion device
NMQ	Nordic musculoskeletal questionnaire
WRULDs	Work-related upper limb disorders
MSD	Musculoskeletal Disorder
NSP	Neck/shoulder pain
LBP	Lower back pain
PC	Personal Computer
CES-D	Center for Epidemiological Studies Depression Scale
CES	Cervical erector spinae
UT	Upper trapezius
PPT	Pain -pressure threshold
NDI	Neck disability index
EPL	Extensor pollicis longus

AP	Abductor pollicis
EMG	Electromyography
SCM	Sternocleidomastoid
NDI	Neck Disability Index
DASH	Disability of Arm, Shoulder and Hand
VAS	Visual Analog Scale
sEMG	Surface Electromyography
ECR	Extensor carpi radialis
CHDQ	Cornell Hand Discomfort Questionnaire
APB	Abductor pollicis brevis
APL	Abductor pollicis longus
BDI	Beck Depression Inventory
FRR	Flexion-relaxation ratio
MNP	Mild neck pain
UC	Upper cervical
LC	Lower cervical
ECR	Extensor carpi radialis
FDS	Flexor digitorum superficialis
OSI	Overall Stability Index
APSI	Anterior-Posterior Stability Index
MLSI	Medial-lateral stability index
RULA	Rapid Upper Limb Assessment
UEFI	Upper Extremity Functional Index
CBCT	Cone Beam Computed Tomography
CT	Computed Tomography

INTRODUCTION

Connectivity plays an integral part in humans life. It has revolutionalized from in person to telecommunication method. Initially, simple electronic devices has been evolved for the purpose of communication that create connections worldwide like telegraph, radio, television, newspaper, magazines, fax, email, landline phone and mobile phone. Multiple revolutionary changes has been made in the field of telecommunication like most of the functions were carried out just by a single touch, making it trouble free and time conservator for the human lives which lead to the invention of smartphone in the year of 1992 by IBM company. After which, the first generation of smartphone has been introduced by the Blackberry Company, later many companies came forward in the manufacturing business of smartphone like

Apple, Samsung, Nokia by which the usage of smartphones has been increased exponentially.[1]

A smartphone is a mobile phone that typically has a touchscreen interface, internet access, an operating system capable of running various downloaded apps and performs many functions like a computer. The technology of smartphone has been used for a variety of purposes more than just making a phone calls or sending a text messages. It has also been used for communicating with peers via WhatsApp, Instagram, SnapChat, Facebook, etc. There are thousands of smartphone apps including games, personal-use, and business-use programs that are used for a wide range of purposes with no bounds on time or place, which makes an individual persistent to it.[2]

In today's modern society, life without a smartphone is simply out of imagination. It might be because of their daily work pattern, as the world of work is increasingly focused on greater flexibility, collaboration and connectivity. So, the flexible, independent use of mobile devices is believed to be an essential element in the new world of work. Also because of increase demand of time , many people prefer to do work on the smartphones. Most of the students use their smartphones to read e-books and also to get easy access of the course materials through the different mobile apps. Regarding business purpose, the advanced and powerful features of the smartphones allows the effortless sharing of the important files which allows the business deals and transactions to get done smoothly outside the office. Also, it has been considered as one of the medium to get away from boredom because they are a window into many worlds other than the one right in front of you.

So, although initially , the use of a smartphone may start as a mode of fun, entertainment purpose or for a daily work determination, but gradually it becomes a manditory equipment for the survival and leads to the psychological and behavioural dependance of an individual on it, which drive them towards the addiction.

Smartphone addiction is defined as an excessive, uncontrollable and damaging use with neurotic dependency on its related services, subsequently leading to a state of being habitual to it.[3] It's addiction can includes use of mobile phones in socially or physically inappropriate situations , spending more time and money on it , used to feel anxious, irritable and incomplete when do not check it , having frequent "check habit" to the phones or the fear of missing out something when not having it**.**

According to Elliot Berkman, "Habits are a product of reinforcement learning, and people tend to develop habits of completing behaviors that have rewarded them in the past.For many people, past experience of mobile phone usage has been enjoyable ,which drive them to feel excited and positive. [4]

Dependance on the smartphone varies in different ages. Young adults believed to get more influenced by it . The reason behind that could be, they are more likely to act impulsively and might defend the benefits of an action while ignoring its consequences. Their brain picks up any patterns (object,person,situation etc.) faster as compared to an adult brain, especially when there's a positive reward associated with it. Also, they used smartphones for connecting them socially , reputation building and for online self-presentation.

In some ways , smartphones has changed people's lives for the better, but it's overuse has definitely some drawbacks, too. When an individual is habitual to hold it for a prolonged duration while doing a routine chores day after day , it results in a distribution of tension on the muscles which are associated with them. Regarding smartphone, it has been postulated that, its overuse could bring out the contraction of the cervical and facial muscles , when its use occur in a static position with an unsupported arm for a longer time. [5]

Besides communication , variety of purposes are being served by this smartphone which brings out involuntary movements like forward flexion of the head and neck . Secondly, the communication purpose through smartphone has been served by elevation and retraction of mandible. All this activities leads to the contraction of the muscles which supports the body to execute the respective functions. Most common cervicofacial muscles which are believed to get affected due to overuse of smartphone includes upper trapezius, sternocleidomastoid , splenius capitus ,cervical spinae erector, temporalis and the masseter.

Smartphone addiction is also believed to cause significant alterations in the upper cervical posture due to increased stress on the cervical spine due to flexed forward head position while its continous and prolonged use, which may develop the skeletal changes in the cervical spine.[3]These skeletal changes can be assessed using different angles like cervical lordosis angle (CVT/EVT) which represents cervical spine alignment. Craniocervical angles like (NSL/OPT) and (NSL/CVT) which represents head posture relative to the cervical column line.[3]

Suspecting the effects on cervical spine in the smartphone overusers , many researchers has assessed it using different methods like photometric analysis and radiographic methods.[6] Among various methods , the most reliable ,cost effective

,readily available method for assessment of cervical spine is believed to be radiographic analysis. Among which , Lateral cephalogram radiograph provides precise sight of skeletal structures of cervical spine without overlapping of soft tissue shadows and also provide less exposure (3-6 microSv) as compared to the recent diagnostic modalities like CT and CBCT.

The increased use of smartphones has created a great concern among the scientific community due to the speculations that smartphone addiction may increase a number of health risks. Because smartphone technology has been around for more than one decade, scientists still not yet fully understand the exact musculoskeletal effect due to smartphone addiction in the craniocervical area .There are evidences that, musculoskeletal system gets adversely affected due to continuous and prolonged use of computers. Therefore, there is a need for the research to evaluate whether smartphone overusage is a risk factor that could induce musculoskeletal system disorder and thereby affect cervical spine.Thus, the present study was planned to evaluate the changes in cervicofacial muscles and cervical spine posture using digital lateral cephalogram in smartphone addicted individual.

AIMS AND OBJECTIVES

AIM

To evaluate the effect of smartphone overuse on cervicofacial muscles and cervical spine.

PRIMARY OBJECTIVES

1. To evaluate the effect of overuse of smartphone on **cervicofacial muscles**.
2. To evaluate the effect of overuse of smartphone on **cervical spine** using digital lateral cephalogram.

REVIEW OF LITERATURE

In modern society, one of the commonest necessity for most of the people is smartphone. It is used for both communication and entertainment purposes including messaging, musics , playing games and for internet access. It not only functions as mobile phone but also as a computer,mp3 or video player.The various application of smartphones are being developed and drastically improving day by day to suit our modern lifestyle (Figure 1) .And truly , it has changed our life style beyond our imagination.[7] Due to all this ,peoples are extremely interested in acquiring a smartphone in this modern society .[8] But , the overuse of smartphone has also developed a major psychosocial and physiological problems of its addiction which fall under the category of behavioural addiction.[9]

Figure 1-Image of Smartphone Showing Various Applications.

EVALUATION OF SMARTPHONE ADDICTION USING SMARTPHONE ADDICTION SCALE SHORT VERSION (SAS-SV) QUESTIONNAIRE

Assessment of smartphone addiction level has been done using various scales like Smartphone addiction scale (SAS) , Smartphone Addiction Proneness Scale (SAPS) and Korean self-reporting internet addiction scale (KS-scale). But, their use has been restricted in recent years because of several drawbacks associated with them including large number of questions and no gender specifications.[8]

To overcome with this disadvantages , a new validated scale called smartphone addiction scale-short version (SAS-SV) invented which was originally constructed in South Korea and published in English by Kwon, Kim et al. [8] This scale was also used widely in the literatures by Akodu AK et al (2018) [10], Alonazi A et al(2019) [11],Alsalameh AM et al (2019) [12],Karkusha RN (2019)[13].

Akodu AK , Akinbo SR, Young QO (2018)[10] assessed the correlation between smartphone addiction level, craniovertebral angle and scapular dyskinesis in physiotherapy undergraduates. A total of 77 final-year students with 33 females and 44 males were recruited in the study. First, the participants were requested to fill a questionnaire form of Smartphone Addiction Scale-Short Version (SAS-SV) to identify the excessive users who has score >30 and non-excessive users with score<30 . The photographic method was used to assess craniovertebral angle and scapular dyskinesis. Results revealed significant relationship between smartphone addiction, craniovertebral angle and scapular dyskinesis with p value = 0.007. Reduced craniovertebral angle and increased scapular dyskinesis was found in excessive smartphone users. So was the conclusion made that smartphone addiction has an impact on the neck and shoulder posture of undergraduates, which may result in musculoskeletal disorders in future. So, recommended to give emphasis on assessment of smartphone addiction level in all patients with neck and shoulder pain.

Alonazi A , Daher N, Alismail A, Nelson R, Almutairi W, Bains G (2019)[11] examined the effects of smartphones addiction on cervical posture and compared the cervical range of motion (ROM) between addicted and non-addicted boys and girls. A total of 50 asymptomatic subjects within the age range of 8-13 years old were recruited in the study. Smartphone addiction level was measured using Smartphone Addiction Scale-Short Version(SAS-SV) and on the basis of responses, subjects were assigned into 2 groups. Addicted group constituted 32 participants with score>32 . While non-addicted group included 18 participants with score ≤ to 32 . Lateral view photography was used to measure craniovertebral angle (CVA) and forward head posture (FHP) was measured using Image J 64 software . A CVA of less than 50º represented as FHP. Cervical range of motion device (CROM) device was used to measure cervical ROM in each direction. Results revealed that, addicted participants had forward head posture(FHP) more than four times than those who were non-addicted. Results regarding cervical angle analysis showed significant reduction in addicted compared to non-addicted ones. Also addicted participants with FHP showed significantly more limited cervical ROM in most neck movements compared to participants without FHP. So, was the conclusion made that chances of developing faulty habitual posture due to constant downward neck flexion is more in smartphone addicted individuals, which may place them at high risk of spine abnormalities.

Alsalameh AM, Harisi MJ, Alduayji MA, Almutham AA, Mahmood FM (2019)[12] determined the prevalence of overuse of smartphones among medical students and also investigated the association between smartphone addiction and musculoskeletal pain. The level of smartphone addiction was measured by Smartphone Addiction Scale Short Version (SAS-SV) with cut-off value of 31 for boys and 33 for girls. And musculoskeletal pain was assessed using Nordic musculoskeletal questionnaire (NMQ). Results revealed high prevalence (60.3%) of smartphone addiction among medical students. Musculoskeletal pain related to smartphone addiction was most frequent in the neck region(60.8%), followed by lower back (46.8%) and shoulder (40.0%). Also there was a significant relationship between musculoskeletal pain and smartphone addiction at certain body regions including neck (P=0.041), wrist/hand(P=0.026) and knees(P=0.034). Whereas, there was no statistically significant association found between shoulder,lower back ,upper back,hip,thigh, ankles feet pain and smartphone addiction. Also there was statistically significant association present between academic year level and the level of smartphone addiction suggestive of junior students predicted to be more addicted to smartphone compared to senior students with P value=0.020. And the conclusion made was medical students with more than half of their number found to be addicted to smartphone with musculoskeletal symptoms commonly at neck,lower back and shoulder region. And recommended to limit the overuse of smartphone among medical students and also emphasized the awareness regarding the consequences associated with it.

Karkusha RN, Mosaad DM , Abdel Kader BS (2019) [13] investigated the effect of smartphone addiction on cervical range of motion and neck function among undergraduate students of physiotherapy. A total of 100 students within the age range of 19-24 years old were recruited in the study. Students were assigned into two groups on the basis of grades of addiction after filling questionnaires of short version of smartphone addiction (SAS- SV) 6 point likert scale . Group A, comprised of 62 non–addicted smartphone users and Group B, consisted of 38 addicted smartphone users. Cervical range of motion (ROM) was assessed by CROM. Cervical Flexion, extension, right lateral bending, left lateral bending , right and left rotation were measured. Neck function was assessed by Copenhagen neck functional disability index scale with scores ranged from 0 to 30. Study results regarding cervical range of motion showed statistical significant differences between both group in all direction (flexion, left lateral flexion, right lateral flexion, left rotation and right rotation)

except extension with lower degree of flexion angles in Group B. Addicted group showed significantly higher scoring of Copenhagen neck functional disability index. They concluded that smartphone addiction has deleterious effects on cervical range of motion and neck function . So, it is recommended that students should make an effort to reduce the amount of time spent using a smartphone to prevent long term neck disability and not to use smartphone in addicted manner .

GENDER DISTRIBUTION IN SMARTPHONE ADDICTION

Tavakolizadeh J, Atarodi A , Ahmadpour S, Pourgheisar A (2014) [14] investigated the prevalence of excessive mobile phone use and its relationship with mental health status and demographic factors on the students. A total of 700 students in the university were asked to fill mobile phone addiction scale (MPAI). Results revealed ,36.7% of prevalence rate regarding excessive mobile phone use in the students. Prevalence of excessive mobile phone use and mental health status showed significant difference ($P > 0.05$). Regarding , relation with social dysfunction ,sex, age, marital status, settlement, academic achievement and excessive mobile phone use , no significant relation was found ($p<0.05$). Out of total 700 students , 390 (56%) of the subjects were female and 310 (44%) were male , but no significant relation was found between the excessive mobile phone use and gender ($P >0.05$). Whereas, significant relation found between education degree in MSc, doctoral degree students and the excessive mobile phone ($P > 0.05$). Conclusion made that, high use of mobile phone can favor significant mental health problems, so its excessive use should be avoided.

Demirci K, Akgonul M, Akpinar A (2015)[15] evaluated the relationship between smartphone use severity and sleep quality, depression, and anxiety in university students. A total of 319 university students (203 females and 116 males) were included in the study with the mean age of 20.5 ± 2.45.On the basis of smartphone addiction scale, three groups were made ,a smartphone non-user group (n = 71, 22.3%), a low smartphone user group (n = 121, 37.9%), and a high smartphone user group (n = 127, 39.8%). Sleep quality, depression, and anxiety were evaluated using the Pittsburgh Sleep Quality Index, Beck Depression Inventory, Beck Anxiety Inventory. Results revealed that the females are more addicted to smartphones than males with significantly high smartphone addiction scale scores in females. While, high smartphone user group showed high depression, anxiety, and daytime dysfunction scores than the low smartphone user group. Also, smartphone addiction scale score showed positive correlation with the depression levels, anxiety levels, and some sleep quality scores. They concluded that, smartphone overuse may lead to depression , anxiety which further can lead to sleep related problems. And recommended a careful monitoring for smartphone addiction in the University students with high depression and anxiety scores.

Aljomaa SS , Qudah MF , Albursan IS , Bakhiet SF , Abduljabbar AS (2016)[16] investigated smartphone addiction on the basis of gender, social status, educational level, monthly income and hours of daily use. A total of 416 students including both male and female were asked to fill questionnaire which consisted of five factors including overuse of smartphone, the psychological-social dimension, the health dimension, preoccupation with smartphones, and the technological dimension. Results revealed that 48% of total participants were smartphone addicted. On the basis of five dimensions, smartphone addiction order were as follow: overuse of smartphone, the technological dimension, the psychological-social dimension, preoccupation with smartphones, and the health dimension. Significant differences in the level of addiction were found in favour of male with the deviation towards technological dimension. Regarding social and educational status, addiction level was high in the unmarried and bachelor groups respectively. Smartphone addiction in terms of hours of daily usage showed significant differences, with high addiction status in participants using the smartphone for more than 4 h a day. Also, significant differences were found on the health dimension in favor of participants with lower monthly income. And they recommended the need of interventions among students to take out them from smartphone addiction.

Bisen S and Deshpande Y (2016)[17] evaluated the impact on behavior of engineering students in relation with Smartphone User Applications (Apps). A well structured self design questionnaire was distributed among 100 engineering students (with 50 males and 50 females) with age ranged from 18-22 years. The questionnaire measured the amount, duration and pattern of usage of various Smartphone apps specifically health apps, entertainment apps, shopping apps, communication apps, and education apps using different 30 items . Results revealed significant difference in the level of smartphone addiction across the gender with overall trend of male predominance than females. A total 84% of participants have high level of smartphone addiction in which 45 (95%) of candidates were males and 39(78%) were females . Results regarding smartphone application showed that,females used more education related apps , whereas, high propensity to use smartphone apps regarding health, communication, shopping by males which made them more prone for smartphone addiction. So, the conclusion was made , that, smartphone apps utilization and dependency are more in males than females.

Chen B , Liu F , Ding S , Ying X , Wang L, Wen Y (2017)[18] investigated the prevalence of smartphone addiction and the associated factors in male and female undergraduates. A total of 1441 medical undergraduate students were asked to fill the smartphone addiction scale short version (SAS-SV) to assess the level of addiction among them. Results revealed that total 29.8% of participants were prevalent for smartphone addiction .The prevalance is 30.3% in males and 29.3% in females.Significant factors for male addiction were use of game apps, anxiety, and poor sleep quality. Whereas, use of multimedia applications, social networking services, depression, anxiety, and poor sleep quality were found to be significant in female undergraduates. So, was the conclusion made, that, smartphone addiction was common in both males and females , but with different associated factors. And they recommended the need of interventions among undergraduate students to take out them from smartphone addiction.

EFFECTS OF OVERUSE OF COMPUTER ON MUSCULOSKELETAL SYSTEM

The exponential rise in the use of computers and electronic administration systems leads to a marked growth in the working hours on computer among academics and administrative staff . Computing software and the internet are widely used for academic core activities of teaching and research field . As well as sitting for longer duration on computer by the administrative staff leads to the deleterious health effects and recognised as an occupational risk factor for musculoskeletal disorders.[22]

Blatter BM and Bongers PM (2002)[19] examined the association between duration of computer and mouse use with work-related upper limb disorders (WRULDs) . Also investigated their association differences according to gender. A total of 5400 office employees had filled out a questionnaire form which was based on job characteristics, job content, physical workload, psychosocial workload and musculoskeletal symptoms. Long-lasting pain or discomfort in neck, shoulder, arm, elbow or wrist/hand during the past 12 months which are not related to any trauma were considered as WRULDs. Results stated that computer work for >6 hours/day has been associated with WRULDs in all body regions. And moderate symptoms were associated with computer work between 4 and 6 h/day . Also more WRULDs found among the subjects with frequent computer use but without mouse as compared to subjects with frequent computer use but with a mouse oftenly. Regarding gender distribution , result showed moderate associations of symptoms in men for computer use more than 6 h/day. And women's showed strongly increased risks of symptoms for a computer use more than 6 h/ day. And they concluded that musculoskeletal disorder get positively influenced by the duration of computer use.

Mooma RK, Sing LP , Moom N (2015)[20] examined the prevalence of musculoskeletal disorder(MSD) among Bank Office employees. A total of 60 computer users bank employess aged above 25 years were asked to filled a self-designed questionnaire based on Nordic musculoskeletal disorder . Out of which ten forms were excluded due to partially filled out. Results showed that prevalance of MSD was highest in the lower back (40.4%), followed by the upper back (39.5 %), neck (38.6 %), hand/wrist (36.8%) and shoulder (15.2 %) and least in the knees (2.2%). Also , in this study , various factors other than computer use were found to be associated with MSD like age, smoking/drinking habits, bad work postures, job insecurity, unhealthy working conditions. They concluded that ,high prevalence of MSDs are associated with the daily working conditions. And recommended to maintain easy , relaxed work conditions and proper work posture to overcome with the future MSDs.

Szetoa GPY, Straker L , Raine S (2002) [21] compared the head, neck and shoulder postures of office workers with and without symptoms across a five trials in a single working day. A total of 16 female subjects within the age range of 22-40 year old, with a minimum of 4 hour of computer hour daily were included in the study . Standardised Nordic Questionnaire was used to revealed any past history of discomfort in neck and upper limb region. Also , individuals were asked regarding history of their computer work through a series of questions. Also, 10-point numerical scale was used for rating the current musculoskeletal discomfort in neck and upper limb region. The subjects with presence of current complain with the score of >2/10 on discomfort scale considered as case group (n=8) . And subjects without any current discomfort with score <2/10 were recruited under control group (n = 8). Results regarding discomfort score showed statistically significant difference between two groups with p value <0.001. Mean discomfort score in case subjects was 4.2 and 0.2 in the control subjects. However, comparison of discomfort within each group among the different trials was found to be non-significant with p=0.271.The results regarding posture, showed increased head tilt and neck flexion postures in the case subjects , compared to the control subjects. Case group subjects also showed more protracted acromions and greater excursions in the head segment compared to subjects in control group. The conclusion made was , more forward head posture is generally associated with symptomatic office workers than asymptomatic workers and stated the need of furthur investigation for the precise relationship between discomfort and posture.

James C , James D, Nie V, Schumacher T, Guest M, Tessier J , **Marley J, Naismith JB , Snodgrass S (2018)** [22] investigated the association of musculoskeletal discomfort and computer use in university staff. A set of online questionnaire consisted of 58 questions were distributed among the staff members . Questions included were about demographic information, workstation configuration and use, ergonomic training undertaken, musculoskeletal discomfort, and work-life balance. Participants were also asked about the duration of musculoskeletal discomfort they experienced . In addition, eleven point numerical continous rating scale was also provided and each of them was asked to rate the severity of discomfort in each body area where zero indicates no pain and 10 indicates worse possible pain. They were also asked about previous visits to a health professional regarding their musculoskeletal discomfort and whether they believed work is the cause for discomfort . Results showed that musculoskeletal discomfort was shown by a high prevalence of staff (80%) during the preceding year , with neck (60%) being the most common followed by shoulder (53%) and lower back discomfort (47%) . Most believed that work is the cause for their discomfort. 16% of staff has attended ergonomic training (16%) . However, professional treatment was taken by high rates of staff (65%) reporting musculoskeletal discomfort in the shoulder region and 35.2% in the wrist/hand. They concluded that , preventive measures for musculoskeletal discomfort should be strategized in universities.

EFFECT OF OVERUSE OF SMARTPHONE ON CERVICOFACIAL MUSCLES

Various psychosocial and physiological symptoms has been occurred in conjunction with overuse of smartphone. [23] Among them, musculoskeletal disorders occur predominantly in the regions like fingers, neck, back and shoulder as they are believed to be mainly involved in the overuse of smartphone.[24]

Smartphone overuse could also bring out contraction of the cervical and facial muscles , when its use occur in a static position with an unsupported arm. As smartphones have small monitors that are typically held downward near the laps, users have to bend their heads to see the screens while using smartphone for a longer duration, which furthur increases neck extensor muscles activity, decreases working capacity and ultimately affects the musculoskeletal system. So, it has been postulated that, continuous static pressure on specific sites while using smartphone for longer duration could be the reason for muscle fatigueness and cervical pain. [25]

Also, many studies has suggested that, misalignment of upper cervical posture could also be responsible for musculoskeletal disorders due to changed muscle tone of the system. But , the exact musculoskeletal effect in the craniocervical area due to overuse of smartphone still remains unclear.[3]

The most common cervicofacial muscles which are believed to get affected due to smartphone addiction are upper trapezius, sternocleidomastoid , splenius capitus ,cervical spinae erector, temporalis and the masseter.

A) Upper Trapezius muscle-The trapezius is a large, flat, triangular muscle that forms a diamond shape with its contralateral counterpart. The muscle extends over the posterior aspect of the neck and the superior part of the thorax. The upper fibers of trapezius, originates from the medial third of the superior nuchal line and the external occipital protuberance of the occipital bone. These fibers pass downwards to insert onto the posterior border of the lateral third of the clavicle (Figure 2). Action of this muscle is to extent the neckneck.[26]

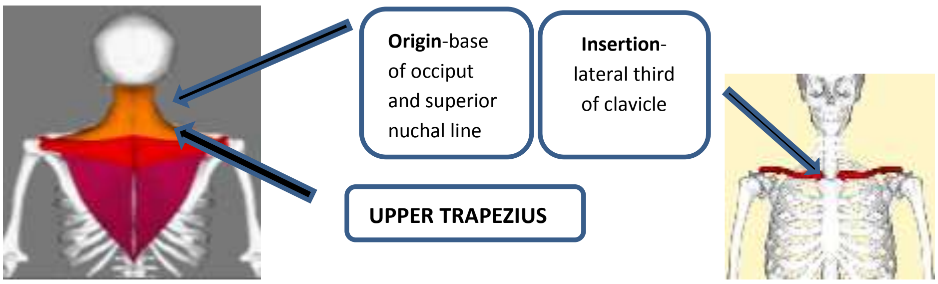


Figure 2: Origin and Insertion of Upper Trapezius Muscle

B) Sternocleidomastoid muscle-The sternocleidomastoid is a large muscle of the neck and it has clavicular and sternal head which originates from the medial third of the clavicle and the manubrium of sternum respectively. The heads come together and ascend diagonally to insert onto the mastoid process of the temporal bone (Figure 3). Action of this muscle is to rotate the neck to the contralateral sides.[26]

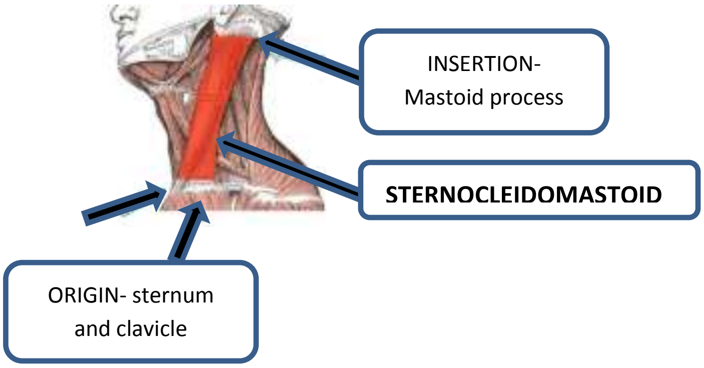


Figure 3-Origin and Insertion of Sternocleidomastoid Muscle

C) Splenius Capitus

The superficial muscle of the posterior neck is the splenius capitus. These muscle belong to the superficial layer of the deep (intrinsic) back muscles.- The splenius capitis originates from the spinous processes of vertebrae C7-T3 and the nuchal ligament, and inserts just below the lateral superior nuchal line of the occipital bone, and the mastoid process of temporal bone (Figure 4). Action of this muscle is to extent the head and neck as well as lateral flexion and rotation of head.[26]

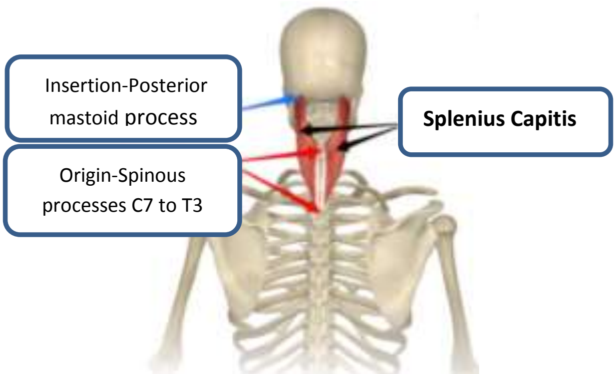


Figure 4-Origin and Insertion of Splenius Capitus Muscle

D) Cervical Spinae Erector-

The erector spinae muscle extends the vertebreal column. It is formed of 3 muscles and its fibers run more or less vertically throughout the lumbar, thoracic and cervical regions.In cervical region it is covered by nuchal ligament. It originates from the spinous process of C7 and ligamentum nuchae and inserts in to the spinous process of C2 and C3-C4 (Figure 5). Action of this muscle is flexion of head.[26]

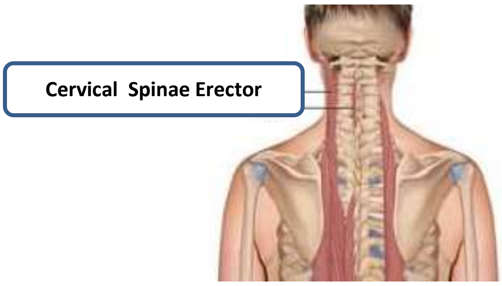


Figure 5: Origin and Insertion of Cervical Spinae Erector Muscle

E) Masseter muscle

It is a strong, quadrangular muscle that covers the lateral aspect of the ramus of the mandible.The Superficial layer of the muscle arises from the maxillary process of the zygomatic bone and the anterior two-thirds of the zygomatic arch. From this origin, these muscle fibers run inferiorly and posteriorly to insert to the lateral surface of the angle and lower half of the ramus of the mandible (Figure 6).Action of this muscle is elevation the mandible.

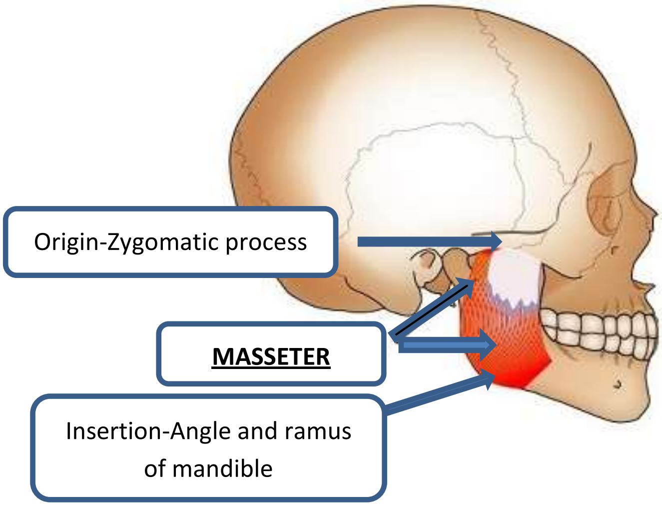


Figure 6: Origin and Insertion of Masseter Muscle

F) Temporalis Muscle- The temporalis muscle is a large, flat muscle that arises from the entirety of the temporal fossa below the temporal line. Its muscle fibers converge anteriorly to form a tendon which runs deep to the zygomatic arch and inserts on the apex and medial surface of the coronoid process, and the anterior border of the ramus of mandible (Figure 7). Action of this muscle is to elevate and retract the mandible as well as helps in side to side movements of mandible.

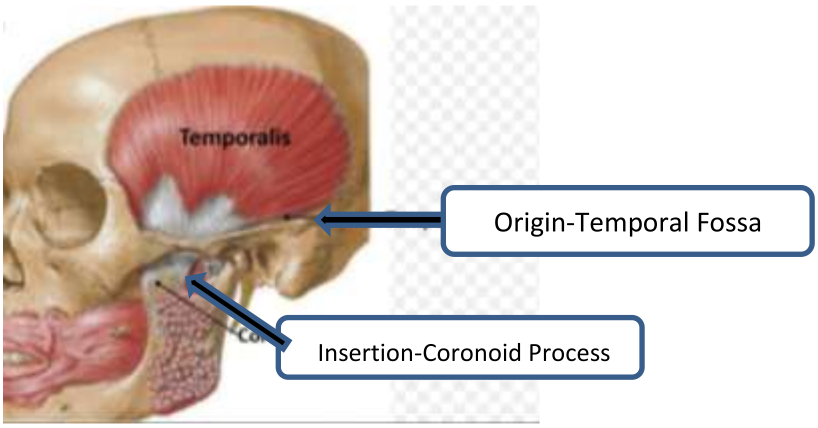


Figure 7: Origin and Insertion of Temporalis Muscle

Berolo S , Wells RP, Amick BC (2011)[27] investigated the distribution of musculoskeletal symptoms of the upper extremity, upper back and neck and assessed the relationship between device used and symptoms. A total 140 students, staff, and faculty members with 80 female and 60 male were participated in the study. All participants were asked to fill internet-based questionnaires to collect self-reported measures of daily mobile hand-held device use and self-reported symptoms of pain in the upper extremity, upper back, and neck. Out of 140 participants ,137 (98%) reported using a mobile device. (84%) participants reported pain in at least one body part. Most common site reported was right hand pain at the base of thumb. Results regarding relationship between device used and symptoms showed significant association between time spent on internet browsing and pain in the base of the right thumb and total time spent using a mobile device and pain in the right shoulder and neck . And concluded that, rising use of mobile devices and its associated musculoskeletal symptoms may raise concern for heavy users in future.

Shan Z ,Deng G, Li J, Zhang Y, Zhao Q (2013)[28] evaluated the neck/shoulder pain (NSP) ,lower back pain (LBP) and its relationship with the possible influencing factor including digital products, physical activity, and psychological status among current high school students in Shanghai .A total of 3,600 students across 30 high schools in Shanghai were administered with a self-assessment questionaires which examined the prevalence of NSP and LBP influence with the level of physical activity , use of mobile phones, personal computers (PC) and tablet computers . Survey also included CES-D (Center for Epidemiological Studies

Depression) scale. Results of the study showed 40.8% participants associated with NSP and 33.1% with LBP. Rates of both NSP and LSB was influenced by the student's grade, use of digital products and the associated mental status . The multivariate logistic regression analysis revealed that the NSP get negatively influenced by PC using habits, tablet use, sitting time after school and academic stress. Whereas , in addition to PCusing habits, mobile phone use, sitting time after school, academic stress and CES-D score were considered as possible influencing factor for LBP. And concluded that high prevalence of NSP and LBP was found among high school students in Shanghai that were closely related to multiple factors.

So YJ and Woo YK (2014)[29] investigated the effects of smartphone use on muscle fatigueness and tenderness in the cervical erector spinae (CES) and the upper trapezius (UT) and on the cervical range of motion among subjects with and without neck muscle pain. Thirty smartphone users with their aged in 20's were recruited in the study and divided into two groups- an experimental group with neck muscle pain and a control group without neck muscle pain. Muscle fatigue and tenderness as well as the subjects cervical range of motion before and after 20-min of smartphone sessions in a sitting position were measured . And found that in between-group comparison , the experimental group showed a significantly greater muscle fatigueness in the CES and the UT as compared to control group with p value <0.05. The assessment of muscle tenderness in experimental group , revealed statistically significant decrease in the pain -pressure threshold (PPT) in all muscles ($p<.05$). Regarding the assessment of the cervical range of motion, experimental group showed statistically significant reduction with p value<0.05 in the cervical flexion-extension and left lateral flexion . However, there was no significant change in the cervical range of motion in the control group after smartphone use($p>0.05$). Finally conclusion made was, the use of a smartphone further increased muscle fatigue and tenderness in the neck , reduced pain pressure threshold and the cervical range of motion when smartphone users have pre-existing neck muscle pain.

Lee JI and Song HS (2014) [30] Analysed the relationship between hours of smartphone use and neck pain in the Gachon University students. A survey was conducted among 2,353 students using a self report questionnaire. Questions regarding the hours of using smartphone, mainly used functions by participants, smartphone and neck discomfort degree were included in the questionnaire. Result showed that 99.07% participants were smartphone users. 66.97% of them answered that they used their smartphone for more than 2 hours and 48.18% of them used smartphone 10-30 mins everytime they use it. Evaluation of degree of neck pain was done by Neck disability index (NDI). And they found that 62.92% of participants showed NDI no diability which scored between 0~4 . 32.85% showed mild disability with NDI score 5~14 score. Moderate disability was showed by 1.19% with score between 15~24. And they found that the average NDI score for female students was significantly higher than for male students with $p<0.05$. And also revealed that total NDI scores for neck pain intensity has a significant strong correlation with both of total time spent daily using smartphones and time duration for one time smartphone usage with $p<0.05$. So, was conclusion made that, longer the time of usage of smartphone, stronger the probability with neck pain.

Lee M, Hong Y, Lee S , Won J , Yang J , Park S (2015)[31] determined whether muscle activity and pressure-induced pain in the upper extremities are affected by smartphone overuse, and compared the effects of phone handling with one hand and withboth hands. The asymptomatic women of 20-22 years of age group were included in the study. Subjects were asked to type the Korean anthem for 3 min, one-handed as well as with both hands. Task was repeated for three times by each subject ,with a 5-min rest period between tasks to minimize fatigue. Muscle activity of the upper trapezius (UT), extensor pollicis longus (EPL), and abductor pollicis (AP) was recorded by the electromyography (EMG) and dolorimeter was used to measure the pressure-induced pain threshold in the upper trapezius (UT). They observed that during single-handed smartphone use, muscle activity of the UT,AP and EPL were significantly higher than in two-handed smartphone use ($p<0.05$). Also showed significant increased in pressure induced pain in the upper trapezius, especially with single-handed smartphone use with $p<0.01$ followed by smartphone use by both hands ($p<0.05$) . And finally concluded that,pressure induced pain in UT and activity of upper extremity muscles get worsened more in one handed smartphone users.

Lee KJ , Han HY, Cheon SH, Park SH, Yong MS (2015)[32] investigated whether forward head posture (FHP) affects muscle activity or not. A total of twenty subjects were participated in the study and divided into two groups according to craniovertebral angle: a control group (n=10) and a forward head posture FHP group (n=10). Craniovertebral angle of each subject was measured through lateral view photography which is defined as the angle between the horizontal line passing through C7 and the line extending from the tragus of the external auditory meatus to C7. Subjects with an angle less than 53° were put in the FHP group. Electromyography was used to measure muscle activity of the upper fibers of the trapezius, middle fibers of the trapezius, the splenii (splenius capitis and splenius cervicis), and the sternocleidomastoid (SCM) muscle during the neck protraction and retraction. There was significant results regarding muscle activity of the middle trapezius between two groups during neck retraction ($p<0.05$).Also, splenii and SCM muscle showed significant difference between two groups during neck protraction with p value<0.05. However, upper trapezius muscle showed non significant difference between the two groups during neck protraction and retraction. Upper trapezius may not play a major role in neck protraction and retraction in FHP ,this could be the possible reason of non-significant difference between two groups .Finally conclusion made was FHP reduces the muscle activity in neck protraction and retraction activities resulted from changes in muscle length and are associated with a reduced ability to generate force.

Alzarea BK and Patil SR (2015)[33] aimed to assess the health effects of mobile phone usage among university students of Saudi Arabia. A total of 396 students studying in dental college and medical college were participated in the study. Self-administered, pre-tested questionnaire forms were given to the participants which included various mental and physical health symptoms related to mobile phone usage . Study results showed that, most commonly reported complaint was cervical pain which was seen in 71.2% of study respondents, followed by headache (63.3%), irritability shown by (54.5%), (50.7%) showed anxiety, lack of concentration in (47.4%), (36.8%) showed straining of eyes, insomnia in (31.3%), whereas memory problems and depression shown by (19.69%) and (28.5%)respectively. (16.91%) of subjects showed Itching and/or erythema of periauricuar skin. They concluded that significant health related problems could be caused by excessive usage of smartphones, specifically in head and neck region. Intensity of the subjective symptoms was dependent on the intensity of use of mobile phones. Finally they recommended to limit the frequency of duration of talking over mobile phones, holding the device as much as away from the head, to adapt proper body posture while texting and avoiding usage of mobile phones during sleeping hours to minimize the adverse effects caused by it.

Xie Y , Szeto GP, Dai J, Madeleine P (2015)[34] evaluated the differences in muscle activity between young people with and without neck -shoulder pain , while performing texting on a smartphone or computer. A total of 40 young adults (24 females and 16 males) with the mean aged of 23.9 years were recruited for the study. Subjects were then asked to complete three questionnaires which were: (1) a modified version of Standardised Nordic Questionnaire, (2) Neck Disability Index (NDI) , (3) Disability of Arm, Shoulder and Hand (DASH). Based on the response of three questionaires ,case group included subjects with usage of smartphones or computers for more than 3 months in the past year with neck-shoulder pain. Also, subjects with the NDI score of 8/100 or higher and a DASH score of 10.1/100 or higher were allocated in the case group. And all other remaining subjects were allocated into Control Group. Texting was compared with using both hands and using only one hand. Muscle activity was recorded with surface electromyography. Results showed significantly higher muscle activity in the cervical erector spinae and upper trapezius while performing texting and typing tasks in case group as compared to control group.

Results regarding type of texting showed , higher muscle activity in unilateral texting compared with bilateral texting especially in the forearm muscles. Also smartphone texting was associated with higher muscle activity in neck extensor and thumb muscles but lower activity was found in upper and lower trapezius as well as wrist extensors when compared with computer typing. So they ,recommended to develop specific ergonomic guidelines regarding the use of modern electronic devices to reduce the risk of developing musculoskeletal disorders.

Kim SY and Koo SJ (2016) [35] investigated the effect of duration of smartphone use on muscle fatigue and pain caused by forward head posture in adults. A total of 34 patients within the age range of 20 and 30 years old were included in the study and classified them under three groups by duration of smartphone use. Group (1)-11 adults for 10 mins, group(2)-12 adults for 20 mins,group(3)-11 adults for 30 mins. An electromyograms (EMG) was performed twiced initially for one minute and then, when use of smartphone began for an additional minute. VAS was used to assess pain before and after smartphone use. The degree of fatigueness in upper left trapezius muscles in group 2 and left cervical erector spinae and bilateral upper trapezius in group 3 were found to be significantly different($p<0.05$). Also they found that there was a significant difference in fatigueness in the upper left trapezius between groups 1 and 3 ($p<0.05$). The VAS scores also showed significant differences with $p<0.05$ in all groups before and after the experiment. Based on the results,they concluded that, pain and fatigueness worsened with longer duration of smartphone use and also provided data on correct posture and recommended a break of at least 20 minutes while using smartphones.

Choi JH , Jung MH, Yoo KT (2016)[36] analyzed the activity and fatigueness of the muscles around the neck under the three most frequent postures while using a smartphone. A total of 15 college students in their 20s were participated in the study and formed a single group. Examiners asked each of them to adopt three different postures (maximum bending, middle bending and neutral) for atleast five minutes. The average degree of neck-bending during each of the three postures was obtained by measuring and averaging the degrees of the three motion markers for each posture during preliminary tests on five subjects. The average degree of neck-bending for the maximum bending posture was 100°,122° for the middle bending posture, and 131° for the neutral posture. While adopting postures he or she was asked to continuosly type the sentences. Surface electromyography (sEMG) of right splenius capitus, right upper trapezius, left splenius capitus and left upper trapezius was performed to measure muscle activity and fatigueness while the subjects maintained the posture. The study results showed that the muslces measured did not show any statistically significant differences in terms of muscle activity for each posture. But , there was statistically significant difference in the muscle fatigueness for each posture. Significantly higher level of muscle fatigueness was found with maximum bending posture as compared with middle and neutral bending posture($p<0.05$). So , they concluded that while using a smartphone, individuals should bend their neck slightly , rather than bending it too much, or should prefer straight neck position to reduce fatigueness of the cervical muscles.

Kim YL , Yoo JH, Kang SW, Kim TR , Kim NY, Hong SJ (2016)[37] assessed the changes in the muscle activity in persons using a smartphone. A total of 15 right-handed university students aged between 20-27 years were selected for an experiment. Firstly, experiments were carried out in a sitting position with one-handed and both handed operation of smartphone use. The same parameters were applied with smartphone use in a standing position. And subjects were asked to wrote a text message in Korean on the smartphone for 3 minutes with a rest period of 10 seconds between each 3 minute period. Muscle activity of the upper trapezius (UT), extensor carpi radialis (ECR), and abductor pollicis (AP) was recorded by electromyography(EMG). Study results revealed that muscle activity of the AP and ECR were significantly higher during single handed compared to double handed use in both sitting and standing position($p<0.05$). Also the muscle activity of the AP and ECR was significantly higher with double handed use of the smartphone in standing positionas compared to sitting position($p<0.05$). Results regarding muscle activity of upper trapezius (UT) showed that activation of right UT has been more than twice compared to the left UT in a sitting position. While in a standing position , right UT muscle has been activated more than five times compared to the left . And finally concluded that, using smart phones with two hands in sitting position will be helpful to prevent musculoskeletal disorders rather than giving burden to the upper limb with smartphone usage with one hand in a standing position.

Lee S , Choi YH, Kim J (2017)[38] -investigated the effects of the cervical flexion angle on the basis of muscle fatigueness and pain in the cervical erector spinae and upper trapezius muscle during smartphone use. A total of 14 normal adults with the mean age of 22.1 ± 1.6 years were participated in the study. After sitting on a chair with their back against the wall, they were asked to hold a smartphone for 10 minutes with both the hands as well as to wore the cervical range of motion instrument (CROM) on their head to adjust the cervical flexion angle at (0°, 30°, and 50°). Analysis of the muscle fatigueness of upper right trapezius, upper left trapezius, right cervical erector spinae, and left cervical erector spinae was done by electromyography(EMG). Algometer was used to measure pain. The study results showed statistically significant differences with p value<0.05 regarding fatigueness and pain of the upper right trapezius and upper left trapezius at different cervical flexion angle. And statistically lower level of muscle fatigue and pain was found at 50° than at 0° or 30°. There were no statistically significant difference found in the fatigueness and pain of the right and left cervical erector spinae(p>0.05). They concluded that fatigueness and pain of the upper trapezius muscle may get influenced by different cervical flexion angle during smartphone use.

AlAbdulwahab SS, Kachanathu SJ, Almotairi MS (2017)[39] determined the level of smartphone addiction and its relationship with neck function in healthy young adults. A sample of 78 healthy adults were recruited for the study with their mean age of 21.3 ± 1.7 years. Smartphone Addiction Scale (SAS) and Neck Disability Index (NDI) were used to measure self-reported addiction to smartphone use and any abnormal symptoms of neck function respectively. Smartphone Addiction Scale (SAS) consists of six factors and 33 items, with a six-point Likert scale. Higher score indicates greater degree of use of the smartphone and vice versa . The NDI assessed the effects of neck pain and symptoms during a range of functional activities with the involvement of 10-item and 50-point index questionnaires. A higher NDI score determined greater neck disability and vice-versa. Results of the study showed a significant association ($p<0.05$) between smartphone addiction and various degrees of neck disabilities among the subjects. The mean SAS and NDI scores were 119.4 ± 20.7 and 20.98 ± 5.1, respectively. Based on the results ,they concluded that, significant neck disability could be caused by the excessive use of smartphone because of the bad posture associated with their use. And they recommended the individuals, to minimize the amount of time spent using a smartphone, and make an effort to maintain an appropriate posture during its use.

Iqbal MH , Ahmad A, Gillani SA , Hanif K, Iqbal Z (2017) [40] evaluated the association of neck pain with use of smartphone and their usage duration among students of Lahore Universities. A total of 700 university students were recruited in the study and requested them to fill the questionaire form. Questionaire included questions regarding the usage of smartphone, duration of daily usage ,neck pain. And in last participants were requested to rate associated neck pain on VAS scale. Study results regarding phone usage revealed, 679 (97.0%) participants answered yes, 21 (0.3%) answered that they don’t use smartphone. Regarding duration of cell phone usage daily , (12.6%) used for 1-2 hours, 196 (28%) used for 2-3 hours and 416 (59.4%) used for more than 3 hours daily. About associated neck pain, 500 (71.4%) had neck pain and ,200 (28.6%) answered no. And lastly results regarding rating of pain on VAS Scale ,291 (41.6%) had no pain, 343 (49%) answered moderate Pain and 66 (9.4%) answered Worst Pain. According to the results, conclusion made was that there is moderate association of neck pain with daily usage of smartphone.

Shah PP and Sheth MS (2018) [41] assessed self-reported addiction to smartphone use and correlated its use and musculoskeletal disorders (MSDs) in neck and hand in young healthy adults. The total of 100 healthy physiotherapy students in the age group of 20-25 years were included in the study. Participants were asked to filled the proforma including questionnaires regarding Smartphone Addiction Scale (SAS), Neck Disability Index (NDI), and Cornell Hand Discomfort Questionnaire (CHDQ). There was a significant moderate positive correlation between both SAS and NDI ($p<0.001$) and between SAS and CHDQ ($p<0.001$) in the study results. Mean with standard deviation of SAS, NDI and CHDQ was 102.49 ± 22.15, 30 ± 0.10 and 6.12 ± 8.73 respectively. And finally concluded that, smartphone addicted students had musculoskeletal problems in neck and hand(predominantly thumb) which may be for short duration initially but may later lead to long term disability. And recommended the need of public health educational programmes especially among students to aware about the deleterious effects of excessive use of smartphone and the physical risks associated with it.

Punmiya A and Oberoi M (2018)[42] assessed the smartphone addiction grades and its influence on cervical pain in young adults. 100 young asymptomatic adults between the age group of 19-35 years were participated in the study. Participants were divided into low, medium and high grades of addiction on the basis of smartphone addiction scale (SAS). SAS scoring constituted ,low addiction smartphone users with scored of 33 to 66, medium addiction smartphone users with 67 to 132 scoring and high addiction smartphone users with 133 to 198. Depending upon the scores, 20 subjects has been selected in each of the groups. Cervical pain during or immediately after using a smartphone in the past 1 week was reported on the Numerical Rating Scale(0-10) . Regarding cervical pain assessment results showed a significant difference between low and medium smartphone users(p=0.0026) as well as between low versus high smartphone users (p=0.0001)but there was no significant difference in neck pain between medium and high smartphone users(p=0. 0718). The study concluded that , study population with smartphone addiction had direct correlation with the cervical pain .

Namwongsaa S, Puntumetakul R, Neubert MS, Boucaut R (2018)[43] investigated the differences in neck muscle activity in smartphone users with and without neck pain at various neck flexion angle. 44 young adults aged between 18-25 years old were recruited in the study and allocated into two groups .The control group without neck pain and the case group with neck pain who have had experienced pain during smartphone usage for more than 3 months. Participants were asked for texting in a smartphone for 1 minute and 30 seconds with 2 minutes of rest between each 0 , 15 , 30 and 45 degree of neck flexion angles. Surface Electromyography (sEMG) and visual analogue scale (VAS) was used to measure neck muscle activity and pain in the neck at different flexion angles respectively. Results revealed that muscle activity of both cervical erector spinae (CES) and upper trapezius(UT) were acceptably low at neck flexion angle of 0 -15 degree .Whereas muscle activity significantly increased with higher degree neck flexion angle. Also there was significantly higher muscle activity shown by smartphone users with neck pain as that of smartphone users without neck pain. They suggested that neck flexion angles between 0-15 degrees should be adopted during smartphone use to minimize the neck muscle activity as much as possible.

Irshad N, Raza S , Moiz JA , Mujaddadi A , Bhati P (2019)[44] investigated the electromyographic (EMG) activity of upper trapezius (UT), abductor pollicis brevis (APB) and abductor pollicis longus (APL) during smartphone use in three different positions (standing, sitting on the chair and sitting cross legged on the floor) in young male versus female subjects. 26 young males and 26 young female smartphone users were recruited in the study. EMG activity of UT, APB and APL muscles was recorded in three different positions, i.e. standing, sitting on a chair, sitting cross-legged on the floor while performing a smartphone task. Results showed significantly reduced EMG activity of the UT muscle when sitting on a chair as compared to standing($p<0.001$) and sitting cross-legged ($p=0.008$) during smartphone use.Whereas ,there were no significant difference regarding muscle activity between the three postions ($p>0.05$) . Moreover, the activation patterns of these muscles did not show any significant result between male and female subjects . They concluded that , as UT muscle activation significantly varies with the position of smartphone use, thus, the position which causes least strain on muscles, i.e. sitting on the chair should be adopted while using smartphone.

EFFECT OF OVERUSE OF SMARTPHONE ON CERVICAL SPINE

The cervical spine is the most superior portion of the vertebral column , lying between the cranium and the thoracic vertebrae. It normally has a slight curve to it, the degree of which can vary according to the position you are in. But, this curve can be affected through misalignment that is sustained over a long period of time or through any injury. Smartphone addiction has been reported to allow an individual to hold prolonged flexed position of head during its use which leads to significant alterations in the upper cervical posture due to increased stress on the cervical spine, which changes the natural curve and surrounding structure of the cervical angle.[3](Figure 8 a& b).

Figure 8a: Green line represents normal spine alignment.

Figure 8b: Red line represents abnormal deterioration and misalignment over time.

Selvaganapathy K , Rajappan R, Dee TH (2013) [45] analyzed the effect of smartphone addiction among university students on the basis of craniovertebral angle and depression status . Total of 68 subjects were recruited for this study and divided in to normal group and addicted group on the basis of level of smartphone addiction and depression symptoms. Smartphone Addiction Proneness Scale (SAPS) questionnaire was used to evaluate the level of smartphone addiction and depression symptoms were evaluated by self-reported Beck Depression Inventory (BDI) . Craniovertebral angle of all the subjects was measured through lateral view photography to evaluate forward head posture which was defined as the angle between the horizontal line passing through C7 and the line extending from the tragus of the external auditory meatus to C7. In this study, the craniovertebral angle more than 50° were considered as normal and <50° as abnormal . The mean CVA of regular user group was 49.83±5.54 and addicted group was 50.68±3.44. Study results, regarding CVA showed no significant difference($p>0.05$) between regular user and addicted groups. The mean of depression status in regular user group was 13.5±6.67 and addicted group was 18.79±7.55.There was a significant change in the depression status between both groups($p<0.05$). So, was the conclusion made that, head posture couldn't get influenced in smartphone addiction , but it has negative impact on affect the depression status.

Shin H and Kim K (2014)[46] measured the cervical flexion-relaxation ratio (FRR) and intensity of neck pain and identify the differences according to postures adopted while using smartphones. The total of fifteen healthy adults with no neck pain, spinal trauma, or history of cervical surgery were participated in this study. Standardized cervical flexion-extension movement in three phases (flexion, sustained full flexion, extension) was used to record the activity of cervical erector spinae muscle. And visual analog scale (VAS) with score between 0 and 10 was used to record neck pain intensity. Two postures which were identified while using a smartphone were lap and desk posture. The flexion-relaxation ratio (FRR) was calculated by dividing the maximal muscle activation during the extension phase by average activation during the complete flexion phase. The study results revealed no significant differences regarding the assessment of FRR between desk posture and lap posture, but the intensity of the neck pain significantly increased in the lap posture as compared to desk posture with the mean of 1.7 and 5.2 VAS for desk and lap posture, respectively. They concluded that, in chronic neck pain patients , FRR could be a significant criterion of neuromuscular impairment . And recommended that, the use of smartphones for a longer time in lap posture might cause neck pain ,so it should be avoided.

Lee J and Seo K (2014)[47] compared cervical repositioning errors according to smartphone addiction grades . A total of 200 adults in their 20's were recruited for the survey of smartphone addiction . Smartphone addiction grading was done using smartphone addiction scale survey form developed by the Internet Addiction Response Center. A total 30 subjects were chosen to participate in this study based on survey results, and divided into three groups. The subjects (scored below 40) were considered in normal group, (scored between 40 and 43) was moderate addiction group, and (scored over 43) was severe addiction group. Cervical range of motion (C-ROM) meter was used to measure the cervical repositioning errors of flexion, extension, right lateral flexion and left lateral flexion around the neck. Study results regarding cervical repositioning errors of flexion, extension, and right and left lateral flexion showed significant differences between the three groups ($p<0.05$) . In particular, the severe addiction group had the largest cervical vertebrae repositioning error. And finally conclusion made was ,smartphone overuse for a long time could impaired proprioception, as well as impaired ability to recognize the right posture , thereby uplifting musculoskeletal problems.

Park J, Kim J, Kim J, Kim K , Kim N, Choi I , Lee S, Yim J (2015)[48] investigated the effect of smartphone overuse on craniovertebral angle, head position angle, pain threshold of the sternocleidomastoid and upper trapezius muscles, and on depression. The total of 20 healthy students were included in the study. And according to smartphone addiction proneness scale, participants were divided into a heavy smartphone user group (n=10) and a control group (n=10). Pain pressure threshold of the sternocleidomastoid and upper trapezius muscles was evaluated using electronic algometer over potential trigger points on the body, craniovertebral angle and head position angle was evaluated using cervical angle measurement and depression status assessed using the beck depression inventory (BDI). The study results revealed , pain threshold of the sternocleidomastoid and the upper trapezius muscles between the two groups had significant differences($p<0.05$). Regarding the comparison of cervical angle between the two groups, there was a significant difference in the head position angle($p<0.05$) but not in the craniovertebral angle. Also they found a significant difference between the two groups regarding psychological status like depression($p<0.05$). And conclusion made was, significant stress develop on the cervical spine due to heavy smartphone use which changes the cervical curve and pain threshold of the muscles around the neck. Also , negative psychological effects such as depression could also be developed with the overuse of smartphone.

Kim MS (2015)[49] evaluated the changes in the posture of young adults with and without mild neck pain (MNP) while using a smartphone. For this study 27 young adults(12 male and 15 female) who had use a smartphone use for at least 1 year were included in the study. Subjects who had experienced cervical symptoms during smart-phone use within the last year were included in the study. Neck Disability Index(NDI) was used to evaluate neck pain which involved a 10-item questionnaire regarding the effects of neck pain and symptoms during a range of functional activities. Subjects with NDI score >8 were grouped into the MNP group (n=14).Whereas subjects with NDI score <8 were grouped into without MNP group (n=13) . The upper cervical (UC) and lower cervical (LC) angles in the saggital plane were measured using an ultrasound based motion analysis system and all subjects were instructed to maintain a neutral cervical posture during smartphone use for 5 min .Each subject performed three test trials with a 3 min-rest period between trials. Study results showed the degree of both upper cervical and lower cervical flexions in the MNP group were significantly greater ($p<0.05$) than those in the control group without MNP. They concluded that individuals with MNP adopt a posture of greater neck flexion than individuals without MNP while using a smartphone and suggest that young adults with MNP must be aware of their posture and modify their non-neutral cervical alignment while using a smartphone.

Jung SI, Lee NK, Kang KW, Kim K, Do YL (2015)[50] evaluated the changes in posture and respiratory functions depending on the duration of smartphone usage.

A total of 50 subjects with the mean age of 21 ± 2.41 years old were included in the study. The subjects who used smartphones for 4 hours/day comprised of group I (n=25) and subjects who used smartphones for >4 hours/day comprised of group II (n=25).To assess the change in posture, craniovertebral angles (CVA) measurement of all participants were taken and also scapular indices were calculated . To assess changes in respiratory function, forced vital capacity, forced expiratory volume in 1 second, the ratio of forced expiratory volume in 1 second to forced vital capacity, and peak expiratory flow were measured . Study results showed significant differences in the craniovertebral angle, scapular index, and peak expiratory flow between group I and group II (p<0.05). Group II showed lesser degree of craniovertebral angle(53.0 ± 6.3) as compared to group I (54.5 ± 4.2) . Regarding scapular index, group II showed lesser degree value of 65.5 (± 4.5) as compared to group I 67.5 (± 4.2). Peak expiratory flow of group I was 6.2 (± 2.3) L/sec and group II showed 4.3 (± 1.5) L/sec. Depending on the study results conclusion made was , both posture and respiratory function could be negatively influenced by prolonged smartphone usage.

Kietrys DM, Gerg MJ, Dropkin J, Gold JE (2015)[51] determined the effects of input device type, texting style and screen size on upper extremity and trapezius muscle activity and on cervical posture among college students. Inclusion criteria were- students with atleast 18 years old age , experienced with text messaging and right hand dominant . According to the inclusion criteria, 20 students were eligible for the study . Students then asked for texting over a period of 10 s with randomized conditions. Two trials of each condition were taken with the rest period of 30 s between each. Condition were as follows-a) physical keypad device, right hand holding device, right thumb typing (1/1) b) physical keypad device, both hands holding device, both thumbs typing (2/2) c) 3.5” touch screen device, right hand holding device, right thumb typing (1/1) d) 3.5” touch screen device, both hands holding device, both thumbs typing (2/2) e) 3.5” touch screen device: preferred style f) 7” touch screen device: preferred style g) 9.5” touch screen device: preferred style . Surface EMG was used to record the muscle activity of upper trapezius (UT) , extensor carpi radialis (longus and brevis) (ECR), flexor digitorum superficialis (FDS), and abductor pollicis brevis (APB) prior to and during each texting trial. Also the cervical posture of all subjects were measured through lateral view photography at both neutral and flexed position while texting. Results showed greater thumb, finger flexor and wrist extensor muscle activity with the users of a physical keypad than the users of touch screen device of similar dimensions. Also there was greater wrist extensor muscle activity when texted with 1 hand/thumb compared with both hands/thumbs while texting on either device. Morever, increased touch screen size showed significant greater finger flexor, wrist extensor and trapezius muscle activity ($p<0.05$). Results regarding cervical posture measurement ,small mean difference between neutral and flexion condition was found. So, they recommended to aware mobile device designers and ergonomists about the potential link of physical exposures and musculoskeletal disorders associated with the texting styles and mobile device designs in order to prevent the consequences of this behavior.

Guan X , Fan G, Wu X, Zeng Y, Su H , Gu G, Zhou K, Gu X, Zhang H , He S (2015) [52]determined the head and cervical postures when viewing the mobile phone screen by photogrammetry method and compared with those in neutral standing posture. A total of 186 subjects (81 females and 105 males) aged from 17 to 31 years old were recruited in the study and all were instructed to stand neutrally while using mobile phone as in daily life. Head tilt angle, neck tilt angle, forward head shift and gaze angle were used to assessed head and cervical posture using photographic method. Results showed significantly increased head tilt angle (from 74.55 to 95.22) and decreased neck tilt angle (from 54.68 to 38.77) when looking at mobile phone as compared to neutral standing posture with p=0.000. Regarding head posture, result showed significantly increased head shift (from 10.90 to 13.85 cm) when looking at mobile phone(p=0.000). The posture assumed while using mobile phone displayed a more forward head posture compared to neutral standing. Females displayed a less forward head posture than males. However, gaze angle showed no significant differences between two posture. So, was conclusion made that , for evaluating the head and cervical posture during smartphone use ,the photogrammetry is consider as a reliable and quantitative method.

Lee SY, Lee DH, Han SK (2016)[53] investigated the changes in the neck flexion angle according to posture and the duration of smartphone usage. 16 healthy young students in their 20s were recruited for the study. The subjects were asked to wear a cervical range of motion instrument and instructed to use a smartphone in three different posture- standing, sitting on a chair, and sitting on the floor with their arms kept freely and back connected to the wall or to the back of the chair. The neck flexion angle was measured at different duration for each posture such as zero, three, six, and nine minute. Study results revealed that neck flexion was affected by the different posture while using a smartphone . There was significantly larger neck flexion angle in the standing position than that in the sitting on the floor position($p<0.05$) . Also longer duration of smartphone usage showed significantly larger neck flexion angle($p<0.05$). They concluded that , problems including pain caused by neck flexion was affected by both posture while using smartphone as well as the duration of its usage. And suggested that, to reduce the neck flexion angle, smartphone use in a standing position for the short duration of time could be considered as best method to reduce the neck flexion angle.

Guana X, Fan G, Chen Z, Zeng Y, Zhang H, Hu A , Gu G, Wu X, Gu X , He S (2016)[54] identified the gender differences in the cervical postures while using mobile phones in young adults , as well as the correlations between the postures and the digital devices use (computer and mobile phone). A total of 429 subjects aged from 17 to 33 years were requested to fill questionnaires regarding the habits of computer and mobile phone use. After completing questionnaires , subjects were instructed to use a mobile phone as in daily life and head , neck postures were measured using standard photographic analysis procedure. Head flexion angle is the angle between the line joining the tragus and the canthus to the vertical line. Neck flexion angle is the angle between the line joining C7 spinous process to the tragus, and the vertical. Gaze angle is measured as angle between the horizontal and a line running through the canthus and the centre of the mobile phone when the participant looked at it. Results showed significantly larger head flexion ($p=0.018$) and neck flexion angle ($p<0.001$) in males than females, which were associated with the amount of computer use . This study indicated the association of gender with daily digital device use and its impact on cervical posture health. And recommended to undertake furthur research into consideration about neck pain and muscle activity during mobile phone and computer use, to better understand its impact on cervical health.

Alshahrani A, Aly SM, Abdrabo M, Asiri F (2018)[55] evaluated the impact of heavy use of smartphones versus light use on Joint Position Error (JPE), Craniovertebral Angle (CVA), and balance measures. 30 healthy participants aged from 18 to 27 years old were recruited in the study and divided into two groups . Subjects with (phone use<4 h/d) were included in the light-use group, and the subjects with (phone use>4 h/d) in the heavy-use group. Cervical repositioning errors of each subject was assessed using the JPE test using a laser beam and colored target. Forward head posture was measured by craniovertebral angle(CVA) through lateral view photography. Biodex stability system was used to assess dynamic balance. BSS software calculates three separate measurements: Overall Stability Index (OSI), Anterior-Posterior Stability Index (APSI) and medial-lateral stability index (MLSI) with higher scores indicating worse postural control. Study results regarding JPE showed statistically significant difference of both right and left rotation in the heavy-use group compared with that of light-use group. Also, heavy-user group showed significant increase in balance indices. However, CVA measurement showed no significant difference between two groups. Finally , concluded that cervical proprioception and dynamic balance ability could be negatively influenced by the overuse of smartphone.

Saaman MN, Elnegmy EH, Elnahhas AM, Hendawy A (2018)[56] assessed the effect of overuse of smartphones on cervical spine, hand grip strength, median and ulnar nerves conduction velocities of the forearm in adolescent children. 60 normal subjects with ages ranging from 14 to 18 years were included in the study and divided randomly into two groups .Group A represented control group including subjects with smartphones use< 4h/day. Group B represented study group with subjects who used smartphone >4h/day. Conduction velocity of ulnar and median nerves was measured by electromyography. Measurement of forward head angle was done by universal goniometer. Assessment of neck pain was done by Visual Analogue Scale. Hand grip strength of subjects of both the groups was measured by hand dynamometer. Results of the study regarding conduction velocity of ulnar nerve, forward head angle and visual analog scale of pain showed significant differences($p<0.05$) indicating the effect on group B. Results regarding conduction velocity of median nerve and hand grip strength showed no statistically significant differences ($p>0.05$) between two groups. And finally concluded that prolonged use of smartphones in adolescence had negative influence on conduction velocity of ulnar nerve, leading to increased forward head position angle and neck pain, whereas handgrip strength and conduction velocity of median nerve lack its effect.

Samir SM , Elshinnawy AM, Abd Elrazik RK, Battesha HH (2019) [57] evaluated the association between the cervical range of motion (ROM) and cervical posture and duration of smartphone use in sedentary asymptomatic adults. A total of 400 healthy asymptomatic smartphone users with age ranged of 20-25 years old were recruited for the study and divided into 2 groups. Group A included 200 subjects (those using smartphones for <4 h/day) and group B included another 200 subjects (those using smartphones for >4 h/day). Craniovertebral angle (CVA) of all participants was taken using lateral view photography to obtain cervical posture . Electromagnetic tracking device (MTD) was used to measure cervical flexion, extension, rotation (left and right), and side bending (left and right) range of motion (ROM). Results regarding CVA and ROM showed ,significant differences between the two groups ($p < 0.05$) with lesser angle score in group B. Finally, the conclusion made was , longer duration of time spent using a smartphone can induce long term neck disability. Also the ability to maintain the correct posture of the neck may be worsened due to high levels of smartphone addiction.

Alfaitouri S and Altaboli A (2019) [58] investigated the changes in the neck flexion angle while using a smartphone according to posture and duration of usage. Twenty young adults (10 females and 10 males) ranging in age from 19 to 30 years old were recruited in the study . Posture and the duration of usage are the two factors which were used to measure the changes in neck flexion angle. Participants were asked to maintained the posture at three levels: standing, sitting without arms rest and sitting with arms rested on a table. Also asked to used the same smartphone for zero, five, ten, fifteen and twenty minutes. To measure the neck flexion angle at different duration photographic analysis procedures were carried out. The angle between the vertical line passing through C7 and a line extending from the tragus of the ear to C7 was calculated using Image J software . The results of the study showed that standing posture showed significantly smaller neck flexion angle than that of the sitting postures($p<0.001$) and there were no significant differences between sitting without arms rest and sitting with arms rest. They concluded that, duration of smartphone usage had negative influence on posture and it significantly increased with duration of smartphone use.

Mani MS , Ahamed SY, Kavithagiri NL, Ambiga P, Sivaraman G, Balan N(2019)[59] examined the relationship between long-term mobile usage and craniocervical posture in patients with TMD. A total of 50 patients with the mean age range of 23.4 years were recruited in the study. Subjects were screened for TMDs using Research diagnostic criteria-TMD Axis I screening questionnaire (2013) and categorized into three groups -20 patients with no TMD served as the controls. 30 patients diagnosed with TMDs were furthur categorized into Groups 1 and 2. Use of mobile phone with frequency between > 3 and ≤ 5 h/day and duration between 3 and ≤ 6 years were included in Group 1 (n-15)and use of mobile phone with frequency > 5 h/day and duration >6 years were included in the Group 2 (n-15) .Three angular and two linear measurements were carried out on the lateral cephalograms which as follows-Craniocervical angle (CCA) ,Cervical curvature angle ,head flexion angle , suboccipital Space (C0–C1 distance), Atlas-axis distance (C1–C2 distance) . Results revealed significantly reduced cervical curvature angle and subocccipital distance in the symptomatic study group 2 with prolonged mobile phone usage($p<0.001$). There was also significant reduction in horizontal length between vertical plumb line and cervical spinous process in study group 2($p<0.001$). Whereas atlantoaxial distance and head flexion angle was significantly increased in study Group 2 with comparison to controls and Group 1($p<0.001$). Based on the results , they concluded that mobile phone usage with cervicogenic signs appeared to be more common in the TMD group.

Wiguna NP, Wahyuni N, Indrayani AW, Wibawa A, Thanaya SA (2019) [60] evaluated the relationship between smartphone addiction and forward head posture In Junior High School students In North Denpasar. 56 samples within the age range of 14-16 years were recruited in the study. Smartphone Addiction Scale questionnaire was used to obtain addiction grades of students and forward head posture was measured by measuring craniovertebral angles. Results of the study showed , smartphone addiction among 45 samples (80.35%) while those who didn't had smartphone addiction were 11 samples (19.65%). Craniovertebral angle measurement showed 29 samples had forward head posture (51.78%) while those who hadn't forward head posture were 27 samples (48.22%). So, finally concluded that, there is a negative influence of smartphone addiction on forward head posture .And also provided education to the childrens who have been indicated with forward head posture by doing chin tuck exercise to minimize forward head posture , and by educating about ergonomic positions while using a smartphone.

Chheda P and Pol T (2019)[61] examined the effect of sustained use of smartphone on the Craniovertebral Angle(CVA) and hand dexterity in young adults pre and post the smartphone use. Also assessed relationship between the CVA and hand dexterity in post smartphone use. 60 young adults in the age group of 18-28 years using smartphone were recruited for the study. All participants were given smartphone in hand and asked them to play games for 15minutes. Craniovertebral angle (CVA) was taken using lateral view photography at first and fifteen minutes of playing game . Pre and post hand dexterity was measured using Purdue pegboard test. Test kit consist of two rows having 25 small holes drilled in them which represent the score equal to 1 with each properly inserted pin in each hole. Results showed significantly decreased CVA at the 15th minute of sustained smartphone use when compared to 1st minute of use. Also post hand dexterity smartphone use was reduced than the pre hand dexterity. They concluded that craniovertebral angle significantly reduced with sustained use of smartphone which, in turn, leads to a forward head posture in young adults and also had a negative effect on the hand dexterity.

Boro T and Nagrale O (2020)[62] investigated the cervical extension deficit and its prevalence among the current young adults. A total of 436 subjects of both genders between the age group of 18-30 years were recruited in the study. Questionnaire titled as Questionnaire for smartphone users was filled by the participants which categorized the subjects depending on their duration of smartphone use and associated neck pain. Digital inclinometer was used to measure the range of motion of the cervical flexion and extension movements. Subjects were asked to touch their chest with their chin and cervical flexion measurement was taken. And cervical extension measurement was taken by asking the subjects to look at the ceiling as much as possible. Study results showed that 167(38%) of subjects had less than 60 degree extension ,55 -59 degree extension deficits shown by 93 subjects(21%) and 60 (13%)subjects showed 50 -54 degree extension deficits. Finally 14 subjects (3.2%) had less than 50 degree cervical extension deficits. Whereas, no extension deficit shown by 269 subjects(62%) . Also there was a moderate positive correlation between the duration of smartphone usage and cervical extension deficit with history of neck pain. They finally concluded that smartphone addiction has deleterious effects on cervical range of motion and neck function.

Ramnaath M , Sudharsan S, Yadhav KS, Priya DB, Subramaniyam M (2020) [23] correlated the relationship between muscle fatigue and the head flexion angle. The normal 14 subjects of 17-26 years of age were selected for the study . All subjects were instructed to use a smartphone in a sitting posture for atleast 1 hour. Electromyogram (EMG) sensor was used to measure the neck muscle activity while head flexion angle was measured by gyroscope sensor. The Rapid Upper Limb Assessment (RULA) method was used to calculate the postural risks loading within the upper limbs and neck. Study results showed that increase in head flexion angle also increases muscle activity in the neck region after long term usage of the smartphone. Also calculated the force acting on C7 at different flexion angle and found that large amount of load/force act on the neck when subject maintained higherdegree flexion angle and vice versa. Also higher flexion neck angle was meant that the posture is wrong or at high risk according to the RULA chart. The conclusion made was , higher flexion angle had negative influence on muscle fatigueness and recommended topractice reduced head flexion angle as much as possible while using a smartphone to minimize the musculoskeletal disorders.

Mohammed AH (2020) [63] assessed the impact of overuse of smartphone on head posture and functional ability of upper extremity in adolescents and the correlation between them. A total of forty adolescents (12 males and 28 females) with age ranged from 14 to 18 years were included in the study. And based on smartphone time usage per day, they were divided into group I (smartphone usage<4 hours per day) and group II (smartphone usage>4 hours per day) . Assessement of neck pain was done by Visual analogue scale (VAS), the disability of the upper extremity by Upper Extremity Functional Index (UEFI) and the head posture angles was measured by lateral photographic analysis. Results of the study represented significant differences between group I and group II in all measurable variables($p<0.05$) with effects on group II. Based on the results, they concluded that both head posture and functional ability of adolescents get worsened by the prolonged duration of smartphone usage.

ASSESSMENT OF CERVICAL SPINE BY LATERAL CEPHALOGRAM

Altered cervical posture due to smartphone addiction has been recognized by various techniques in previously done studies. But ,there is only single study which has been documented in the literature which assessed cervical posture in smartphone addicted subjects using lateral cephalogram.[3] Also, lateral cephalogram has been used successfully for analysis of cervical vertebrae anomalies in class III skeletal malocclusion by Bebnowski D et al [66] , Meibodi SE et al [67] , Attilio MD et al [64] also used lateral cephalogram for measurement of Cervical Lordosis Angle(CVT/EVT) in skeletal class II female subjects with and without TMD. However, there is no single study for cervical spine assessment in smartphone addicted individuals using three dimensional technique like CT,CBCT.

D'Attilio M , Epifania E,Ciuffolo F, Salini V, Filippi MR, Dolci M, Festa F, Tecco S (2004)[64] evaluated the existence of a significant correlation between CVT/EVT angle and craniofacial morphological features in subjects with TMD. A cephalometric record of total of 50 females aged between 25-35 years with documented TMJ disk displacement and cervical pain were compared with 50 females of control group with no TMDs and cervical pain. Radiographs were taken in mirror position and the CVT/EVT angle, were traced. Results found to be statistically significant between CVT/EVT angle and mandibular length ($p<0.01$), mandibular position ($p<0.05$), mandibular divergence ($p<0.01$), and overjet ($p<0.01$) in both groups. Also , significant differences was found between the group in CVT/EVT angle ($p<0.05$), maxillary protrusion ($p<0.01$), mandibular protrusion ($p<0.01$), mandibular length ($p<0.01$), mandibular divergence ($p<0.05$), and overbite ($p<0.05$). And conclusion made was, TMD causes cervical pain and an alteration of the cervical lordosis angle.

Sonnesen L , Pedersen CE, Kjaer I (2007) [65] described the cervical column as related to head posture, cranial base, and mandibular condylar hypoplasia using lateral cephalogram. Participants were divided into two group. The normal group comprised of 21 subjects including 15 females aged between 23 – 40 years, and 6 males aged between 25 – 44 years with neutral occlusion and normal craniofacial morphology. The study group comprised of 11 subjects (8 females and 3 males, aged between 12 – 38 years) with condylar hypoplasia . To perform a visual assessment of the morphology of the cervical column of each individual, a profile radiograph was taken in the standardized head posture to measure the head posture and the cranial base angle. Morphological deviations of the cervical column in the subjects with condylar hypoplasia was significantly more compared with the normal group. Results regarding cervicohorizontal angle (OPT/HOR , CVT/HOR) and cranial base angle(n-s-ba) showed significantly larger degree values in females than in males. Also there was no statistically significant age differences were found. Cervical lordosis angle (OPT/CVT) , the inclination of the upper cervical spine (OPT/HOR) and the cranial base angle (n – s – ba) showed significant positive correlation with the fusion of the cervical column in females only. These associations were not due to the effect of age.Conclusion was made that, the pattern of morphological deviations was significantly more severe in patients with TMDs.

Bebnowski D , Hanggi MP, Markic G, Roos M , Peltomaki T (2011)[66] evaluated the prevalence of CVA (cervical vertebral angle) in Class II subjects on lateral cephalograms and compared those findings with cone beam computed tomography (CBCT). For CVA analysis standardized cephalograms of 238 Class II patients were assessed. An additional Cephalogram and CBCT were available for 21 subjects. Results regarding , lateral cephalograms inspection showed 9.7% potential fusions whereas, 90.3 % of the subjects could exclude CVA findings. The cephalometric values and potential vertebrae anomalies dont showed any correlational findings. Results regarding additional 21 subjects showed potential fusion in 9 cases, while none of the case could be confirmed by CBCT. And so was the conclusion made that, false-positive findings may occur with visual examination of a cephalogram.

Kee KI , Byun JS, Jung JK, Choi JK (2016) [3] investigated the effect of smartphone addiction on cervical posture and temporomandibular disorders (TMDs) in teenagers with smartphone addiction. A total of 100 teenage subjects were recruited in the study. Based on the criteria of the smartphone addiction scale-short version (SAS-SV) questionnaire they were divided into normal and addiction groups. Lateral cephalometric analysis was done to examine craniocervical angles (CVT/EVT),(NSL/OPT) and (NSL/CVT) and cervical mobility was examined by cervical range of motion instrument(Inclinometer) .Study results showed no significant difference in the craniocervical angles of the resting positions of the two groups regarding cephalometric analysis.However,there was significantly flexed cervical posture and decreased cervical range of motion in almost every direction in the smartphone addicted teenagers as compared to normal group ($p<0.05$). The clinical profile of TMDs revealed that smartphone-addicted teenagers were more prone for muscular problems. They concluded that,smartphone addicted teenagers had a negative influence on craniocervical mobility and may be more prone for myogenous cause,which probably has deleterious effects on the pathologic process of TMDs.

MATERIALS AND METHODS

This is a hospital based cross sectional, observational study which was initiated after getting approval from the Institutional Ethics Committee and was carried out in the Department of Oral Medicine and Radiology.

A total of 195 smartphone users of age range 18-28 years were recruited as per inclusion criteria from the outpatient department of Oral Medicine and Radiology. According to Smartphone Addiction Scale-Short Version (SAS-SV)[8], individuals were divided into two groups. The study group comprised of 130 smartphone addicted individuals ,whereas, control group comprised of 65 non-addicted individuals within the same age range.

INCLUSION CRITERIA:

1. Individuals using smartphone for more than one years.
2. Individuals between the age group of 18-28 years.
3. Individuals willing for Lateral cephalogram radiograph.

EXCLUSION CRITERIA

1. Individuals with the history of rheumatoid arthritis.
2. Individuals with congenital dentofacial and cervical abnormality.
3. Individuals with history of trauma in the cervicofacial region.
4. Individual with history of TMD and/or undergoing treatment for it.
5. Individuals with history of chewing areca nut, tobacco and chewing gum for more than one year.

MATERIALS-

I) Armamentarium for clinical examination :
   - Mouth mirror
   - Straight probe
   - Digital vernier caliper

II) Digital lateral cephalograms using CS 8100 SC Carestream Digital Panoramic and Cephalometric System software.

METHODOLOGY-

PROCEDURE

In the present study, among total 195 smartphone users, 130 addicted and 65 non-addicted individuals were identified by using Smartphone Addiction Scale-Short Version (SAS-SV).[8] Written Informed consent was obtained from all the smartphone users who has fullfiled the inclusion criteria. Detailed case history of 195 smartphone users were recorded in structured proforma. Cervicofacial muscles of all the individuals were examined clinically, followed by evaluation of cervical spine using digital lateral cephalogram radiographs.

DIGITAL LATERAL CEPHALOGRAM

Digital lateral cephalogram was taken using digital cephalometric system at parameters applicable for particular patient with all protective measures. Patient were positioned in cephalostat with Frankfort Horizontal plane parallel to the floor and teeth in centric occlusion.

Cervical spine posture was examined by the following three parameters. [3]

1. **Cervico-lordosis angle (CVT/EVT)** (Figure 9)

Cervico-lordosis angle is the angle formed by line CVT and EVT.

CVT is the line passing through Cv2tg and Cv4ip.

EVT is the line passing through Cv4ip and Cv6ip.

Where,

- Cv2tg- tangent point of the superior, posterior extremity of the odontoid process of the second cervical vertebra.
- Cv4ip-the most inferior-posterior point on the body of the fourth cervical vertebra.
- Cv6ip-the most inferior-posterior point on the body of the sixth cervical vertebra.

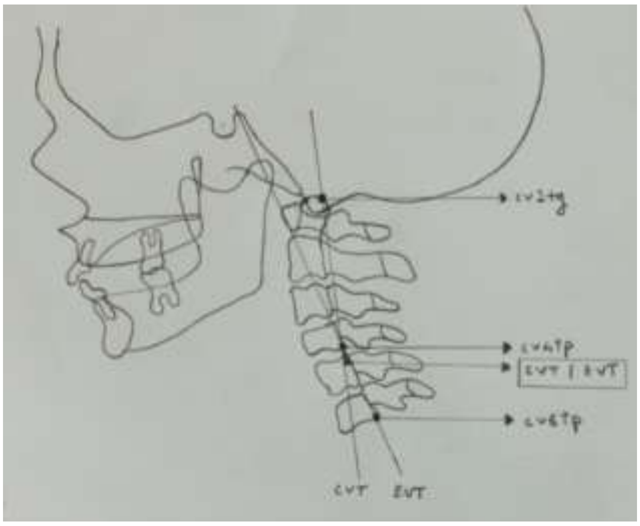


Figure 9: Cervico Lordosis angle (CVT/EVT)

2. Craniocervical Angle (NSL/OPT) (Figure 10)

Craniocervical angle is the angle formed by line NSL and OPT.

NSL is the line joining nasion and sella point.

OPT is the line passing through Cv2tg and Cv2ip.

Where,

- N-nasion point , S-sella point NSL-nasion sella line.
- Cv2tg- tangent point of the superior, posterior extremity of the odontoid process of the second cervical vertebra.
- Cv2ip-the most inferior-posterior point on the body of the second cervical vertebra.

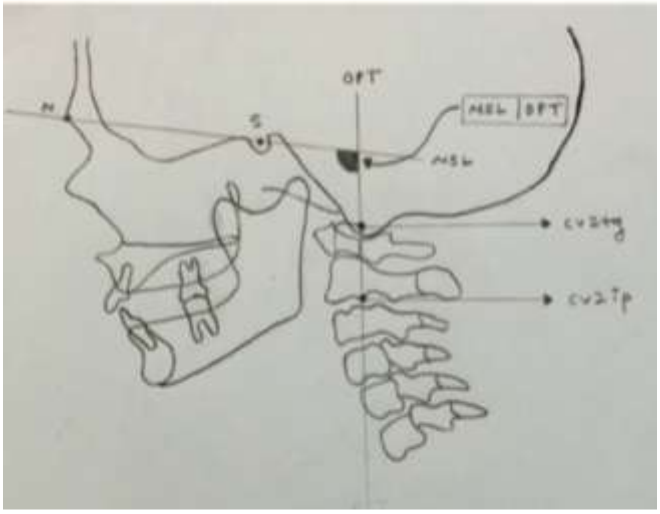


Figure 10: Craniocervical Angle (NSL/OPT)

3. **Craniocervical Angle (NSL/CVT)**(Figure 11)

Craniocervical angle is the angle formed by line NSL and CVT.

NSL is the line joining nasion and sella point.

CVT is the line passing through Cv2tg and Cv4ip.

Where,

- N-nasion point , S-sella point NSL-nasion sella line.
- Cv2tg- tangent point of the superior, posterior extremity of the odontoid process of the second cervical vertebra.
- Cv4ip-the most inferior-posterior point on the body of the fourth cervical vertebra

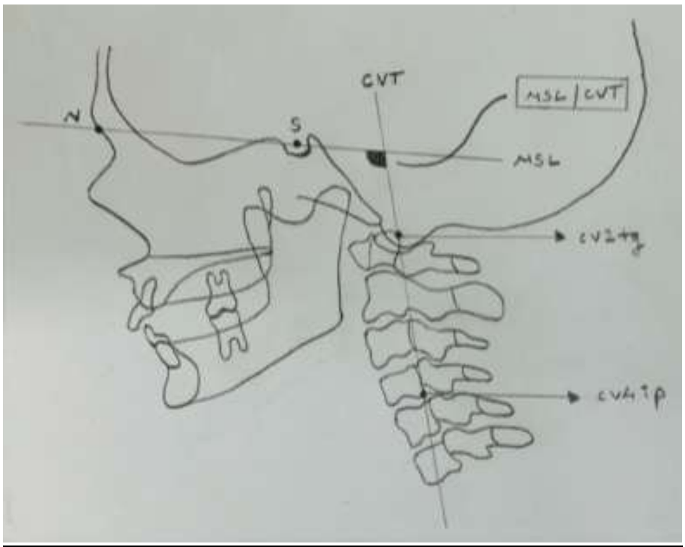


Figure 11: Craniocervical Angle (NSL/CVT)

Smartphone Addiction Scale Short Version (SAS-SV) [8]

The present study used SAS-SV for the assessment of smartphone addiction among participants . This scale consists of 10 questions with a self reporting 6-point Likert scale (1: strongly disagree, 2:disagree,3: slightly disagree,4:slightly agree, 5: agree and 6: strongly agree) . Questions were concerned about daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse and tolerance by smartphone.

The total score of level of addiction was obtained by summation of all the responses on 6 point likert scale which ranges from 10 to 60 where 60 represents maximum addiction. This scale has high sensitivity (0.867 for boys , 0.875 for girls) and high specificity (0.893 for boys and 0.886 for girls) with cut-off values being 33 for girls and 31 for boys.

SAS-SV Questionnaire included the following 10 questions.[8]

1. Missing planned work due to smartphone use.
2. Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use.
3. Feeling pain in the wrists or at the back of the neck while using a smartphone.
4. Won't be able to stand not having a smartphone
5. Feeling impatient and fretful when I am not holding my smartphone
6. Having my smartphone in my mind even when I am not using it
7. I will never give up using my smartphone even when my daily life is already greatly affected by it.
8. Constantly checking my smartphone so as not to miss conversations between other people on Twitter or Facebook.
9. Using my smartphone longer than I had intended
10. The people around me tell me that I use my smartphone too much.

METHODS OF DATA COLLECTION-

Data was obtained from the findings of lateral cephalogram and clinical examination of muscles and results were tabulated and statistical analysis was performed using SPSS version 20.0 (IBM Corp) software.

PLATE NO.1

I: Armamentarium used for clinical examination

II: Patient Positioning on Lateral Cephalometric Machine

PLATE NO.2

Cervical Muscles Examination In Smartphone Overusers

III: Upper Trapezius

IV:Sternocleidomastoid

V: Splenius Capitus

VI: Cervical Spinae Erector

PLATE NO.3

Facial Muscles Examination In Smartphone Overusers

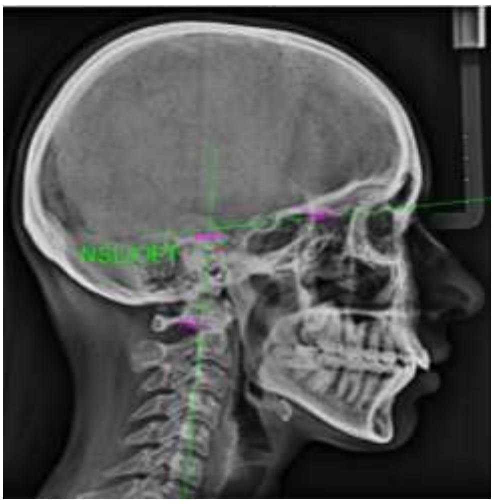
VII: Masseter

VIII: Temporalis

PLATE NO. 4

Cervical Spine Angles on Lateral Cephalogram Radiograph

IX:Cervical Lordosis Angle (CVT/EVT)



X: Craniocervical Angle (NSL/OPT)

XI: Craniocervical Angle (NSL/CVT)

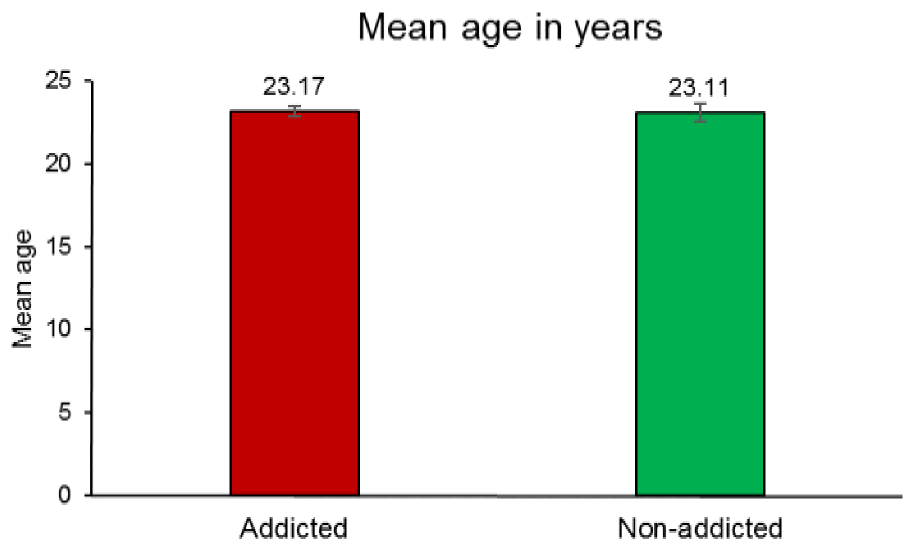
RESULTS AND OBSERVATIONS

Table 1: Descriptive statistics for age of participants in two study groups.

Parameter	Addiction status	
	Addicted	**Non-addicted**
N	130	65
Mean	23.17	23.11
Standard deviation	1.87	2.2
Median	23	23
Minimum	18	19
Maximum	28	28

Table 1 provides the descriptive statistics for age in the two study groups (addicted and non-addicted). The total of 195 participants of using smartphone were categorized into two study groups according to smartphone addiction scale-short version (SAS-SV). There were 130 participants with addiction of smartphone with a mean age of 23.17 years, with standard deviation of 1.87 years.

In the non-addiction group, there were 65 participants with a mean age of 23.11 years and standard deviation of 2.2 years.The age range in two groups was almost similar.

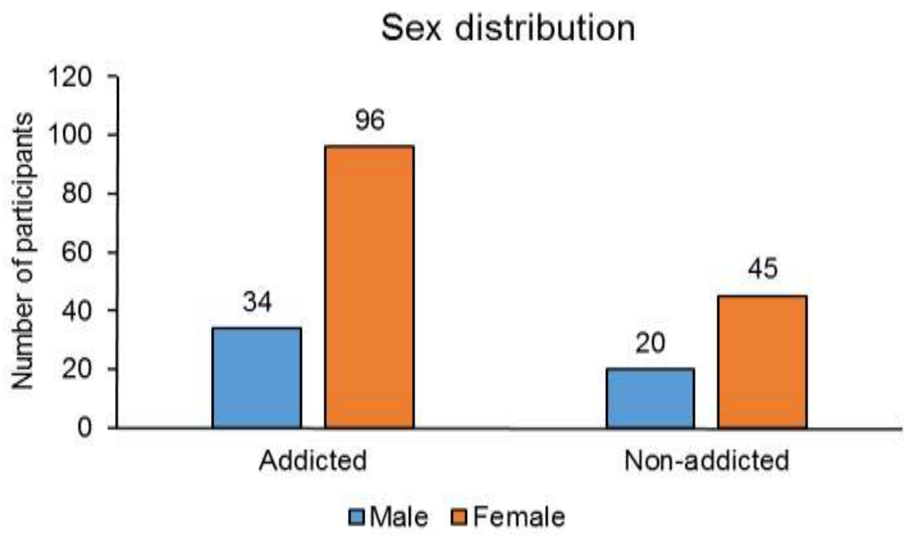


Graph 1: Column chart showing mean age of participants in two groups

Table 2: Distribution of participants according to sex in the addicted and non-addicted groups.

Sex	Addiction status		Total
	Addicted	**Non-addicted**	
Male	34	20	54
Female	96	45	141
Total	130	65	195

Table 2 shows the distribution of participants according to sex in two study groups. In the addiction group, out of 130, 34 (26.15%) were males, while 96 (73.85%) were females. In the non-addiction group, there were 20 (30.77%) males, while 45 (69.23%) were females. Overall, there were 54 (27.69%) males and 141 (72.31%) females in the study.



Graph 2: Column chart showing distribution of participants according to sex in two groups

Table 3: Status of cervicofacial muscle tenderness in participants from addicted and non-addicted groups.

Muscles		Addiction status				P-value
		Addicted		Non-addicted		
		(n=130)	%	(n=65)	%	
Masseter	Absent	117	90.0%	60	92.3%	0.793 (NS)
	Present	13	10.0%	5	7.7%	
Temporalis	Absent	127	97.7%	65	100.0%	0.537 (NS)
	Present	3	2.3%	0	0.0%	
Upper trapezius	Absent	67	51.5%	32	49.2%	0.879 (NS)
	Present	63	48.5%	33	50.8%	
Sternocleidomastoid	Absent	130	100.0%	65	100.0%	-
Splenius capitus	Absent	100	76.9%	49	75.4%	0.952 (NS)
	Present	30	23.1%	16	24.6%	
Cervical spinae erector	Absent	75	52.7%	41	70.2%	0.859(NS)
	Present	55	47.3%	24	29.8%	

P-value obtained using Pearson's chi-square test; NS: Non-significant

Table 3 provides the presence or absence of tenderness in various cervicofacial muscles according to addiction groups. As regards Masseter, in the addicted group, the tenderness was observed in 13 (10%) of the participants, while in non-addicted group, it was observed in 5 (7.7%) of the participants. The difference in the proportions was statistically insignificant with a p-value of 0.793.

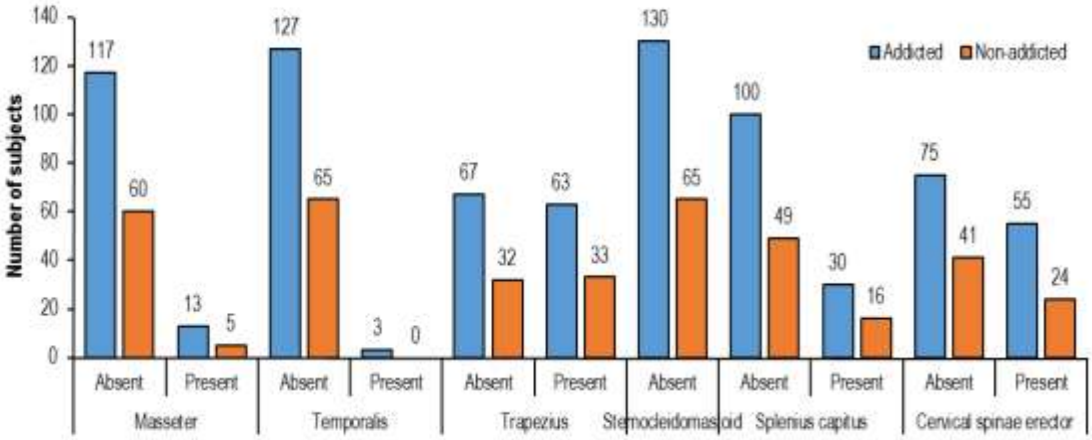
The tenderness in temporalis muscles was observed in 3 (2.3%) participants from addiction group, while none of the participants had such tenderness in non-addiction group. The difference was statistically insignificant with p-value of 0.537.

Further, the tenderness of trapezius muscle was seen in 63 (48.5%) of cases in addiction group, while it was present in 33 (50.8%) of the non-addicted cases; and this difference of proportion was statistically insignificant with p-value 0.879.

In Splenius capitis muscle, the tenderness was seen in 30 (23.1%) in addicted group, while it was present in 16 (24.6%) cases in non-addicted group. The difference of proportions was statistically insignificant with p-value of 0.952.

The tenderness in cervical spinae erector muscles was observed in 55(47.3%) participants from addiction group, while it was present in 24(29.8%) of participants of non-addicted group.The difference was statistically insignificant with p-value of 0.859.

None of the participants from either groups showed tenderness of Sternocleidomastoid muscle.



Graph 3: Column chart showing number of subjects according to muscle involvement in two study groups

Table 4: Status of cervicofacial muscle spasm in participants from addicted and non-addicted groups

Muscles		Addiction status			
		Addicted		Non-addicted	
		N	%	N	%
Masseter	Absent	130	100.0%	65	100.0%
Temporalis	Absent	130	100.0%	65	100.0%
Trapezius	Absent	130	100.0%	65	100.0%
Sternocleidomastoid	Absent	130	100.0%	65	100.0%
Splenius capitus	Absent	130	100.0%	65	100.0%
Cervical spinae erector	Absent	130	100.0%	65	100.0%

Table 4 reveals that the spasm in various cervicofacial muscles was absent in participants from both the groups.

Table 5: Descriptive statistics for angular measurements of cervical spine in participants from addicted and non-addicted groups

Angle	Addiction status				P-value
	Addicted (n=130)		Non-addicted (n=65)		
	Mean	SD	Mean	SD	
Cervical lordosis (CVT/EVT)	6.21°	±2.78°	6.31°	±1.57°	0.788 (NS)
Craniocervical (NSL/ OPT)	98.99°	±4.88°	104.86°	±2.38°	**<0.0001 (HS)**
Craniocervical (NSL/CVT)	101.87°	±4.53°	102.71°	±1.64°	< 0.151(NS)

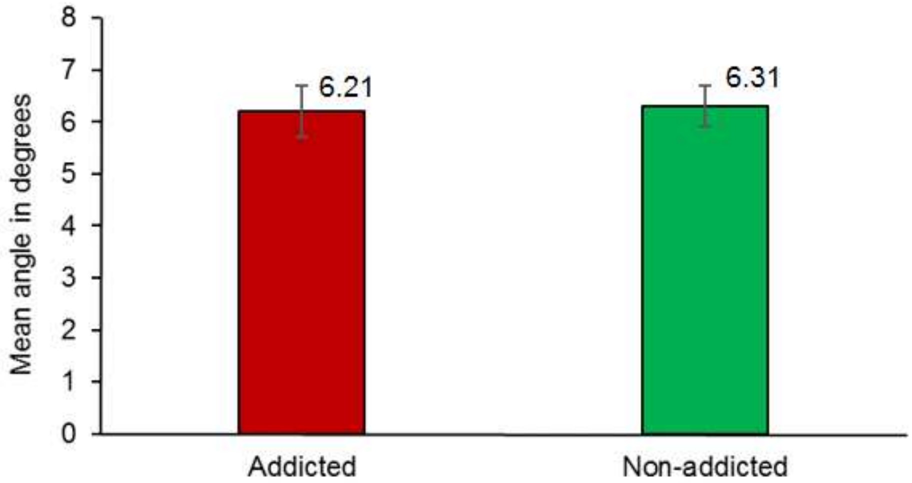
P-value obtained using t-test for independent samples; NS: Non-significant; HS: Highly Significant

Table 5 provides the descriptive statistics for angular measurements of cervical spine in participants from two study groups. As regards Cervical lordosis angle(CVT/EVT), the mean in addicted group was 6.21^{o} with a standard deviation of 2.78 ^{o}. In the non-addicted group, the mean was 6.31 ^{o} with a standard deviation of 1.57 ^{o}. The difference in the mean angles between two groups was statistically insignificant, as indicated by a p-value of 0.788.

Further, the mean angle for Craniocervical (NSL/OPT) in addicted group was 98.99^{o}, while standard deviation was 4.88^{o}. In the non-addicted group, the mean was 104.86^{o}, with standard deviation of 2.38^{o}. The difference in the means was statistically highly significant with a p-value of <0.0001.

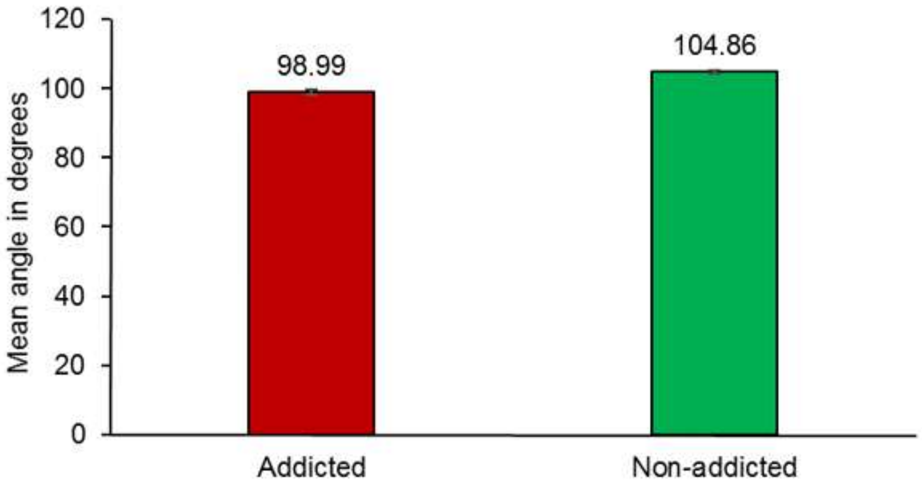
The mean angle for Craniocervical (NSL/CVT) in addicted group was 101.87^{o} with standard deviation of 4.53^{o}, while in the non-addicted group, the mean was 102.71^{o} with standard deviation of 1.64^{o}. The difference in the means was statistically insignificant by a p-value 0.151.

Cervical Lordosis Angle (CVT/EVT)



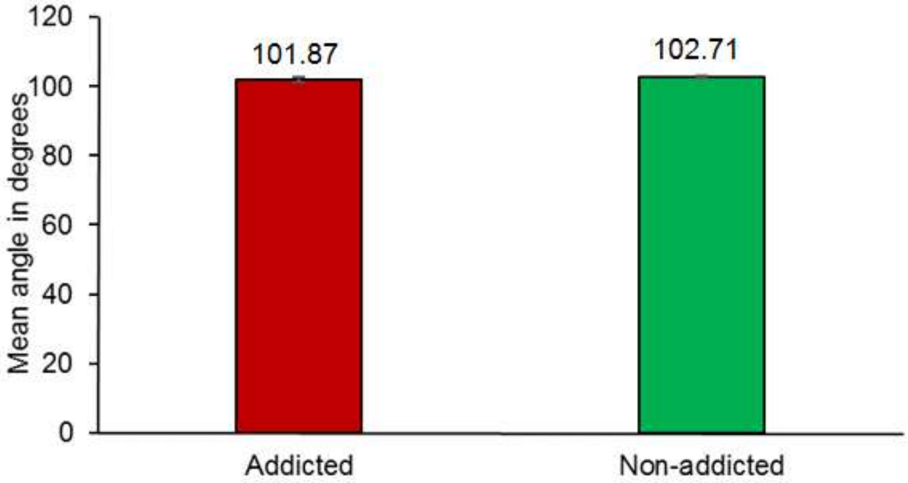
Graph 4: Column chart showing mean angle for Cervical lordosis(CVT/EVT) in two study groups.

Craniocervical Angle (NSL/OPT)



Graph 5: Column chart showing mean angle for Craniocervical (NSL/OPT) in two study groups.

Craniocervical Angle (NSL/CVT)



Graph 6: Column chart showing mean angle for Craniocervical (NSL/CVT) in two study groups.

Statistical methods

The demographic parameter age was summarized in terms of mean, standard deviation, median and range for both the addicted and non-addicted groups. The gender distribution was given in terms of numbers and percentages. The status of cervicofacial muscle tenderness in participants from two groups was given in terms of numbers and percentages, and the statistical significance of muscle tenderness and addiction was assessed using Pearson's chi-square test. Also the status of cervicofacial muscle spasm in participants from two groups was summarized in terms of numbers and percentages. The angular measurements of cervical spine in participants from two groups were compared using t-test for independent samples.

All the analyses were performed using SPSS ver 20.0 (IBM Corp) software and the statistical significance was tested at 5% level.

The formulations used in the study were as under:

1. Measures of central tendency

If x_1, x_2,…x_n are the observations on a random variable X, then following measures of central tendency can be obtained:

- **Mean** for a set of observations is given by

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

- **Median**: It is the middle value of a set of values when arranged in the increasing order of magnitude.

2. Measures of dispersion

- **Standard deviation** for a set of observations in given by

$$s = \sqrt{\frac{1}{(n-1)}\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

where x_i = observation on each object

n = number of objects

- **Range** is the difference between maximum and minimum value of the variable.

3. Student's t-test for independent samples

The test is used for comparing the statistical significance of difference in the means of two samples. It compares the sample difference between two means in relation to the variation in the data (expressed as the standard deviation of the difference between the means).

It is given by the formula:

$$t = \frac{(\overline{x}_1 - \overline{x}_2) - (\mu_1 - \mu_2)}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where $\overline{x}_1$ and $\overline{x}_2$ are the means of sample observations of two different groups, μ_1 and μ_2 are the means of the respective populations from which the samples are derived, and *S* is the pooled sample standard deviation, which is given by:

$$s^2{}_{pooled} = \frac{(n_1 - 1)s_1{}^2 + (n_2 - 1)s_2{}^2}{n_1 + n_2 - 2}$$

here $s_1{}^2$ and $s_2{}^2$ are the variance of two samples and n_1 and n_2 are the sample sizes in two groups. If the test statistic results in a *P*-value > 0.05 (level of significance), then the null hypothesis H_0: *There is insignificant difference in the means of two groups* is accepted and the alternative hypothesis H_1: *There is significant difference in the means* is rejected. On the other hand, if *P*-value < 0.05, then the H_1 is accepted and H_0 is rejected.

4. Pearson's Chi-square test

Let *X* and *Y* be two variables under study with *r* and *s* levels respectively; and the data on $r \times s$ levels be in the form of counts. Let the null hypothesis be that the two variables are independent. That is, knowing the levels of *X* does not help in predicting the levels of Y; against the alternative hypothesis that the two factors are not independent. That is, knowing the level of X can help in predicting levels of Y. To decide about the acceptance of hypothesis, the Chi-square test statistic is used which is defined as:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{s}\frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} is the observed frequency count for i^{th} level of variable X and j^{th} level of variable Y. E_{ij} is the expected frequency count for same cell. The expected count is given by:

$$E_{ij} = \frac{n_i \times n_j}{n}$$

where n_i and n_j are the total counts for i^{th} level of variable X and j^{th} level of variable Y; and n is the total count. The calculated Chi-square value is compared with the tabulated one for $(r\text{-}1)\times(s\text{-}1)$ degrees of freedom. If the corresponding p-value is smaller than the pre-decided significance level, say 0.05, then we reject the null hypothesis and accept the alternative one.

If the p-value is more than 0.05, then we accept null hypothesis.

DISCUSSION

The modern technological era has led to the revolutionary changes in the present culture by launching the different types of devices and gadgets in the world. And one of the most important digital device of this era is smartphone.[68] In the recent years, the number of smartphone users has sharply increased .The possible reason behind that can be the ease of convenience , its multifunctionality and the well-established internet infrastructure associated with it ,which made an individual to use them more persistently.[12] Worldwide, around 2.7 billion people are estimated to use smartphones. In India , the total number of smartphone users has increased tremendously from 200 million to 400 million in the year of 2015-2019 .[23]

Despite having more advantages, smartphone is also associated with its own disadvantages. Excessive usage of smartphone for daily purposes can lead to its addiction more easily than any other digital media and is an emerging phenomenon in the communities which is a behavioural addiction .[69] Behavioral addiction produces short term reward that may lead to persistent change in activities despite of awareness of adverse consequences regarding the same .[70]

The extensive use of smartphone has affected physical and mental health adversely. [23] It includes psychosocial as well as musculoskeletal disorders mainly in the region of fingers ,neck , back and shoulder. [24] It is thought that, forward flexed posture of head poses increased overload on spine and in turn leads to pain and fatigue of cervicofacial muscles. (Xie Y et al [34] ,Hansraj [71]) . However , studies by Viljanen M et al [72] , Chung MK et al [73], Kraemer et al [74] stated that continous static pressure applied on specific sites while using smartphone could be the reason for increase muscle fatigueness and pain. So, the exact effect on cervicofacial muscles in smartphone addiction still remains unclear. Most common muscles which are believed to get affected due to overuse of smartphone includes upper trapezius, cervical spinae erector, splenius capitus , sternocleidomastoid, masseter and temporalis.

There are mixed outcome reported in the literature regarding the influence of smartphone overuse on cervical spine. Various researchers like Saaman MN et al [56], Akodu AK et al [10], Samir SM et al [57] ,Jung SI et al [50] stated that cervical posture get positively influenced by the overuse of smartphone. While the studies by Selvaganapathy K et al [45] , Kee KI et al[3] ,Alshahrani A [55] denied the significant influence of smartphone overuse on cervical spine.

Cervical lordosis angle (CVT/EVT) and craniocervical angles (NSL/OPT and NSL/CVT) are found to get adversely affected due to postural changes. So, these angles were used to assess the alteration in cervical spine in smartphone users.

Literatures suggest that, Lateral cephalogram was used successfully for the assessment of cervical spine. Bebnowski D et al [66] has used lateral cephalogram for the analysis of cervical vertebrae anomalies in class III skeletal malocclusion. Attilio MD et al [64] also used lateral cephalogram for measurement of Cervical lordosis angle(CVT/EVT) in skeletal class II female subjects with and without TMD. Another study by Qadir M and Mushtaq M [75], which have also evaluated cervical column curvature with respect to sagittal jaw position using lateral cephalometric analysis. Kee KI et al [3] used lateral cephalogram for assessment of cervical spine alterations in smartphone overusers using three different angles (CVT/EVT, NSL/OPT and NSL/CVT).

So, being cost effective, readily available with good diagnostic accuracy and less exposure compared to other diagnostic modalities , lateral cephalogram was used in the present study for the assessment of alteration in cervical spine .

With increased demand in technical , academic and entertainment areas ,there is continous enhancement of use of smartphone and more commonly among adolescents and early adults which may lead to its addiction in them. So, if become addicts, its adverse effects on cervicofacial muscles and cervical spine should be made known.

Thus, the present study was carried out with the aim to evaluate the effect of overuse of smartphone on cervicofacial muscles and cervical spine using digital lateral cephalogram.

This hospital based , observational study was carried out on total 195 healthy smartphone users. All participants were divided into addicted(n=130) and non-addicted (n=65)groups according to smartphone addiction scale-short version (SAS-SV).

Smartphone Addiction Assessment Using SAS-SV

To date level of smartphone addiction has been assessed by various scales like Smartphone addiction scale (SAS) , Smartphone Addiction Proneness Scale (SAPS) and Korean self-reporting internet addiction scale (KS-scale). But large number of questions included in SAS and SAPS and no gender specification leads to the infrequent use of these scales.[8]

However, the Smartphone Addiction Scale Short-Version (SAS-SV) is a validated scale and because of less number of questions and gender specification , this scale proved to be less time consuming and easy for smartphone addiction screening of individuals who are considered to be more vulnerable for addiction.[8] It is widely accepted scale for evaluation of level of smartphone addiction by **Alsalameh AM et al [12] , Akodu AK et al [10], Alonazi et al [11], Karkusha RN et al [13]**, **Kee KI et al [3], Chen B et al .[18]**

The present study was also carried out with the use of SAS-SV for evaluating smartphone addiction in young adults.

Selection Criteria As Per Age

In the present study smartphone overuse was assessed in participants of **age ranged 18-28 years.**

The age range selection criteria was based on the fact that young adults within this mentioned age range believed to get their personal smartphones for the first time by their parents for various reasons like to access to the study materials that they have provided , to improve their organization, to encourage responsibility, to have access to their daily work determination etc. But, besides these all mandatory tasks ,their own determinations also get easily satisfied without any efforts like chatting, electronic mails, watching movies, navigating remote locations , web browsing etc. which drive their mind to accept the overuse of smartphone more efficiently. Therefore , they are more prone to get addicted to it.

Various studies has been carried out in the same age range for evaluating the effects of overuse of smartphone like Chheda P et al [61] with the age ranged of (18-28 years), Karkusha RN et al [13] (19-24 years) , Lee M et al [31] (20-22 years) , Xie Y et al [34] (mean age of 23.9 years) , Kim SY et al [35] (20 -30 years) , Kim YL et al [37] (20-27 years) , Shah PP et al [41] (20-25 years) , Namwongsaa S et al [43] (18-25 years) , Jung SI et al [50] (mean age of 21 ± 2.41 years), Samir SM et al [57] (20-25 years), Alfaitouri S et al [58] (19-30 years) , Mani MS et al [59] (mean age of 23.4 years), Boro T et al [62] (18-30 years) **,** Ramnaath M [23] (17-26 years).

Gender Distribution In Smartphone Users

In the present study , out of 130 participants in the addicted group, 96 (73.85%) were females, while 34 (26.15%) were males. (Table 2),(Figure 2) .

The probable reason could be , females are more habitual to use smartphones for text messaging, media applications, online shopping, creating personal histories and for having fun. While, males use smartphone more often for professional work in contrast to females who preferred to use their mobiles for personal works. Also, females tend to choose messaging as an option while males choose to directly call first rather than engaging with typing text in order to save time.

The findings of the present study are similar to the finding reported by **Demirci K et al** [15]**, Tavakolizadeh J et al** .[14]

Demirci K et al (2015)[15] found that , out of total 127 participants, high smartphone user group constituted 102 (80.3%) females and 25 (19.7%) males . And smartphone addiction scale score was significantly higher in females (80.50) than males (66.59) with $p < 0.001$. The reason explained behind gender difference was , due to different usage pattern or purpose of smartphone by genders ,like females are more inclined towards increased use of social networks than males.

Tavakolizadeh J et al (2014) [14] stated that , out of total 700 students , 390 (56%) of the subjects were female and 310 (44%) were male , but no significant relation was found between the excessive mobile phone use and gender ($P > 0.05$). The probable reason can be , all the study samples were belong to academic field where use of smartphone is likely to be done by all the students irrespective of their gender specification.

While the studies not similar to the above findings which showing male predominance were reported by **Aljiomaa SS et al [16], Bisen S and Deshpande Y et al [17], Chen B et al [18].**

Aljiomaa SS et al (2016) [16] found statistical significant gender difference in smartphone addiction with mean scores of addiction in male participants was (36.32) while in female participants, it was (33.96). The possible reason behind male predominance for addiction was that, males tend to be more preoccupied with smartphones for various purposes than females which makes them negatively affected by it.

Bisen S and Deshpande Y (2016) [17] showed 84% participants have high level of smartphone addiction in which 45 (95%) of candidates were males and 39(78%) were females .The mean score of addiction in male students was 80 ,while , in female students, it was 75.42. The mentioned reason behind this was, high propensity to use smartphone apps regarding education by females ,whereas health, communication, shopping regarding apps by males which made them more prevalent to smartphone addiction.

Chen B et al (2017) [18] showed that prevalence of smartphone addiction was 29.3% in females , while 30.3% in males. And they stated that, although the gender difference regarding smartphone addiction found to be non-significant($p>0.05$) , but the use of smartphones were differed between them like male students were more inclined to use smartphones for playing games, watchting videos and listening music, whereas female students likely to use it for communication functions and social networking services.

Assessment of Cervicofacial Muscles in Smartphone Overusers

In the present study four cervical muscles (Upper trapezius , splenius capitus, cervical spinae erector, sternocleidomastoid) and two facial muscles (masseter and temporalis) were evaluated on the basis of clinical parameters like tenderness and spasm in smartphone users.

'Tenderness' of muscle is pain or discomfort in an affected area after touch, while 'Spasm' is sudden , abnormal, involuntary contraction of muscle which is hard to touch and is associated with pain.

In the present study, participants from the addicted group showed , the upper trapezius muscle tender in 63 (48.5%) cases , splenius capitus in 30 (23.1%) cases ,and cervical spinae erector muscle in 55(47.3%) cases. (Table 4)

The probable reason behind this could be , looking downward while using smartphone for prolonged duration causes cervical flexion and allow the weight of the head to move further forward which ultimately increased the contraction of cervical erector spinae muscle which is mainly involved in flexion movement of the head. In order to withstand the flexion movement , the activity of the upper trapezius and splenius capitus muscle increased and started acting against the gravity, as they are mainly involved in cervical extension , which ultimately leads to cause pain by stimulating trigger points associated with them.

Other possible reason could be, smartphone overusers is habitual to hold a static position while using it for prolonged duration , which results in increased tension on the muscles which are associated with them, leading to hyperactivity of muscle and fatigue.

A. Assessment of Cervical Muscles Tenderness

The above findings of the present study are similar to the findings reported by Lee M et al [31], Berolo S et al [27] ,So YJ et al [29] , Lee JI et al [30] , Alzarea BK et al [33],Kim SY et al [35], Choi JH et al. [36]

Lee M et al(2015) [31] found significant increase in tenderness and muscle activity of upper trapezius muscle (p<0.01) especially in single-handed users compared to both handed users. The reason behind increased tenderness mentioned was continuous muscle contraction has occurred due to repeated upper extremity movements required by mobile phone use , which resulted in microscopic damages to the muscles, nerves, and blood vessels during task performance . The probable reason for increased muscle activity was given as , highest muscle load and fatigue occur with the prolonged smartphone use especially with one-handed users.

Berolo S et al (2011) [27] found that, 84% of participants experienced pain in atleast one region, 52% experienced pain in the right shoulder, 46% in the left shoulder, 68% in the neck and 62% in the upper back. Also, significant association found between total time spent using a mobile device and pain in the shoulder and neck region. The probable reason could be, static pressure applied over the neck, upper back and shoulder region ,when continous use of smartphone occur for the longer duration.

While in the present study, 38% of participants experienced tenderness in neck and shoulder region due to overuse of smartphone. The reason could be the same , as continous flexion movement of neck while using smartphone for prolonged duration leads to increased stress in the cervical region (neck and shoulder) which further made them tender.

Lee KJ et al (2015)[32] found upper trapezius muscle hyperactivity during neck protraction and retraction in study group(forward head posture) and control group , but the difference was statistically non-significant. The possible reason for non-significant difference between two groups mentioned was , upper trapezius muscle may not play major role in neck protraction and retraction.

In the present study also ,non-significant difference was found regarding tenderness of upper trapezius muscle between addicted and non-addicted group. The upper trapezius muscle was affected in both the groups as they are involved in neck protraction and retraction . And the probable reason for non-significant difference was that the participants in both the groups were smartphone overusers, irrespective of their addiction status.

So YJ et al (2014)[29] found significantly greater upper trapezius and cervical spinae erector muscle tenderness ($p<0.05$) in the experimental group (subjects with neck muscle pain) as compared to control group (subjects without neck muscle pain) after 20-min of smartphone sessions in a sitting position. The probable reason could be, increased static stress on cervical spine while using smartphone , which ultimately worsened the tenderness of the muscles associated with it.

In the present study, 63(48.5%) of participants from the addicted group(n=130) and 33(50.8%) participants from the non-addicted group(n=65) experienced tenderness in upper trapezius muscle but the difference was statistically non-significant (p=0.869).

Regarding cervical spinae erector muscle, tenderness was present in 55(47.3%) of participants from addicted group and 24(29.8%) of participants from non-addicted group with statistical non-significant difference between two groups(p=0.859).

The reason behind non-significant results regarding tenderness of these two muscles between the two groups could be that, the study samples in the present study were belong to the academic level or the official work region , where use of smartphone is likely to be done by all of them irrespective of their smartphone addiction status.

Lee JI et al (2014)[30] evaluated the degree of neck pain by Neck disability index (NDI). And they found that 62.92% of participants were without disability . 32.85% showed mild disability . The total NDI scores for neck pain intensity significantly increased with the duration of time spent on smartphone ($p<0.05$). The probable reason mentioned was, increased stress in the neck region while using smartphones for longer duration further initiates the musculoskeletal disorders.

In the present study also, 38% of participants experienced tenderness in neck and shoulder region and the reason could be the same that, due to forward head flexion while seeing downwards at the screens of mobile phone for a longer duration initiates fatigueness in the neck and shoulder region.

Alzarea BK et al (2015) [33] found that , 71.2% of mobile users in the study, reported complaint about cervical pain . And the reason mentioned was, increased consistent load applied to the cervical region.

In the present study, 38% of total participants experienced tenderness in cervical region. The reason behind the presence of tenderness in cervical region could be ,as the participants from both the group were using smartphone from either for academic or the official purpose for long time in a same static posture , leading to increased stress on cervical muscles , which made them fatigue.

Kim SY et al (2016) [35] found the degree of fatigue and pain in the upper trapezius and cervical spinae erector muscle was significantly increased with the duration of smartphone use ($p < 0.05$). And the possible reason behind this finding was , continous static pressure applied on it , while using smartphone for longer duration.

In the present study , more number of addicted participants who intended to use smartphone for longer duration showed tenderness in upper trapezius and cervical spinae erector muscle as compared to non-addicted ones. Although the statistical difference between the two group was non-significant , but we believed that tenderness of muscles worsened with the duration of smartphone use.

Choi JH et al (2016) [36] showed significant increase in muscle fatigue due to more flexed posture in smartphone users . The reason behind this was mentioned , to support the position of forward head posture or flexion posture ,larger load were applied to the cervical extensor muscle e.g. upper trapezius and splenius capitus which made them fatigue.

In the present study also, increased tenderness was found in both cervical extensor muscles (upper trapezius and splenius capitus) in the smartphone users and there could apply the same reason that, bowed or flexed position while using smartphone increases the activity of the extensor muscles and it started acting against gravity, in order to withstand the flexion movement , leading to pain and discomfort in them.

Kee KI et al (2016)[3] found , out of total 100 TMD participants, smartphone addicted group (50 TMD subjects) included 22 participants with joint problems, 21 with muscular and 7 with mixed problems. While the participants from non-addicted group (50 TMD subjects), included 36 individuals with joint problems, 9 with muscular problems, and 5 with mixed problems (joint and muscular). And stated that, significantly higher proportion of myogenous problems was present in TMD patients with smartphone addiction as compared to TMDs patient without addiction.

In the present study, all the TMD patients were excluded from the study. The muscle tenderness was also found in non-addicted smartphone users , but the difference was statistically non-significant, when compared to addicted ones. From the non-addiction group , upper trapezius muscle was tender in 33 (50.8%) of participants, splenius capitus in 16 (24.6%) and cervical spinae erector muscle in 24 (29.8%) of participants .(Table 4)

The probable reason for cervical muscle tenderness among non-addicted participants was that , participants in the present study were in their early adulthood , where, improper posture while performing routine academic or official work might have caused increased activity of cervical muscles and pain in it.

None of the participant in this study had tenderness in the sternocleidomastoid muscle (Table 4). The possible reason behind this could be, the sternocleiodomastoid muscle mainly involved in rotation of the neck to the contralateral sides. While these *action is* less frequently performed during smartphone use.

The results of the present study are inconsistent with the findings reported by **Lee KJ et al [32] and Park J et al.[48]**

Lee KJ et al (2015) [32]found significant decreased sternocleidomastoid muscle activity in smartphone users during neck protraction in forward head posture group as compared to control group ($p<0.05$). And the possible reason explained behind this finding was, reduced length and increased weakness of the sternocleidomastoid muscle during forward head posture may affect the muscle activity and so there was presence of tenderness in it.

Park J et al (2015) [48] stated that, pain threshold of the sternocleidomastoid muscle significantly decreased in heavy smartphone users compared to control group ($p<0.05$) .And the probable reason mentioned was ,significant stress developed on the cervical spine due to heavy smartphone use which decreases the pain threshold of the muscles around the neck.

B. Assessment of Facial Muscles Tenderness

In the present study, masseter muscle showed tenderness in total 18(7.69%) of participants, while from addiction group it was seen in 13 (10%) participants and 5(7.7%) participants from non-addiction group.

Temporalis muscle tenderness was seen in total 3(1.53%) of participants . All of them were from addiction group (Table 4).

The possible hypothesis behind the masseter and temporalis muscle tenderness could be that , besides many purposes which being served by smartphone , one of which is communication purpose which drive the mandible for elevation and retraction. Prolonged hours of talks believed to be responsible for increased muscle contraction which supports the body to execute the respective functions and leads to their fatigueness.

In contrast to the above hypothesis , participants of the present study probably may be involved more in text messages ,chats ,games, reading study material, performing official work etc. rather than communication purpose where the direct involvement of these muscles were infrequent. Thus, the fewer particpants from the present study showed facial muscle tenderness .

The present study findings are contrary to the findings reported by **Kee KI et al.**[3]

Kee KI et al (2016) [3] found significant difference in the TMD diagnostic profile between the addicted and non-addicted groups with higher proportion of myogenous problems present in TMD patients with smartphone addiction. And suggested that, onset and progression of myogenous symptoms among TMDs got furthur influenced by the presence of smartphone addiction. The possible reason mentioned was, contraction of masticatory muscles including the masseter and temporalis muscles may occur due to prolonged use of smartphone. Also , central sensitization may get trigger in smartphone addiction secondary to cervical muscle fatigueness which leads to the prolonged contraction of masticatory muscles and played causal role in the progression of myogenous TMDs.

The present study showed non-significant tenderness in the masseter and temporalis muscle between two groups . The possible reason could be, patients having TMDs or any other clenching habits were excluded from the study. Also , the present study contradicts to the "central sensitization theory" where cervical muscles were affected but not the facial muscles in smartphone users.

In the present study, none of the participants showed spasm of the cervicofacial muscles. The probable reason could be that, spasm resulting secondary to overuse of smartphone takes time to develop which might be inadequate for the present study participants.

Also, the participants of the present study were using smartphone as their routine , so their muscles may get gradually adapted to its overuse , thereby the muscle spasm in them was not developed.

There is paucity of the literatures which has evaluated spasm in cervicofacial muscles in smartphone overusers , so, the present study findings were not correlated.

Assessment of Cervical Spine in Smartphone Overusers

In the present study, evaluation of cervical spine of all the participants was done on the basis of three different angular measurements (CVT/EVT, NSL/OPT and NSL/CVT) using lateral cephalogram radiograph.

The mean cervical lordosis angle (CVT/EVT) was non-significantly decreased in addicted group (6.21^{o} ±2.78SD) as compared to non-addicted group (6.31±1.57). (Table 5) (Graph 4).

The mean craniocervical angle (NSL/CVT) was non-significantly decreased in addicted group (101.87^{o}±4.53) as compared to the non-addicted group (102.71^{o}±1.64).(Table 5)(Graph 6).

The probable reason for non-significant skeletal changes could be due to , duration of smartphone use might be insufficient to cause any significant alteration of cervical spine that could appear on the radiograph.

The mean craniocervical angle (NSL/OPT) was significantly decreased in addicted group (98.99^{o}±4.88) as compared to the non-addicted group (104.86^{o}±2.38).(Table 5) (Graph 5).

The possible reason for this could be, smartphone addiction from prolonged duration produces stress on the cervical spine and believed to cause significant alterations in the upper cervical posture, which changes the natural curve and surrounding structures of it gradually.

The present study findings are consistence with the studies by Samir SM et al[57] , Mani MS et al [59], Mohammad AH [63] , Jung SI et al [50], Saaman MN et al [56] , Alonazi A et al [11], Chheda P et al [61] , Akodu AK et al .[10]

The above studies assessed cervical spine posture using craniovertebral angle (CVA) by lateral photometric analysis method where the craniovertebral angle (CVA) is the angle between the vertical line extending from the tragus of the external auditory meatus to the horizontal line passing through C7. CVA angle below 53 degree suggestive of forward head posture. As head posture is represented by craniovertebral angle , it was compared with craniocervical angle (NSL/OPT) of the present study.

Samir SM et al (2019) [57] found significant difference in craniovertebral angle (CVA) between the two groups i.e. group A (smartphone use <4 h/day) and group B (smartphone use>4 h/day) with adverse effects on group B. The possible reason mentioned was increased flexion angle increases the stress on the neck which may furthur initiates skeletal changes leading to forward curve in the cervical spine, instead of C-shaped curve to it.

Saaman MN et al (2018) [56] stated that heavy smartphone users (smartphone use>4 hrs/day) produces forward head posture as compared to control group (smartphone use<4 hrs/day) The probable reason could be the same as stated in our study , that considerable stress applied on the cervical spine during prolonged smartphone use, thus decreasing the cervical angles associated with it.

Mohammed AH (2020) [63] found significant difference in craniovertebral angle between group I (smartphone usage<4 hours per day) and group II (smartphone usage>4 hours per day) with a p value <0.05. And stated that , individuals with heavy usage of smartphone assumed more forward head posture relative to the cervical spine which may produces alterations in cervical posture.

Jung SI et al (2015) [50] showed significant effect on heavy smartphone users (smartphones use> 4 hours/day) with p<0.05 as compared to control group (smartphone use <4 hours /day) . And the possible reason explained behind effect on cervical spine was, forward head position in heavy smartphone users causes an excessive pressure on cervical spine leading to development of posterior curve in it.

Alonazi A et al (2019) [11] stated that , addicted subjects (with SAS-SV score>32)showed significant reduction in craniovertebral angle compared to non-addicted ones(with SAS-SV score≤ to 32) . And revealed that, forward head posture was four times greater in addicted participants than those who were non-addicted. The probable reason given was , constant downward neck flexion was more in smartphone addicted individuals which produced the faulty cervical posture in them.

Chheda P et al (2019)[61] showed significantly decreased craniovertebral angle (CVA) with the sustained use of smartphone. The possible reason behind decrease CVA was, excessive use of smartphone developed forward flexion of head which decreases the lordosis (anterior curve) of lower cervical vertebrae and creates a posterior curve in the upper cervical vertebrae to maintain balance in it.

Akodu AK et al (2018) [10] found reduced CVA in excessive smartphone users.The reason behind reduced CVA given was, downward head shifted posture in excessive smartphone users caused gradually decreased anterior curve of lower cervical vertebrae and creates posterior curve in upper cervical vertebrae to maintain balance in it.

However , the studies contrary to the present study was reported by **Kee KI et al [3], Alshahrani A et al [55] , Selvaganapathy K et al.[45]**

Kee KI et al (2016)[3] showed non-significant difference in the craniocervical angles between the addicted and non-addicted groups . Although the difference was non significant , but the mean value of the angles was smaller in addicted group than in the control group . The mean value of (CVT/EVT) was 6.64° for the normal group and 5.78° for the addiction group. While, (NSL/OPT) was 102.87° for the normal group and 101.63° for the addiction group. Regarding (NSL/CVT) the mean value was 107.07° for the normal group and 106.22° for the addiction group. . And stated that smartphone use in the addicted teenagers was in a more flexed craniocervical posture, which likely to produce alteration in the cervical posture .

In the present study , craniocervical angle (NSL/OPT) was significantly reduced in addicted as compared to non-addicted ones. The probable reason mentioned was same , that heavy smartphone use for longer duration produces forward head flexion of neck and developed considerable stress on the cervical spine , which leads to the development of posterior curve to it.

Second reason for significant decrease in (NSL/OPT) in smartphone addicted compared to non-addicted ones could be that, OPT is the line which is made from cv2tg which is tangent point of the superior, posterior extremity of the odontoid process of the second cervical vertebra and cv2ip which is the most inferior-posterior point on the body of the second cervical vertebra. As cv2ip point is placed anteriorly compared to cv4ip because of C shaped curvature of cervical spine, any minor deviation related to head or neck posture made pronounced difference in the angle related to cv2ip i.e.NSL/OPT.

Alshahrani A et al (2018) [55] stated that CVA measurement showed non significant difference between heavy (>4 hrs /day) and light(<4 hrs/day) smartphone users. The reason behind this non-significant results mentioned was, postural changes that can occur, may be more related to the adaptive posture during smartphone use rather than its duration.

Selvaganapathy K et al (2013) [45] showed non significant change in craniovertebral angle (CVA) between regular users and addicted group. The mentioned reason was, smartphone do not produce considerable change in CVA , because based on their lower cervical spine changes , upper cervical region started undergoing natural changes ,while using smartphone in usual positions.

SUMMARY

The present study “Evaluation of effect of smartphone overuse on cervicofacial muscles and cervical spine” was carried out to evaluate the changes in cervicofacial muscles and cervical spine in smartphone overusers.

The study was conducted on total 195 healthy individuals using smartphone for minimum of one year. Participants were in the age range of 18-28 years. Information regarding their smartphone use habits was gathered using a SAS-SV questionnaire and accordingly divided them into addicted and non-addicted groups. Clinical examination of total six cervicofacial muscles were carried out on the basis of two clinical parameters i.e. tenderness and spasm. After clinical examination ,all the participants underwent lateral cephalometric examination of cervical spine to evaluate the effect of smartphone on it.

The observations of the study were subjected to statistical analysis and results were tabulated .

Thus, the present study represents the best attempt to evaluate the effect of smartphone overuse on cervicofacial muslces and cervical spine and following conclusions were drawn:

1. Young adults in the age range of 18-28 years were more addicted (n=130) to smartphones.
2. Gender differences was associated with smartphone addiction with female predominance (n=141) than males(n=54).
3. Tenderness was present in cervicofacial muscles in both smartphone addicted group and non-addicted group except in sternocleidomastoid.
4. Muscle tenderness in smartphone addicted group - (Upper trapezius=48.5% , splenius capitus=23.1%, cervical spinae erector=47.3% , masseter=10%, temporalis=2.3%) .
5. Muscle tenderness in non-addicted group (upper trapezius=50.8% ,splenius capitus=24.6%,cervical spinae erector=29.8%, masseter=7.7%) .
6. None of the cervicofacial muscles developed spasm in both the groups.
7. The cervical lordosis angle(CVT/EVT) showed non-significant changes between addicted (6.21 ± 2.78^{o}) and non-addicted group (6.31 ± 1.57^{o}). Also craniocervical angle (NSL/CVT) showed non-significant differences between addicted (101.87 ± 4.53^{o}) and non-addicted group (102.71 ± 1.64^{o}).Although ,

the result was non-significant , but there was reduced angular measurements seen in both of these angles in addicted group as compared to non-addicted group.

8. Whereas , craniovertebral angle(NSL/OPT) was significantly reduced in addicted group (98.99±4.88 ^{o}) when compared to non-addicted group (104.86±2.38 ^{o}) represented the probable forward head posture in smartphone addicted individuals.

Limitations and future perspectives

1. The sample size in the present study was limited to 195 subjects. Further, larger sample size studies would be desirable to substantiate the present study results and to confirm and reveal the exact pathophysiology underlying such changes.

2. Future studies should be focus on comparison with control group (smartphone non-users) for obtaining more significant results.

3. In this study , young adult population was kept on focus considering they were more prone for smartphone addiction, but in future, wide age range studies would be require, as smartphone use becoming a routine pattern of all ages in today's modern world.

4. In the present study , no consideration was given for the frequency and duration of smartphone use for evaluating its effect, which facilitate the further research to evaluate the effects of duration and frequency of smartphone overuse on musculoskeletal system.

CONCLUSION

The smartphone has captured great importance in the modern life with the multiple functions associated with it, but keeping its adverse effect in mind we can't deny that we are carrying a silent killer with us.

From the present study , we can conclude that smartphone overuse is associated with muscular disorders and also has its adverse effect on the cervical spine which may bring out various future complications. Although in todays technological era , many of the mandatory functions are carried out with the smartphones , so avoiding its use is beyond our imagination, but , at the same time considering its adverse effects , we recommend to bring out its use, by maintaining the proper body posture ,minimizing excessive downward head tilt , holding the device as much away from the head, reducing the frequency and duration of its use and maintaining the frequent time gap between its uses to avoid further potential complications associated with it.

REFERENCES

1. Madhumitha J. Number of Smartphone users in India 2015-2022.2019. https://www.statista.com/statistics/467163/forecast-of-smartphone-users-in-india/

2. Bala K, Sharma S, Kaur G. A study on smartphone based operating system. International Journal of Computer Applications. 2015;121:17-22.

3. Kee IK, Byun JS, Jung JK, Choi JK. The presence of altered craniocervical posture and mobility in smartphone-addicted teenagers with temporomandibular disorders. Journal of physical therapy science. 2016;28(2):339-46.

4. Berkman E, Donde R, Rock D. A Social Neuroscience Approach to Goal Setting for Coaches. Beyond Goals: Effective Strategies for Coaching and Mentoring. 2016 Apr; 15:109.

5. Kim SY, Koo SJ. Effect of duration of smartphone use on muscle fatigue and pain caused by forward head posture in adults. Journal of physical therapy science. 2016;28(6):1669-72.

6. Samir SM, Elshinnawy AM, Abd Elrazik RK, Battesha HH. The long-term effect of smartphone overuse on Cervical Posture and range of motion in asymptomatic sedentary adults. Journal of Advanced Pharmacy Education & Research. 2019;9(4):89-95.

7. Silver L, Smith A, Johnson C, Jiang J, Anderson M, Rainie L. Use of smartphones and social media is common across most emerging economies. Pew Research Center. 2019 .

8. 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):e83558.

9. Lee YS. Biological model and pharmacotherapy in Internet Addiction. J Korean Med Assoc.2006 ; 49(3):209-14.

10. Akodu AK, Akinbo SR, Young QO. Correlation among smartphone addiction, craniovertebral angle, scapular dyskinesis, and selected anthropometric variables in physiotherapy undergraduates. Journal of Taibah University Medical Sciences. 2018 ;13(6):528-34.

11. Alonazi A, Daher N, Alismail A, Nelson R, Almutairi W, Bains G. The Effects Of Smartphone Addiction On Childrens Cervical Posture And Range Of Motion. Int J Physiother.2019; 6(2):32-39.

12. 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;8(9):2953-59.

13. Karkusha RN, Mosaad DM, Abdel Kader BS. Effect of smartphone addiction on neck function among undergraduate physical therapist students. The Egyptian Journal of Hospital Medicine. 2019;76(4):4034-38.

14. Tavakolizadeh J, Atarodi A, Ahmadpour S, Pourgheisar A. The prevalence of excessive mobile phone use and its relation with mental health status and demographic factors among the students of Gonabad University of Medical Sciences in 2011-2012. Razavi Int J Med. 2014;2(1):e15527.

15. 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 ;4(2):85-92.

16. Aljomaa SS, Qudah MF, Albursan IS, Bakhiet SF, Abduljabbar AS. Smartphone addiction among university students in the light of some variables. Computers in Human Behavior. 2016;61:155-64.

17. Bisen S, Deshpande Y. An analytical study of smartphone addiction among engineering students: a gender differences. The International Journal of Indian Psychology. 2016;4(1):70-83.

18. 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;17(1):1-9.

19. Blatter BM, Bongers PM. Duration of computer use and mouse use in relation to musculoskeletal disorders of neck or upper limb. International Journal of Industrial Ergonomics. 2002;30(4-5):295-306.

20. Mooma RK, Sing LP, Moom N. Prevalence of musculoskeletal disorder among computer bank office employees in Punjab (India): A case study. Procedia Manufacturing. 2015;3:6624-31.

21. Szeto GP, Straker L, Raine S. A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers. Applied ergonomics. 2002 ;33(1):75-84.

22. James C, James D, Nie V, Schumacher T, Guest M, Tessier J, et al. Musculoskeletal discomfort and use of computers in the university environment. Applied ergonomics. 2018;69:128-35.

23. Ramnaath M, Sudharsan S, Yadhav KS, Priya DB, Subramaniyam M. Muscle Fatigue and Head Flexion Angle Analysis while using Smartphone.IOP Conference Series: Materials Science and Engineering .2020;912:062017.

24. Korpinen L, Paakkonen R.Physical symptoms in young adults and their use of different computers and mobile phones. Int J Occup Saf Ergon.2011;17:361-71.

25. Mekhora K, Liston CB, Nanthavanij S, Cole JH. The effect of ergonomic intervention on discomfort in computer users with tension neck syndrome. International Journal of Industrial Ergonomics. 2000 ;26(3):367-79.

26. McHanwell S. The back. In:Standring S, editor. Gray's Anatomy The Anatomical Basis of Clinical Practice.40th ed. Churchill Livngstone: Elsevier 2008.p 707-748.

27. Berolo S, Wells RP, Amick III 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(2):371-8.

28. Shan Z, Deng G, Li J, Li Y, Zhang Y, Zhao Q. Correlational analysis of neck/shoulder pain and low back pain with the use of digital products, physical activity and psychological status among adolescents in Shanghai. Plos one. 2013 ;8(10):e78109.

29. So YJ, Woo YK. Effects of smartphone use on muscle fatigue and pain and, cervical range of motion among subjects with and without neck muscle pain. Physical Therapy Korea. 2014;21(3):28-37.

30. Lee JI, Song HS. The correlation analysis between hours of smartphone use and neck pain in the Gachon university students. Journal of Acupuncture Research. 2014;31(2):99-109.

31. Lee M, Hong Y, Lee S, Won J, Yang J, Park S. The effects of smartphone use on upper extremity muscle activity and pain threshold. Journal of physical therapy science. 2015;27(6):1743-5.

32. Lee KJ, Han HY, Cheon SH, Park SH, Yong MS. The effect of forward head posture on muscle activity during neck protraction and retraction. Journal of physical therapy science. 2015;27(3):977-9.

33. AlZarea BK, Patil SR. Mobile phone head and neck pain syndrome: proposal of a new entity. OHDM.2015;14 – 5:313-17.

34. Xie Y, Szeto GP, Dai J, Madeleine P. A comparison of muscle activity in using touchscreen smartphone among young people with and without chronic neck–shoulder pain. Ergonomics. 2016 ;59(1):61-72.

35. Kim SY, Koo SJ. Effect of duration of smartphone use on muscle fatigue and pain caused by forward head posture in adults. Journal of physical therapy science. 2016;28(6):1669-72.

36. Choi JH, Jung MH, Yoo KT. An analysis of the activity and muscle fatigue of the muscles around the neck under the three most frequent postures while using a smartphone. Journal of physical therapy science. 2016;28(5):1660-64.

37. Kim YL, Yoo JH, Kang SW, Kim TR, Kim NY, Hong SJ et al. The comparison of muscle activity according to various conditions during smartphone use in healthy adults. Physical Therapy Rehabilitation Science. 2016;5(1):15-21.

38. Lee S, Choi YH, Kim J. Effects of the cervical flexion angle during smartphone use on muscle fatigue and pain in the cervical erector spinae and upper trapezius in normal adults in their 20s. Journal of physical therapy science. 2017;29(5):921-23.

39. AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. Musculoskeletal care. 2017 ;15(1):1-3.

40. Iqbal MH ,Ahmad A , Gillani SA , Hanif K , Iqbal Z. Association of neck pain with use of android phone and its daily usage among students of universities of lahore. International Journal of Scientific & Engineering Research. 2017;8(9):485-94.

41. 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 ;5(6):2512-6.

42. 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(1):17-19.

43. Namwongsa S, Puntumetakul R, Neubert MS, Boucaut R. Effect of neck flexion angles on neck muscle activity among smartphone users with and without neck pain. Ergonomics. 2019 ;62(12):1524-33.

44. Irshad N, Raza S, Moiz JA, Mujaddadi A, Bhati P. Electromyographic analysis of upper trapezius, abductor pollicis longus and abductor pollicis brevis during smartphone use in different positions among young male and female subjects. International journal of adolescent medicine and health. 2019 ;1.

45. Selvaganapathy K, Rajappan R, Dee TH. The effect of smartphone addiction on craniovertebral angle and depression status among university students. International Journal of Intagrative Medical Sciences. 2017;4(5):537-42.

46. Shin H, Kim K. Effects of cervical flexion on the flexion-relaxation ratio during smartphone use. Journal of physical therapy science. 2014;26(12):1899-901.

47. Lee J, Seo K. The comparison of cervical repositioning errors according to smartphone addiction grades. Journal of physical therapy science. 2014;26(4):595-8.

48. 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(3):12-17.

49. Kim MS. Influence of neck pain on cervical movement in the sagittal plane during smartphone use. Journal of physical therapy science. 2015;27(1):15-7.

50. 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(1):186-89.

51. Kietrys DM, Gerg MJ, Dropkin J, Gold JE. Mobile input device type, texting style and screen size influence upper extremity and trapezius muscle activity, and cervical posture while texting. Applied ergonomics. 2015 ;50:98-104.

52. Guan X, Fan G, Wu X, Zeng Y, Su H, Gu G et al. Photographic measurement of head and cervical posture when viewing mobile phone: a pilot study. European Spine Journal. 2015 ;24(12):2892-8.

53. Lee SY, Lee DH, Han SK. The effects of posture on neck flexion angle while using a smartphone according to duration. Korean Society of Physical Medicine. 2016 ;11(3):35-9.

54. Guan X, Fan G, Chen Z, Zeng Y, Zhang H, Hu A et al. Gender difference in mobile phone use and the impact of digital device exposure on neck posture. Ergonomics. 2016 ;59(11):1453-61.

55. Alshahrani A, Aly SM, Abdrabo M , Asiri F. Impact of smartphone usage on cervical proprioception and balance in healthy adults. Biomedical Research 2018; 29 (12): 2547-52.

56. Samaan MN, Elnegmy EH, Elnahhas AM, Hendawy A. Effect of prolonged smartphone use on cervical spine and hand grip strength in adolescence. Int J Multidiscip Res Dev. 2018;5(9):49-53.

57. Samir SM, Elshinnawy AM, Abd Elrazik RK, Battesha HH. The long-term effect of smartphone overuse on Cervical Posture and range of motion in asymptomatic sedentary adults. Journal of Advanced Pharmacy Education & Research. 2019;9(4):89-95.

58. Alfaitouri S, Altaboli A. The Effect of Posture and Duration of Smartphone Usage on Neck Flexion Angle. InProceedings of the Human Factors and Ergonomics Society Annual Meeting.2019;63:962-66.

59. Mani MS, Ahamed SY, Kavithagiri NL, Ambiga P, Sivaraman G, Balan N. Association of Mobile Phone Usage in Patients with Temporomandibular Joint Disorders--A Comparative Study. Journal homepage: www. nacd. in Indian J Dent Adv. 2019;11(3):79-85.

60. Wiguna NP, Wahyuni N, Indrayani AW, Wibawa A, Thanaya SA. The Relationship Between Smartphone Addiction and Forward Head Posture in Junior High School Students in North Denpasar. Jurnal Epidemiologi Kesehatan Komunitas. 2019 ;31:84-9.

61. Chheda P, Pol T. Effect of Sustained Use of Smartphone on the Craniovertebral Angle and Hand Dexterity in Young Adults. International Journal of Science and Research. 2019 ; 8(7):1387-90.

62. Boro T, Nagrale O. The prevalence of cervical extension deficit among young adults: a cross-sectional observational study. International J of Physical Education, Sports and Health.2020;7(2):120-24.

63. Mohammed AH. Head Posture and Functional Ability of Upper Extremity in Adolescents Use Smartphone. Medico Legal Update. 2020.;20(2):647-52.

64. D'Attilio M, Epifania E, Ciuffolo F, Salini V, Filippi MR, Dolci M et al. Cervical lordosis angle measured on lateral cephalograms; findings in skeletal class II female subjects with and without TMD: a cross sectional study. The Journal of Craniomandibular Practice.2004 ;22(1):27-44.

65. Sonnesen L, Pedersen CE, Kjær I. Cervical column morphology related to head posture, cranial base angle, and condylar malformation. The European Journal of Orthodontics. 2007 ;29(4):398-403.

66. Bebnowski D, Hänggi MP, Markic G, Roos M, Peltomäki T. Cervical vertebrae anomalies in subjects with Class II malocclusion assessed by lateral cephalogram and cone beam computed tomography. The European Journal of Orthodontics. 2012 ;34(2):226-31.

67. Meibodi SE, Parhiz H , Hosein M, Motamedi K, Fetrati A, Morshedi E et al. Cervical vertebrae anomalies in patients with class III skeletal malocclusion. Journal of Craniovertebral Junction and Spine.2011;2(2):73-76.

68. Mesquita G ,Reimao R. Quality of sleep among university students Effects of night time computer and television use . Arq Neuropsiquiatr .2010;68(5):720-25 .

69. Cha S ,Seo BK. Smartphone use and smartphone addiction in middle school students in Korea: Prevalence, social networking service, and game use . Health Psychology Open.2018: 1–15.

70. Grant J, Potenza M, Weinstein A, Gorelick D .Introduction to Behavioral Addictions. J Drug Alcohol Abuse. 2010 ; 36(5): 233-41.

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

72. Viljanen M, Malmivaara A, Uitti J, et al. Effectiveness of dynamic muscle training, relaxation training, or ordinary activity for chronic neck pain: randomised controlled trial. BMJ.2003; 327: 475.

73. Chung MK, Choi KI: Ergonomic analysis of musculoskeletal discomforts among conversational VDT operators. Comput Inderstrial Eng. 1997;33: 521–24

74. Kraemer WJ, Volek JS, Bush JA, et al. Influence of compression hosiery on physiological responses to standing fatigue in women. Med Sci Sports Exercise. 2000; 32: 1849–58.

75. Qadir M , Mushtaq M .Cephalometric evaluation of cervical column curvature with respect to sagittal jaw position .International Journal of Applied Dental Sciences .2017; 3(4): 238-42.

ANNEXURE

Title of Research-Evaluation of effect of smartphone overuse on cervicofacial muscles and cervical spine

SAS-SV QUESTIONNAIRE FOR ASSESSMENT OF SMARTPHONE ADDICTION

Age- Gender-

Since how long you are using smartphone?

SR No	QUESTIONS	STRONGLY DISAGREE (1)	DISAGREE (2)	SLIGHTLY DISAGREE (3)	SLIGHTLY AGREE (4)	AGREE (5)	STRONGLY AGREE (6)
1.	Missing planned work due to smartphone use.						
2.	Having a hard time concentrating in class while doing assignments ,or while working due to smartphone use						
3.	Feeling pain in the wrist or at the back of the neck while using a smartphone						
4.	Wont be able to stand not having s smartphone.						
5.	Feeling impatient and fretful when I am not holding my smartphone.						
6.	Having my smartphone in my mind even when I am not using it.						
7.	I will never give up using						

	my smartphone even when my daily life is already affected by it.						
8.	Constantly checking my smartphone so as not to miss conversations between other people on Twitter or Facebook or Whatsapp.						
9.	Using my smartphone longer than I had intended.						
10.	The people around me tell that I use my smartphone too much.						

SCORE- ________________

(Score=Total of all score responses)

(Cut-off value for girls-33 and for boys-31)

INFERENCE-Addicted/Non-addicted

Signature of Assessor- Signature of Patient-

CASE HISTORY PROFORMA

Registration no. : Date:

Name : Age/Sex :

Address :

Chief complaint:

History of present illness :

Past Medical history:

Past Dental history:

Addictive Habits:

Oral hygiene habits:

Parafunctional habits:

Bruxism/tooth clenching

<u>Extraoral examination</u>

Facial symmetry

TMJ-

Maximum interincisal distance-

Clicking-

Jaw deviations-

Tenderness-

Trismus-

Hypermobility-

Cervicofacial Muscles examination-

Sr. No.	**Name of the Muscles**	**Clinical Parameters**	
		Tenderness	**Spasm**
1.	Upper Trapezius		
2.	Sternocleidomastoid		
3.	Splenius capitus		
4.	Cervical spinae erector		
5.	Masseter		
6.	Temporalis		

<u>Intraoral examination:</u>

<u>Hard tissue examination:</u>

<u>Soft tissue examination :</u>

<u>Provisional Diagnosis</u>

INVESTIGATIONS-

Cervical spine angles analysis

Lateral Cephalograph- Cervical Spine Angle	**Normal Reference Range**	**Patients Value**	**Normal**	**Increased**	**Decreased**
1- Cervical lordosis Angle (CVT/EVT)	6.64±4.91				
2-Craniocervical Angle (NSL/OPT)	102.87±8.09				
3-Craniocervical Angle (NSL/CVT)	107.07±7.80				

Inference-

INFORMED CONSENT FORM

Evaluation of effect of smartphone overuse on cervicofacial muscles and cervical spine.

Patients I.D.:

I, Mr./Master/Mrs./Miss.____

Resident of: ________________________________ aged _____ years, exercising my free will/choice, without any pressure/lure of incentive in any form, hereby give my consent/consent on behalf of patient named

Mr./Master/Mrs./Miss.__________________________ Resident of:

______________________aged _____ years, as his/her ___________________.

I acknowledge that doctor has informed me about this research project suitably and sufficiently to my satisfaction. I agree to let my X-rays, photographs, impressions and other investigations to be taken as required. I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time. I shall inform the doctor on any adverse effects or unusual symptoms noticed by me. I shall co-operate with the doctors and paramedical staff, in all respects. I permit to publishing the results of my participation in this study. I shall not be given any reimbursement or compensation. I have been informed of my right to opt out of this research project at any time without giving any reason for doing so.

I hereby record my consent for participation in the said trial.

1	________________	_____________	______	_________
	Patient's name	Signature/thumbprint	Date	Time
Or				
	________________	_____________	______	_________
	Person providing consent	Signature/thumbprint	Date	Time
2	________________	_____________	______	_________
	Witness name	Signature	Date	Time
2	________________	_____________	______	_________
	Investigator's name	Signature	Date	Time

INFORMED CONSENT FORM

Evaluation of effect of smartphone overuse on cervicofacial muscles and cervical spine.

वैयक्तिक जाणकारी

मरीज का नाम :

उमर / लिंग :

पत्ता :

मोबाईल नंबर :

मैं मानता हू कि चिकित्सक ने मुझे इस शोध परियोजना के बरे मी उपयुक्त और पर्याप्त रूप से मेरी संतुष्टी के बारे में बताया है. मै अपने एक्स रे, फोटो, इंप्रेशन और अन्य जांचो को जरुरी रूप में लेणे के लिये सहमत हू. मै इस परियोजना में भाग लेणे के लिये सहमत हूं और इस परीक्षण कि अवधिके दौरान किसी भी अन्य परियोजनाओ को मिला नही करेगा. मैं सभी मामलो में डॉक्टर और पेरामेडिकल स्टाफ के साथ मिलकर काम करुंगा. मैं इस अध्ययन में अपनी भागीदारी के परिणामोको प्रकाशित करणे कि अनुमती देता हूं. मुझे कोई प्रतीपूर्ती या क्षतीपूर्ती नही दि जायेगी. मुझे ऐसा करणे के लिये किसी भी कारण के बिना किसी भी समय इस शोधपरीयोजनासे ऑप्टआऊट करणे का मेरे अधिकार के बरे में सूचित किया गया है. मैं एतद्वारा परीक्षण में भाग लेणे के लिये मेरी सहमती रिकॉर्ड करता हूं.

मरीज का नाम	सही	तारीख	समय
साक्षीदार	सही	तारीख	समय
डॉक्टर का नाम	सही	तारीख	समय

INFORMED CONSENT FORM

Evaluation of effect of smartphone overuse on cervicofacial muscles and cervical spine.

वैयक्तीक माहिती

रुग्णाचे नाव : दिनांक :

वय/लिंग :

पत्ता :

मोबाईल नंबर :

मी कबूल करतो की डॉक्टरांनी मला या संशोधन प्रकल्पाबद्दल समाधानकारक माहिती दिली आहे. मी माझ्या एक्स-रे, छायाचित्रे, इंप्रेशन आणि आवश्यकतेनुसार अन्य तपासण्या करण्यास सहमत आहे. मी या प्रकल्पात भाग घेण्यास सहमती देतो आणि या चाचणीच्या कालावधीत कोणतेही अन्य प्रकल्प एकत्रित करणार नाही. मला डेन्टल हॉस्पिटल किंवा इतर ठिकाणी दिलेल्या भेटीची तारीख आणि वेळ सांगितली आहे. मी डॉक्टर आणि पॅरामेडिकल कर्मचा-यांना सर्व बाबतीत सहकार्य करेल. या अभ्यासात मी माझ्या सहभागाचे निकाल प्रकाशित करण्यास परवानगी देतो. मला कोणतीही नुकसान भरपाई दिली जाणार नाही. असे करण्यासाठी कोणतेही कारण न देता मला कोणत्याही वेळी या संशोधन प्रकल्पातून बाहेर पडण्याचा अधिकार मिळालेला आहे. मी या अन्वये केलेल्या चाचणीत सहभागासाठी माझी संमती नोंदवित आहे.

________	________	________	________
१) रूग्णाचे नाव	स्वाक्षरी	तारीख	वेळ
________	________	________	________
२) साक्षीदाराचे नाव	स्वाक्षरी	तारीख	वेळ
________	________	________	________
३) डॉक्टरचे नाव	स्वाक्षरी	तारीख	वेळ

MASTER CHART

Sr.no.	Age	Sex	Addiction status	Cervicofacial_muscle_ evaluation - TENDERNESS						Cervicofacial_muscle_ evaluation - SPASM						Cervical Lordosis Angle	Craniocervical Angle CVT	Craniocervical Angle OPT
				Masseter	Temporals	Trapezius	Sternocleidomastoid	Splenius capitis	cervical spinae erector	Masseter	Temporals	Trapezius	Sternocleidomastoid	Splenius capitis	cervical spinae erector			
1	22	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	101	95
2	22	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	101	100
3	24	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	107	105
4	26	F	Addicted	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	98	99
5	22	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	10	105	96
6	21	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	104	103
7	24	M	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	93	92
8	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	11	100	96
9	22	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	10	102	100
10	25	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	1	100	96
11	23	F	Addicted	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	104	98
12	25	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2	88	85
13	28	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	94	95
14	26	F	Addicted	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	104	102
15	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	99	94
16	24	F	Addicted	Present	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2	102	95
17	18	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	107	105
18	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	108	101
19	26	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	94	91
20	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	98	94
21	21	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	90	84

22	27	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	12	101	100
23	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	100	95
24	25	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	102	99
25	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	12	105	100
26	19	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	96	88
27	21	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2	103	99
28	23	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	94	87
29	27	F	Addicted	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	100	97
30	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	98	97
31	27	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	108	103
32	26	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	99	98
33	23	F	Addicted	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	11	99	89
34	21	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2	98	98
35	22	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	9	106	105
36	25	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	9	101	93
37	21	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	10	107	102
38	23	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	101	98
39	26	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	11	91	87
40	23	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	93	97
41	22	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	107	103
42	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	111	105
43	21	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	17	105	96
44	20	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	104	99
45	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	107	103
46	21	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	108	102
47	26	F	Addicted	Present	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	100
48	25	M	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	101	103
49	26	F	Addicted	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	106	102
50	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	102	101
51	23	F	Addicted	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	102	104
52	24	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	104	101
53	24	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	102	103
54	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	103	101
55	25	F	Addicted	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	101	101

56	23	F	Addicted	Present	Present	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	108	102
57	22	M	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	102
58	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	109	107
59	22	M	Addicted	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	108	101
60	24	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	101	102
61	23	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	104	102
62	25	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	105	103
63	21	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	106	103
64	23	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	12	101	101
65	24	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	105	103
66	23	M	Addicted	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	104	101
67	22	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	106	99
68	22	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	105	104
69	24	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	104	103
70	24	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	101	98
71	23	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	98	99
72	24	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	105	96
73	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	104	103
74	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	93	94
75	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	10	101	97
76	23	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	9	101	100
77	24	M	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	1	100	96
78	23	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	104	98
79	22	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2	90	85
80	23	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	94	96
81	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	104	101
82	22	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	99	96
83	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	103	95
84	26	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	108	105
85	21	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	107	101
86	23	M	Addicted	Present	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	94	91
87	22	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	98	94
88	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	90	84
89	22	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	11	100	100

90	22	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	101	98
91	21		Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	102	99
92	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	11	105	102
93	21	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	96	89
94	19	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2	103	99
95	19	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	94	89
96	23	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	104
97	24	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	101
98	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	102	103
99	21	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	103	101
100	22	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	101	101
101	22	M	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	102
102	23	M	Addicted	Present	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	102
103	21	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	108	107
104	24	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	108	101
105	24	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	102
106	25	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	104	102
107	27	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	105	103
108	23	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	106	103
109	26	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	10	101	101
110	21	F	Addicted	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	105	103
111	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	104	101
112	25	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	106	99
113	22	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	104
114	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	105	103
115	22	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	100	98
116	22	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	99	99
117	24	M	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	101
118	23	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	107	105
119	24	F	Addicted	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	110	107
120	18	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	102	101
121	26	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	101	100
122	26	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	107	105
123	24	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	105	102

124	19	F	Addicted	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	100	99
125	23	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	101	98
126	25	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	9	99	98
127	23	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	100	98
128	22	F	Addicted	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	101	100
129	24	F	Addicted	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	102	100
130	25	F	Addicted	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	3	96	95
1	26	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	102	105
2	23	M	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	10	104	103
3	21	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	105	107
4	19	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	104	108
5	24	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	101	103
6	27	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	101
7	26	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	106
8	23	M	Non-addicte	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	101	102
9	21	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	104	102
10	24	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	101	104
11	26	F	Non-addicte	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	102
12	21	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	101	103
13	25	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	101	101
14	26	M	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	108
15	25	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	103
16	21	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	107	109
17	22	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	101	108
18	24	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	101
19	23	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	104
20	21	M	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	103	105
21	22	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	106
22	23	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	12	101	101
23	21	M	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	105
24	22	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	101	104
25	21	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	104
26	24	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	107
27	23	F	Non-addicte	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	107
28	21	F	Non-addicte	Present	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	102	107
29	21	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	9	102	106

30	25	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	101	105
31	22	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	104
32	23	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	105
33	25	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	9	103	104
34	21	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	103	104
35	22	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	103	106
36	23	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	106
37	23	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	101	103
38	22	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	101	100
39	23	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	107	107
40	25	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	107	108
41	26	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	102	100
42	22	S	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	104	107
43	21	M	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	106	109
44	24	F	Non-addicte	Present	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	108
45	20	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	104
46	26	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	102	102
47	19	M	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	101
48	26	M	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	100	101
49	23	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	102	105
50	21	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	107
51	26	F	Non-addicte	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	107
52	22	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	108
53	27	M	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	101	108
54	22	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	101	104
55	25	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	106
56	21	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	6	103	104
57	28	M	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	101	105
58	24	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	103	106
59	25	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	101	103
60	27	F	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	107
61	21	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	4	105	107
62	20	F	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	102	106
63	20	M	Non-addicte	Absent	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	8	103	105
64	25	M	Non-addicte	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	7	103	105
65	21	F	Non-addicte	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	5	105	107