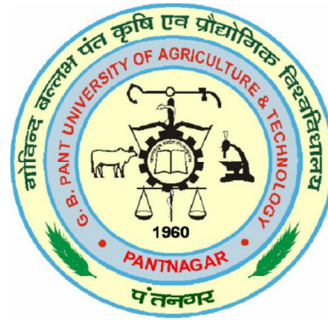


**PSYCHOLOGICAL ASSESSMENT AND POSTURAL
ANALYSIS OF SMARTPHONE USERS**

Thesis

Submitted to the



**G. B. Pant University of Agriculture & Technology
Pantnagar- 263145, Uttarakhand, India**

By

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M.Sc. (Family Resource Management)

***IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF***

Doctor of Philosophy
(Family Resource Management)

JUNE, 2018

Acknowledgement

*All glory to the **God**? - The creator-The supreme Power- the Light or whatever He is, has helped me in all adversities, at every step, on each moment, whose blessing is the success behind this Thesis. Praise, pride and perfection belong to the Almighty, so first of all I would like to express my deepest sense of gratitude to the omniscient and omnipresent power of the Universe, the Almighty God.*

*I am overwhelmed with joy to evince my profound sense of reverence and gratitude to **Dr. Deepa Vinay**, Professor and Head, Department of Family Resource Management and Chairman of my Advisory Committee, for her inspiring guidance, peerless but constructive criticism and continuous encouragement through the tenure of my investigation and preparation of dissertation. She has turned all the stones to complete my thesis work earlier within the due date so that I perceive in all the dimensions of life in her enlightening association.*

*I express gratitude from the depth of my heart and keen thanks to the respected members of my advisory committee, **Dr. A. K. Shukla**, Professor and Head, Department of Statistics and Computer Science, **Dr. R. K. Srivastava**, Professor, Department of Environmental Sciences and **Dr. Seema Kwatra**, Professor, Department of Family Resource Management for their interest, congenial discussions and valuable technical advice in making this task a success.*

I wish to extend my sincere thanks to Dean, College of Home Science, Dean College of Post Graduate Studies, Registrar, all my Professors and Librarian for providing me the essential facilities to conduct the proposed investigation.

*Where emotions are involved words fell short to pay regards to my parents **Mr. Rajendra Prasad Gautam** and **Mrs. Kamla Gautam**, “the maker of my life”. My soul existence is fabricated with their boundless love, immaculate affection, and constant inspiration and scarifies that made me competent enough to fight the battle of life and achieve the goal. With deep sense of respect I feel indebted to them.*

*I cannot forget the love, moral support and co-operation received from my elder brother **Dr. Atul Gautam**, my sister **Minakshi Gautam** and younger brother **Rahul Gautam** who encouraged and helped me in every struggling movement of my life.*

Now the time to express my heartiest thanks to my seniors Bhupindar Aulakh, Anupriya Singh, Monika Negi and Hema Upadhayay, friends Mamta, Upasana, Pankaj, Richa, Avantika and Bhawana. I express heartiest thank to my loving juniors Shweta, Sonia, Deepika and Deepti who encouraged and helped me in every struggling moment of my life.

I am also thankful to all teaching and non-teaching staff members of Department of Family Resource Management for their help and co-operation. The financial assistance offered to me during entire course of Ph.D. degree by UGC helped me to conduct my studies without economic constraints. I, therefore extend my heartfelt thanks to UGC.

I express my thanks to respondents for their cooperation and willingness to provide relevant information.

I also thank those who could not find separate name but had helped me directly or indirectly.

*Pantnagar
June, 2018*

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(Diksha Gautam)
Authoress

C E R T I F I C A T E

This is to certify that the thesis entitled “**PSYCHOLOGICAL ASSESSMENT AND POSTURAL ANALYSIS OF SMARTPHONE USERS**” submitted in partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY** with major in **FAMILY RESOURCE MANAGEMENT** and minor in **ENVIRONMENTAL SCIENCES** of the College of Post-Graduate Studies, G.B. Pant University of Agriculture and Technology, Pantnagar, is a record of *bona-fide* research carried out by **Ms. DIKSHA GAUTAM, Id. No. 47076** under my supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been acknowledged.

Pantnagar
June, 2018



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We, the undersigned, members of the Advisory Committee of **Ms. DIKSHA GAUTAM, Id. No. 47076** a candidate for the degree of **DOCTOR OF PHILOSOPHY** with major in **FAMILY RESOURCE MANAGEMENT** and minor in **ENVIRONMENTAL SCIENCES** agree that the thesis entitled **“PSYCHOLOGICAL ASSESSMENT AND POSTURAL ANALYSIS OF SMARTPHONE USERS”** may be submitted in partial fulfillment of the requirements for the degree.



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(Ex-officio member)
Head of the department

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Introduction



Technology and society are very much interconnected in the 21st century. In this technological era, we are surrounded with several electronic gadgets, which are making our lives easy and convenient in various aspects. In this contemporary world, smartphone is one of most popular device. Technically, Smartphone is a mobile phone that goes beyond the functions of a simple portable phone and phonebook. It is a phone which is wireless and can be carried anywhere. earlier it was not possible for a person to imagine such a device which will be handy, user friendly and can be used for communication, education, gaming, music, camera, internet surfing and news etc. by being at one place. Smartphones have made it possible to access all over the world by just one click.

Nowadays, Smartphones are increasingly becoming an integral part of our lives because of many features such as phone calls, text messaging, camera, internet and many more. Smartphones have made it possible to make task easy and accessible but has also made it a target to malware developers. And while smartphones are great weavers of communication, it can become a nuisance to those who value face-to-face communication (**Rysavy, 2010**).

India is the second most populous country in the world having 340 million smartphone users in 2017 that is more than the smartphone users of U.S. (**Statista.com, 2017**). With greater availability and many exclusive features of smartphone, its use is excessively increased among adolescents and young adults leading to many psychological problems and postural problem. As per India’s Census 2011, Youth (15-24 years) in India constitutes one-fifth (19.1%) of India’s total population. According to **Bianchi and Phillips (2005)**, younger people are more likely to spend an excessive amount of time on their mobile phones than older people which makes them more vulnerable to mobile phone-related problems. Nielsen informed mobile insights also reported that in India half of the smartphone users i.e. 48 percent, younger than 25 years means a majority of smartphone users comes under the 18-24 years of age group.

Smartphone is one the most popular communication devices in this modern world. It is kind of a device which has almost every advanced features and connectivity

options similar to the traditional computer. These features enable new kinds of mobile services that in turn shape the usage habits of smartphone users (**Alfawareh and Jusoh, 2014**). University students are among the highest contributors to the increasing number of smartphone sales. The factor that most influences the increase in smartphone usage is the functionality that helps users in their daily life especially business people and university students (**Jacob and Isaac, 2008**).

In recent years, most of the global populations (especially college and university students), use smartphones, due to its wide range of applications. While beneficial in numerous ways, smartphones have disadvantages such as reduction in work efficacy, personal attention, social nuisance and psychological addiction. Currently, the addiction to smartphones among students is progressively increasing every year. Smartphone is becoming an integral part to students with regard to managing critical situations and maintaining social relationships. This behavior may reduce thinking capabilities, affect cognitive functions, and induce dependency. The signs of smartphone addiction are constantly checking the phone for no reason, feeling anxious or restless without the phone, waking up in the middle of night to check the mobile and communication updates, delay in professional performance as a result of prolonged phone activities, and distracted with smartphone applications.

A mental impairment resulting from modern technology has come to the attention of sociologists, psychologists, and scholars. Smartphone addiction and withdrawal from mobile network may increase anger, tension, depression, irritability, and restlessness which may alter the physiological behavior and reduce work efficacy.

Texting and other smartphone activities take a considerable amount of our time. When using a smartphone, people usually flex their neck downwards to stare at the lowered object and maintain the head in a forward position for long periods of time, which may cause musculoskeletal disorders that potentially causing an overall imbalance in the musculoskeletal system. Heavy smartphone users are commonly found to have forward head syndrome and a slouched posture. Staring at a smartphone display, which is located below a comfortable height for eyesight, for extended periods of time, makes the head tilt forward. Extended smartphone use can cause Forward Head Posture, myofascial syndrome of the hand, forearm, shoulder, and neck muscles, and depression. In addition, the weight supported by the spine dramatically increases when

the head is flexed forward at varying degrees. Therefore, heavy smartphone users lose the natural curve of the cervical spine and instead place increased amounts of stress on the cervical spine. These stresses may lead to changes in the cervical angle and the pain threshold of the neck and shoulder muscles.

Smartphone use in a static position and with an unsupported arm could bring about abnormal alignment of the neck and shoulders. Because smart phones have small monitors that are typically held downward near the laps, users must bend their heads to see the screens, increasing activity in the neck extensor muscles overloading the neck and shoulders increases muscle fatigue, declines work capacity, and affects the musculoskeletal system. Using smart phones for long duration of time cause repetitive use of certain muscles, resulting in muscle fiber injury, and cumulative damage from acute trauma, to the muscles of neck and shoulders.

Furthermore, young Smartphone users are vulnerable to severe musculoskeletal disorders as the duration of usage increased, its symptoms will also increase as well which can include fatigue and pains in the upper extremities, such as the neck, shoulders, arms, wrists, back of the hand, and fingers, in addition to pain in the waist. In addition, a poor posture lead to fatigue, which can have negative effects, such as reduced physiological function, disruption of the autonomic nervous system, daily life problems, and affects both the visual and the musculoskeletal systems.

When flexing the head forward at varying degrees, the forces experienced by the cervical spine considerably increase and lead to cervical curve loss, this may cause neck pain. Studies on the prevalence of smartphone use have reported that the distribution of musculoskeletal symptoms or pain of any severity was most common in the neck, followed by the upper back and then the shoulders. These results showed that the total time spent using a smartphone was significantly associated with any pain in the neck and shoulder (**Hansraj, 2014**).

Literature reports an adverse impact on the physical and psychological health of the users of Hand held device. The incidence of musculoskeletal disorders (MSD) of hand, wrist, forearm, arm and neck has been increasing all over the world due to prolonged, forceful, low amplitude, repetitive use of hand held devices. Sustained and gripping and repetitive movements with the thumb and fingers have all been identified

as risk factors which may lead to disorders of the thumb and thumb musculature in the forearm.

The fact that people use smartphones for so long is not surprising, although it is still worrying. **Berolo et al. (2011)** found out that 84 percent of study participants reported some sort of pain as a result of using a smartphone, mainly in the base of the thumb, hands, elbows, shoulders, neck and upper back. Since smartphones are often used in addition to laptops, desktop computers and tablets the risk of developing musculoskeletal disorders increases as the discomfort caused by different devices (**Karlson et al., 2009**).

Despite of necessity, the excess usage of smartphone has driven us into recognizable psychological illness such as personal illness, insecurity, low self-confidence, sleep disturbances, mood fluctuations, insomnia, neck pain and rigidity, dry eyes, computer vision syndrome, weakness of thumb and wrist, increased frequency of Quervain's tenosynovitis, nomophobia, misconceptions, auditory, and tactile hallucinations.

Some studies have indicated that the excessive use of smartphones has negative effects on human psychology. Excessive smartphone use reduces an individual's social implication in the real world and, as a consequence, his or her psychological well-being because it produces the kind of isolation, loneliness, and depression the individual seeks to ease by connecting to the Internet hence heavy smartphone users meet with their friends less often than smartphone (**Kraut et al., 2002**). The excessive user group experienced difficulty in expressing emotions than the comparison group did. Furthermore, the excessive user group had a higher level of interpersonal anxiety than the comparison group.

As on today, smartphone addiction, nomophobia, depression, isolation, lack of concentration, sleep disturbance has to be considered as the warning signs of excess dependence on smartphone in day to day life and to tackle these problems some preventive measures need to be undertaken to avoid the greater risk of psychological illness among young generations.

However, with all the advantages we gain from mobile technology comes the risk of serious and permanent health problems. There are various health problems that are arising due to excess use of smartphone some problems are psychological and some are postural however all these problems are related to risk of our human body.

Numerous studies in the recent years evidenced that this growing problem has a large impact globally specially on youngsters. It is a right time to assess the prevalence of smartphone related health problems and initiate preventive measures against smartphone overuse, among students and public health without further delay. Therefore the study focused on young college going students those are using smartphone more than other age groups and getting much attached and dependent to their smartphone for at least every work like education, entertainment, communication, news and other daily updates. Hence, the present study was conducted to assess the smartphone usage pattern and various health problems i.e. psychological problems, musculoskeletal disorders and visual problems due to excessive usage of smartphone among young adults. The present study has significant importance to spread awareness and to give preventive measures about smartphone related health issues so that this growing problem can be minimized among the upcoming workforce.

Justification of the study/ Scope of the study

The dependence of smartphone is increasing day by day and creating alarming situation especially for the young adults. Nowadays, it is a kind of device which has almost every advanced feature similar to the laptops/computers as it can be used for education, gaming, music, photos and chatting etc., the list is endless so with these features, smartphone became a new companion for the user. It is simply becoming a habit of the user to spend more time with their smartphone without taking care of their postures and usage pattern. Adopting poor postures while prolonged smartphone usage can lead to various health problems that will not be curable if left untreated.

As it is nearly impossible to avoid the technologies that cause these issues, individuals should have to be aware regarding proper ergonomic interventions that can reduce the incidence of smartphone related health problems. It is very important to consider the smartphone usage and the postures of the students so that the Musculoskeletal and Psychological disorders and its consequences can be controlled before it becomes an obsession. Thus, the present study was designed to evaluate the current practice of smartphone usage and the health problems arising from it. Hence,

this study entitled “**PSYCHOLOGICAL ASSESSMENT AND POSTURAL ANALYSIS OF SMARTPHONE USERS**” was conducted with the following objectives:

1. To find out the practices, usage pattern and standard of living of Smartphone users.
2. To analyse the posture and Musculoskeletal discomforts while using Smartphone.
3. To study the visual fatigue of selected Smartphone users.
4. To assess the psychological problems among youth due to excessive use of Smartphone.
5. Ergonomic intervention for creating the awareness among youth for the vigilant use of Smartphone.

Pursuing the research objectives, the following question will be addressed

- What are the current trend and usage pattern of smartphone among young generation?
- Does there any relation between smartphone use and MSD?
- Does smartphones affects psychological state of students?
- Arising risk factors due to smartphone usage that contribute to MSD?
- Is there any research to provide recommendations and guidelines for health concern and also for future product design?

Hypotheses

H₀1: There is no significant effect of

- i. Age on Addiction and Depression level
- ii. Settlement type on the Smartphone Addiction and Depression level

H₀2: There is no significant relationship between Smartphone Addiction and Depression level of girls and boys

H₀3: There is no significant effect of

- i. Age on Visual Fatigue

- ii. Addiction level on Visual fatigue
- iii. Smartphone usage hours on visual fatigue

H₀4: There is no significant difference in before and after use grip strength of girls and boys.

H₀5: There is no significant difference in before and after use pinch strength of girls and boys.

H₀6: There is no significant effect of green light before and after use of smartphone in the girls and boys.

H₀7: There is no significant effect of red light before and after use of smartphone in the girls and boys.

H₀8: There is no significant difference of posture on neck flexion angle of girls and boys in different durations.

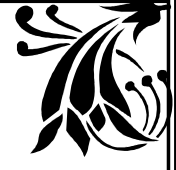
ASSUMPTION

The present study was undertaken with following assumptions:

- The students are suffering from musculoskeletal problems because of excessive use of smartphone.
- The users were adopting unnatural posture while using smartphone which was affecting their health.

Focus of the study

1. The study focused on the students of G.B. Pant University of Agriculture and Technology, Pantnagar.
2. Only 5% sample from the total population was focused for the present study.
3. The study focused on the students in the age group of 18 to 24 years only.



*Review
of
Literature*



The comprehensive list of Review of Literature is an integral part of any research endeavour. The main function of the review of literature is to make the investigation and to determine the amount of theoretical and empirical framework that has been already done in the same area.

It is a critical discussion and summary of statistical literature that helps to establish theoretical framework and methodological focus. Hence, the related aspects are reviewed and presented literature on the topic **“PSYCHOLOGICAL ASSESSMENT AND POSTURAL ANALYSIS OF SMARTPHONE USERS”** under the following headings in this chapter.

2.1 Smartphone

2.2 Current trends of Smartphone

2.3 Demographics and usage of Smartphone

2.4 Practices and Usage pattern of Smartphone

2.5 Musculoskeletal symptoms and disorder due to smartphone

2.6 Hand Anthropometry and Mobile phones

2.6.1 Texting

2.7 Psychological Problems associated with Smartphone usage

2.7.1 Nomophobia (No Mobile phone Phobia)

2.7.2 Smartphone Addiction among smartphone users

2.7.2.1 Smartphone Addiction associated with Social Media usage

2.7.3 Depression among smartphone users

2.7.4 Relationship between addiction and depression among smartphone users

2.8 Visual problems among smartphone users

2.8.1 Critical Flicker Fusion

2.9 Interventions Developed

2.1 Smartphone

A smartphone is expected to perform many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded apps. It has powerful CPU, more storage space, more RAM, greater connectivity options and larger screen than a regular cell phone.

According to **Cassavoy (2013)**, Smartphone can be defined to be a device that enables the users to make telephone calls and at the same time has some features that allow the user to do some activities that in the past was not possible unless a computer or a personal digital assistant (PDA) such as sending and receiving emails or amending an office document.

Buskirk and Andrus (2014) defined Smartphone is a mobile phone that offers more advanced computing ability and connectivity than a contemporary basic feature phone. Smartphone is everywhere nowadays and is being used by people for calls, SMS, emails, browsing the internet, blogging, social networks, watching videos, reading eBooks, listening to podcasts, using applications to shop or bank online and many more ways. Smartphones are giving students the opportunity of new ways to learn and more current ways of learning and simultaneously provide them with more time to learn.

2.2. Current trend of smartphone in India

The information technology is making India more connected more cognizant about the various aspects for development through skills and knowledge. Everything is becoming online through the IT technology even the governance, communication, education, business deals and shopping also. Currently the Digital India is one of the latest flagship program of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy. Likewise different types of scheme, policies and programs of government are arriving to the society through different mediums like computer, laptop, tablets and smartphone having internet connections but in all mediums, smartphone is the easily available device to the people for making possible change for development.

In Indian population smartphone penetration rate is increasing per year and almost everyone has a smartphone. Young population is heavy user of smartphone just

because they want to know what is happening in their surroundings, in their friend's life and in all over the world they want to explore everything through this gadget. They know that the entertainment, social connection sharing, gaming, adventure, current updates and communication with everyone is possible by just only a touch with this small handheld device.

India, the second most populous country in the world, is projected to pass the United States in number of smartphone users in 2017. Around 223 million people in the U.S. will use a smartphone by 2017, compared to 340 million in India. The statistic shows for 2017, the number of smartphone users in India is estimated to reach 299.24 million, with the number of smartphone users worldwide forecast to exceed 2.3 billion users by that time (**Statista, 2017**).

In a report by **Jain (2016)** found the mobile usage habits of over 2000 Indian consumers as part of a global survey of 53, 000 respondents across five continents and 31 countries. India data comprises of representatives from eight urban cities with internet access and adults aging between 18 and 54 years. According to the research, for most smartphone owners, checking their phones is among the first and last things they do in a day. Sixty one percent of respondents look at their devices in <5 minutes after waking up. The number swells to 88 percent comprising of people who take < 30 minutes and 96 percent of the respondents take about less than an hour to peep into their handsets. Interestingly, about 74 percent respondents look into their mobile phones about 15 minutes before preparing to sleep. The research found that communication services namely social networks and Instant Messaging are the two things consumers check on their smartphones first thing in the morning. These are followed by personal emails and text messages.

2.3 Demographics and Usage of Smartphones

Age, or stage in life, is a key variable that influences adaptability to new technology (**Sarker and Wells, 2003**). The use of small handheld devices is more common among young adults, mainly due to their academic demands and higher ability to absorb new technologies. With the increasing popularity of social networking sites, the use of these devices has become ubiquitous, especially among teenagers and college students.

In a recent study, **Berolo et al. (2011)** reported demographic and epidemiological information regarding small handheld device use among college students. For a typical day, the highlights of most common mobile device activities among students are shown in Table

Table 2.1 Hand-held device use in a typical day of the week (hours)

Activity	Usage hours Mean (SD)
Total mobile handheld device use	5.05(6.15)
Browsing	2.77(4.68)
Game controller use	1.23(1.14)
Texting, email and messaging	1.05(1.21)

[Adopted from Berolo *et al.*, Applied Ergonomics 42 (2011)]

Browsing, texting and gaming activities require frequent movement of the fingers. Depending on the design of the device, the activities may require highly repetitive movement of the fingers, which leads to cumulative trauma disorders in hands (**Chatterje, 1999**).

Andone et al. (2016) presented initial results by analyzing how individual differences, such as gender and age, affect smartphone usage in a longitudinal study, the Mental project. For this study sample of 30, 677 participants, of which 16, 147 are males and 14, 523 are females, with a median age of 21 years were selected. Respondents have been tracked for at least 28 days and demographic data was collected through a questionnaire. Females use smartphones for longer periods than males, with a daily mean of 166.78 minutes vs. 154.26 minutes. Younger respondents use their phones longer and usage is directed towards entertainment and social interactions through specialized apps. Older respondents use it less and mainly for getting information or using it as a classic phone.

2.4 Practices and Usage Pattern of Smartphone

Subba et al. (2013) studied that among the total number of students, 335 students possessed mobile phones. Mostly, the persons whom they talked to on their

phones were parents for 51% (220) of the students. 48% (150) talked for less than half hour in a day and 41% (137) were high volume message users. “Ringxiety” was experienced by 34.5% (116) of the students and they were more likely to use their phones at restricted places like classrooms (99%) and libraries (60.3%). A significantly larger proportion of ringxiety sufferers also complained of hampered studies.

Park and Lee (2013) investigated the difference of smartphone usage patterns between two smartphone addiction tendency groups, high and low, which is grouped by self-evaluation. They found that more females belonged to the high addiction tendency group and the high addiction tendency group has a higher shyness, loneliness, and depression score and a lower self-esteem score.

Atarodi et al. (2014) conducted a cross-sectional study on 700 students in the university in which prevalence of excessive mobile phone use was 36.7 percent on the students. There was a significant relationship between the prevalence of excessive mobile phone use and mental health status in general ($P > 0.05$), and also somatization ($P < 0.05$), anxiety and depression specifically ($P < 0.05$), but no significant relation was found between the excessive mobile phone use and social dysfunction ($P < 0.05$), and also sex, age, marital status, settlement, and academic achievement ($P < 0.05$). But there was also a significant relationship between education degree (in MSc and doctoral degree students) and the prevalence of excessive mobile phone ($P > 0.05$).

Lee et al. (2014) analyzed college students' smartphone usage patterns related to smartphone overuse. They divided the subjects into two groups: risk group and non-risk group. They found that the risk group spent the longer time in smartphone usage and the Mobile Instant Message (MIM) app is the most frequently used app. The risk group spent more time on MIM which was triggered by MIM notification.

Alfawareh and Jusoh (2014) surveyed 324 undergraduate students at Najran University to verify trends in smartphones under two categories: normal usage and usage for learning. It was found that smartphones have been used to replace desktop or mobile computers and further revealed that university students have not fully utilized their smartphones for learning purposes. It acknowledges smartphone's disruptive effects of texting on students learning.

Stalin et al. (2016) conducted a Community-based cross-sectional study in Kottakuppam, Tamil Nadu on 2121 participants. They were interviewed and house to house survey was done by pretested structured questionnaire. The prevalence of mobile phone usage was 70 percent. Calling facility (94.2%) was used more than the SMS (67.6%). Health problems like headache, earache, tinnitus, painful fingers, and restlessness etc., were found to be positively associated with mobile phone usage.

2.5 Musculoskeletal symptoms and Disorder due to smartphone

Neck Pain due to prolonged Static posture while smartphone usage

Studies commonly address the association between neck pain and static or awkward postures of the neck or arm abduction/elevation of the arm (**Bernard 1997**).

Ohlsson et al. (1995), mentioned previously, also found a significant association between diagnoses in the neck/shoulders and time spent in neck flexion greater than 15° and elevation/abduction of the arm greater than 60° (p=0.005).

A cross-sectional study (**Bergqvist et al. 1995**) investigated workplace and explored the risk factors to MSDs among 260 VDT users through medical examination. Results showed that workers using highly placed keyboards was associated with neck MSDs (OR = 4.4). Therefore, just holding up the smartphone to reduce neck flexion may not be helpful overall.

In the study conducted by **Lee et al. (2015)**, neck flexion angles were measured from 18 participants who used a smartphone to perform some basic tasks such as texting, web browsing, and video watching in standing and sitting postures. The results showed that neck flexion was between 33° to 45°. A cervical spine model was created with representative values for smartphone users, and calculated the forces on the cervical spine with different degrees of neck flexion (Figure 2.1). The results showed that the force on the cervical spine increases markedly from neutral to 60° of flexion, with 10-12 pounds at neutral, 27 pounds at 15°, 40 pounds at 30°, 49 pounds at 45°, and 60 pounds at 60° of flexion. By combining these two studies, it seems that smartphone users may experience up to a fourfold increase in load on the cervical spine as compared to the neutral posture as illustrated by **Hansraj (2014)**.



Figure 2.1: The weight exerted on the spine increases when flexing the neck at varying degrees. (Retrieved from Hansraj, 2014)

Further, **Bernard (1997)** examined over 40 epidemiologic studies for the evidence for causal relationship between neck MSDs and prolonged static loads, or poor postures at neck/shoulder muscles. Previous studies showed strong evidence that prolonged static poor postures involving the neck/shoulder muscles are the risk factor for neck pain.

Apart from the exhibited poor posture, in **Berolo et al. (2011)**, prolonged use of a mobile handheld device was significantly associated with neck pain (OR = 2.72) and shoulder pain (OR = 2.55). Studies also showed a trend of increasing neck flexion as the time passes (**Hashimoto et al. 2015, Kim 2015**), which may further worsen neck pain symptom. In a recent study, people with neck pain were found to assume a more neck flexed posture during three 5 min. periods of smartphone use as compared to those without neck pain (**Kim 2015**).

Neck flexion increases cervical muscle activity (**Sommerich et al. 2001**). Holding a posture for an extended period of time induces localized muscle fatigue, which is associated with continuous activation of low force/low threshold muscle fibers (**Thorn et al., 2002**). As people are commonly observed with neck flexion during smartphone use, this prolonged static poor posture deserves more attention.

Generally, the person maintains a C-shaped neck, but when the pain in the neck and shoulders causes the symptoms to get worse, especially for those who use their

smartphone in a slanting position on the roads or in public transportation It can make the symptoms worse, and it can seriously cause the neck bone to be deformed into a straight shape. In addition, if these symptoms are severe, dizziness, headache, and hand palpation may occur (**Lee, 2013**). When you bow down your head to look at the small screen, you see a forward head Posture and slouched posture (**Yoo, 2008**).

According to **Lee (2013)** the pain of the neck among the musculoskeletal symptoms that may occur according to the use of the smartphone, the symptom of the pain felt in the neck became stronger as the smartphone was used for a long time causing neck pain. **Ko et al. (2013)** found that the use of a long-time smartphone resulted in the highest muscle fatigue in the upper third hair follicle, and the subjective discomfort also increased. **Straker et al. (2008)** reported that when using a portable smartphone, the posture was not correct when using a general computer and that the muscle activity of the ischemic root and neck muscle was increased. In addition, **Yoo (2008)** compared the neck and shoulder electromyography according to the cervical neutral position and the cervical flexion posture when viewing DMB phone. According to **Berolo et al. (2011)** 137 of 140 participants (98%) reported using a mobile device. 84% participant reported pain in at least one body part. Right hand pain was most common at the base of the thumb. Significant associations found included time spent 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.

Gold et al. (2009) reported in his study that there was an association between shoulder discomfort and the number of daily text messages (PR = 1.40, 95%CI: 1.05, 1.86). When stratifying on gender, an effect was observed in males (PR = 1.94, 95%CI: 1.22-3.06), but not in females (PR = 1.10, 95%CI: 0.76-1.60). Similarly, there was effect modification by gender for neck discomfort (PR = 2.52, 95%CI: 1.16-5.46 males; PR = 0.93, 95%CI: 0.61-1.43 females). The number of daily text messages sent may increase the risk of shoulder or neck discomfort, particularly in males.

Sharan and Ajeesh (2012) evaluated the risk factor and clinical features of the MSD due to handheld devices. Predefined protocols were used to evaluate the type of MSD occurred among the Twenty seven subjects. Results revealed that development of tendinitis in extensor pollicis longus, myofascial pain syndrome (70.37%) of adductor

pollicis, 1st interossei, and extensor digitorum communis. Other associated problems diagnosed were thoracic outlet syndrome (51.85%), fibromyalgia syndrome (25.93%), hypothyroidism (7.41%), wrist tendinitis (14.81%) and De Quervain's syndrome (7.41%).

Eom et al. (2013) found in a study that 18.8 percent of the subjects experienced musculoskeletal symptoms at least in one of body parts. Specifically, 8.1 percent, 5.6 percent, 4.1 percent, and 11.3 percent of the subjects experienced musculoskeletal symptoms at neck, shoulder, elbow, and hand respectively and the symptoms of musculoskeletal disorders were also associated with an amount of text message and time for daily usage of the smartphone. Specifically, relative risks of musculoskeletal disorders at hand/wrist/fingers in terms of "amount of text message" and "time for daily usage" for experienced user were 1.425 and 1.368 respectively to the inexperienced user. This study identified 'amount of text message' and 'time for daily usage' as the major risk factors of smartphone usage in terms of musculoskeletal symptoms.

Kim et al. (2013) included 18 healthy smartphone users (7 males and 11 females) and measured the kinematics of the upper and lower cervical and lumbar spine flexion angles and the reposition error of the upper and lower cervical spine after 3 seconds and 300 seconds smartphone use in sitting. The flexion angles of the lower cervical and lumbar spine and the reposition error in the upper and lower cervical spine were significantly increased after 300 seconds smartphone of use (p.05). These findings suggest that prolonged use of smartphones can induce changes in cervical and lumbar spine posture and proprioception in the cervical spine.

In **The Hong Kong Polytechnic University (2013)**, Department of Rehabilitation Sciences and the Hong Kong Physiotherapy Association have jointly conducted a three-year study on the health effects of using smartphones and portable electronic devices with the major focus on the relationship between the use of electronic devices and the development of musculoskeletal symptoms. The first phase of the survey was conducted on 465 adults aged between 18 to 50 years out of which 221 persons were full-time workers and 244 were college students. Among them 90 percent were daily smartphone users, 74 percent used desktop computers, 61 percent laptop computers, and 35 percent use tablet computers. 70 percent of respondents reported neck pain, 65 percent

had shoulder pain, 46 percent with wrist and finger pain. Results also revealed that maintaining a prolonged static posture, coupled with lack of exercise, would significantly increase the risk of developing musculoskeletal symptoms in different parts of the body. The second phase of the survey was conducted on 582 school children at the age of 10 to 15 years. Results showed that 84 percent students were regular users of smartphones and among that 30 percent reported using smartphones for 1-4 hours/ day while 27.6 percent reported musculoskeletal discomforts related to the use of electronic devices. Close to 80 percent (127 persons) reported neck pain, 30 percent had shoulder pain, and 51 percent had wrist and finger pain symptoms.

Ko et al. (2013) reported that the smartphone groups had results indicating "action level 2" which means that additional research on the posture of the participants while performing tasks is necessary, and their posture needs to be corrected according to the RULA and also found that the smartphone group has the highest levels of fatigue in the upper trapezius muscles, suggesting that the task of inputting text on a smartphone is a high risk for causing cumulative trauma disorders.

Lee et al. (2014) investigated smartphone usage for 95 college students using surveys, logged data, and interviews. They analyzed the usage data after dividing the respondents into risk and non-risk groups based on the self-reported rating scale for smartphone overuse to identify between-group usage differences, which ranged from the overall usage patterns to app-specific usage patterns. Compared with the non-risk group, the results show that the risk group has longer usage time per day and different diurnal usage patterns. Also, the risk group users are more susceptible to push notifications and tend to consume more online content.

Moawd et al. (2015) investigated the effect of over-usage of smartphones in a non-neutral neck position on the cervical range of motion (CROM), spirometric values and maximal static pressures. 94 adult female participants of 19 to 25 years age groups and BMI ranged from 22-25 kg/m², assigned into two equal groups neck pain group and control group. CROM, spirometric values, and maximal static pressures were measured. The results showed a significant reduction ($p < 0.05$) in CROM (extension, right and left rotation, right and left lateral flexion) except flexion movement of the neck ($p > 0.05$), Spirometric values except for VT and FEV1/FVC and maximal static

pressures. The study demonstrated a strong association between a prolonged use of smartphones in the non-neutral neck position and decreased respiratory muscle strength which results in the reduction in CROM, spirometric values, and maximal static pressures.

Park et al. (2015) conducted a study on twenty healthy students with a control group and both groups were assessed for their pain pressure threshold of the sternocleidomastoid and upper trapezius muscles, craniovertebral angle and head position angle, and depression. When comparing the results between the two groups, it was found that there were significant differences in the pain threshold of the sternocleidomastoid and upper trapezius muscles, head position angle, and depression ($p < .05$), but not in the craniovertebral angle. Results also revealed that heavy smartphone usage may produce considerable stresses on the cervical spine, thus changing the cervical curve and pain threshold of the muscles around the neck.

Similar authors also examined the influence of the cervical flexion angle on muscle fatigue of the cervical erector spinae (CES) and upper trapezius (UT) when using a smartphone on 12 healthy adults. Fatigue of the neck and shoulder muscles at different cervical flexion angles (0° , 30° , and 50°) was measured by electromyography. The right upper trapezius, left upper trapezius, right cervical erector spinae, and left cervical erector spinae were assessed. The RtUT and LtUT showed the highest muscle fatigue at a cervical flexion angle of 50° and the lowest fatigue at an angle of 30° . There was no significant difference in the muscle fatigue of the RtCES and LtCES at any of the cervical flexion angles. UT muscle fatigue depends on the cervical flexion angle when using the smartphone.

According to **Kim and Kim (2015)**, the most painful body regions after the use of smartphones were found to be the shoulders and neck. In the musculoskeletal system, back pain was found to have a positive correlation with the size of the smartphone's liquid crystal display (LCD) screen, and pain in legs and feet were found to have a negative correlation with the length of time that the smartphone was used. As a result, it was revealed that the use of a smartphone was correlated with musculoskeletal symptoms.

Yang et al. (2015) conducted a cross-sectional study to explore the association between smartphone use and musculoskeletal discomfort in students at a Taiwanese junior college. Questionnaires on smartphone use were implemented on all the students (n = 315). Results indicated that nearly 50 percent participant experienced neck and shoulder discomfort. The stepwise regression results indicated that the number of body parts with discomfort ($F = 6.009$, $p < 0.05$) increased with hours spent using ancillary smartphone functions. The logistic regression analysis showed that the students who talked on the phone >3 h/day had a higher risk of upper back discomfort than did those who talked on the phone <1 h/day. This study revealed that the relationship between smartphone use and musculoskeletal discomfort is related to the duration of smartphone ancillary function use.

As the awkward posture for longer time leads to symptoms of musculoskeletal disorders and affecting the alignment of body posture. In this context, **Ojha and Vinay (2015)** conducted on workers engaged in bike assembling process and Posture analysis was done by using Rapid Upper Limb Assessment and found that a significant percentage of the workers are working in highly risky postures. Therefore, the workers are under moderate to high risk of work-related musculoskeletal disorders. Proper implementation of ergonomics interventions program was recommended. In addition, **Upasana and Vinay (2016)** found in their study that more than 50 percent of the tailors reported pain in lower back, neck and shoulder due to poorly designed workstation, tasks and awkward working and further reported that tailors were doing very hard job but were ignorant about the risks of musculoskeletal discomforts associated with their postures.

Balakrishnan et al. (2016) evaluated in a study that the largest duration spends on a cell phone was for 14 hours for purpose of email, browsing, Recreation, Gaming, followed by making a call for 12 hours and lastly scheduling for 7 hours on the basis of 24 hours calculation. The symptoms of pain were evaluated by using Visual Analogue Scale, 27.5% of them were not affected by hand pain symptom, 44.5% of them were having mild hand pain and 24% of them having moderate hand pain. Apart from that, there were 3.5% of students affected by severe hand pain and worst possible pain.

In a study, **Lee et al. (2016)** reported the changes in posture and respiratory functions depending on the duration of smartphone usage. Participants were randomly allocated to 2 groups: group 1 (subjects who used smartphones for <4 hours/day, n=25) and group 2 (subjects who used smartphones for >4 hours/day, n=25). The craniovertebral angles of all participants were measured and scapular indices were calculated to assess the change in posture and 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 was measured to assess changes in respiratory function. Findings revealed that there were significant differences in the craniovertebral angle, scapular index, and peak expiratory flow depending on the duration of smartphone usage. The result of this study showed that prolonged use of smartphones could negatively affect both, posture and respiratory function.

Kim et al. (2016) conducted a cross-sectional study to see the changes in muscle activity of the upper limb in persons using a smartphone. Experiments were carried out for 15 right-handed university students using cell phones for more than a year. Experiments were carried out with one-handed and both handed operation of smartphone use in a sitting and standing position. The muscle activity of the AP and ECR were significantly higher during single-handed compared to double handed in both sitting and standing position ($p<0.05$). The muscle activity of the ECR was significantly higher in standing position compared to sitting position with double-handed use of the smartphone ($p<0.05$). UT muscle activity of the right hand has been activated more than twice compared to the left hand UT in a sitting position ($p<0.05$). UT muscle activity on the right hand has been activated more than five times compared to the left in a standing position ($p<0.05$). Using a smartphone with the double hand was reported useful for the prevention of musculoskeletal disorders.

Kim and Koo (2016) investigated the effect of duration of smartphone use on neck and shoulder muscle fatigue and the pain in adults with forward head posture. Thirty-four adults with forward head posture were classified into groups by the duration of smartphone use: 11 used a smartphone for 10 minutes each (group 1), 12 for 20 minutes each (group 2), and 11 for 30 minutes each (group 3). There was a significant difference in the degree of fatigue in the left upper trapezius muscles in

group 2 and left cervical erector spinae and bilateral upper trapeziuses group 3. There was a significant difference in fatigue in the left upper trapezius in groups 1 and 3. The VAS showed significant differences in all groups before and after the experiment and between groups 1 and 3. Pain and fatigue worsened with longer smartphone use. This study provided data on the proper duration of smartphone use. Correct posture and breaks of at least 20 minutes are recommended when using smartphones.

Tonga *et al.* (2017) proclaimed in a study that university students had a high frequency of smartphone use and the frequency was related to the level of addiction ($r=0.199$ $p=0.00$). 43% of students were using their smartphones extremely more than 4 hours. Students specified that they use their smartphones often for messaging with smartphone applications (86.5%). The most frequent symptoms of MSD were found in the neck (59.6%), shoulder (51.82%) and upper back (54.4%) regions. Statistically, significant relationship was found between daily frequency of smartphone use and RULA neck posture score ($r=0.170$, $p=0.001$). Also, there were statistically significant relationships found between BDI score and upper limb ($r=0.15$, $p=0.005$) and upper back ($r=0.152$, $p=0.004$) postures while using a smartphone.

Lee *et al.* (2017) carried out a study to examine the effects of the cervical flexion angle on muscle fatigue and pain in the cervical erector spinae and upper trapezius in 14 normal adults in their 20s. After sitting on a chair with their back against the wall, they held a smartphone with both hands for 10 minutes and fatigue and pain in the neck and shoulder muscles were measured at different cervical flexion angles (0°, 30°, and 50°). Electromyography was performed to analyze the muscle fatigue of the right upper trapezius, left upper trapezius, right cervical erector spinae, and left cervical erector spinae, and a Commander TM Algometer was used to measure pain. The cervical range of motion was used as an instrument to compare and analyze the cervical flexion angles. The study's results showed statistically significant differences in the muscle fatigue and pain of the right upper trapezius and left upper trapezius depending on the cervical flexion angle and a post-hoc test showed statistically significant lower levels of muscle fatigue and pain at 50° than at 0° or 30°. No statistically significant differences were found between the right cervical erector spinae and left cervical erector spinae. The cervical flexion angle during smartphone use may influence the muscle fatigue and pain of the upper trapezius.

Kalirathinam et al. (2017) conducted a cross-sectional survey using self-administered questionnaire from one of the leading university in Malaysia where 20.1 percent of the smartphone users were found to have developed some degree of upper extremity and neck symptoms out of 244 participants. The prevalence of neck symptoms was the highest with 18.03 percent sufferers, followed by right shoulder symptoms 13.93 percent and left shoulder symptoms 11.07 percent. Despite the symptoms experienced, only 10.20 percent participants received treatment while 61.22 percent claimed that they continued using the smartphone during these episodes.

Yang et al. (2017) showed that the students who talked on the phone >3 h/day had a higher risk of upper back discomfort than those who talked on the phone <1 h/day [odds ratio (OR) = 4.23, $p < 0.05$]. The study also revealed that the relationship between smartphone use and musculoskeletal discomfort is related to the duration of smartphone ancillary function use. Moreover, hours spent talking on the phone was a predictor of upper back discomfort.

Gautam and Chacko (2017) conducted a study to evaluate the postures and identify the prevalence of musculoskeletal symptoms in college going students using laptops and found the positive correlation between the posture adopted by the respondents and the incidence of pain in last 12 months to last 7 days. The Musculoskeletal Symptoms was prominent in various anatomic regions like Neck, Shoulders, Upper back and Lower back.

Malik et al. (2017) investigated musculoskeletal disorders among students of 7th class while carrying the heavy back packs. The results showed that majority of respondents expressed severe pain in both shoulders (32 percent), lower back (30 percent), neck (26 percent), upper back (18 percent), right shoulder and legs (16 percent), knees (14 percent), elbows (6 percent) left shoulder (2 percent), wrist and hands just because of heavy backpacks.

2.6 Hand Anthropometry and Mobile phones

Anthropometric is used to consider the level of ergonomics in designing a product or interface that required human interaction. Therefore anthropometry should be considered when designing virtual keyboards on a mobile device. Mobile size and

user interface are two main concerns in designing mobile device **Chong et al. (2004)** Researchers have studied the effect of screen size on the user's experience. **Findlater and McGrenere (2008)** found that screen size impacts user behavior. This finding is supported by **Kim et al. (2011)** that showed screen size has effect on the user's psychology based on the communication modality. There was empirical evidence that high accuracy adaptive menus may have a larger positive benefit on small screen displays Furthermore, it was found that smaller screen-size elicited greater perceived mobility while larger screen-size was key to greater enjoyment.

Balakrishnan and Yeow (2007) investigated influences of hand anthropometry and gender on Short Message Service (SMS) usage satisfaction using structured questionnaire interviews on 110 participants. Hand-size, thumb length, circumference and mobile phone dimensions were recorded of filtered 73 participants. Focus was on keypad design factors including key size, shape, layout, texture, simplicity and space between keys. Results revealed that Females were found to be more satisfied with the key size and layout than males. Significant differences were noted among subjects with different hand size with respect to key size and space between keys. One of the recommended improvements was given to those who have larger keys with more space between them for those with large hand-size.

Phone design and anthropometry influenced the development of discomfort and fatigue during phone use. **Chany et al. (2007)** compared a small cellular clamshell phone with a traditional office phone in the development of discomfort and muscle fatigue over time during phone use. Discomfort information and electromyographic (EMG) muscle activity were monitored on four upper extremity muscles in ten adults. Results indicated that median frequency shifts supported discomfort claims and indicated muscle fatigue in the deltoid and thenar muscles. Biomechanical measures demonstrated that participants with short limb lengths developed more severe signs of thenar fatigue. Participants with longer arms developed greater discomfort in the neck, shoulder, and back. The deltoid confirmed this occurrence, showing signs of muscle fatigue and also concluded that Phone design dictated grip style, resulting in differing discomfort and fatigue levels and anthropometry of phone influenced the severity of the discomfort and fatigue present in the shoulder and hand.

Jain and Pathmanathan (2012) studied hand-size variations and users' satisfaction of mobiles by using anthropometric techniques and structured questionnaire interviews on 160 adult males. A total of 20 hand measurements and mobile phone dimensions were noted. Emphasis was given on keypad design factors, which include: key size, shape, layout, texture, simplicity and space between keys. Factor analysis was performed on both the hands separately meanwhile significant difference was found in hand dimensions when T-test was applied. Hand length, hand breadth, palm length, index finger length, middle finger length, thumb length, and thumb circumference were found to affect the users' grip of mobile handset amongst several factors. One of the recommended improvements is to have larger keys with more space between them for those with large hand-size.

Yu-Cheng (2013) examined that the relationships between touchscreen size and category of hand length and between touchscreen size and category of palm width both are positive from the views of error rate and the subjective fatigue. Hence, larger touchscreen size is more appropriate to larger hand and palm. Furthermore, longer operation time is needed for people who have small hand and palm because they spend more time to move their thumb and handle the smartphone stably.

Lin and Lin (2015) examined the relationship between touchscreen sizes of smartphones and user's relative hand dimensions based on the operation time, operation error rate and subjective thumb fatigue on 100 subjects (50 males and 50 females). The experiment design includes 4 touchscreen sizes as well as hand length and hand width were both divided into 4 categories respectively. The results indicated that there is a rapid increasing trend from 3.5 inch to 5.7 inch screen for smaller hand length/width and the trend decreases firstly slight and then increases for large hand length/width. Touchscreen size from 4.6 to 5.0 inch is suggested for most people because this interval of screen size is relatively suitable based on the analysis of hand dimensions and 3 performances evaluation indices it was suggested that larger touchscreen (5.7 inch) is hard to use for any hand length or width.

Restyandito and Nugraha (2017) investigated the effectiveness of button size (small, medium and large) on Mobile Device based on hand dimension. Usability test was conducted to 26 university students who used mobile device regularly. Subjects

were given some typing tasks using different button sizes. Result found that button size and hand dimension affect the numbers of errors typed and typing completion time in mobile device.

When designing an interface component (i.e. button) for mobile device, many designers tend to use proportional approach against the screen size. They do not consider the ergonomic factor of the users' hand dimension. The results obtained from these studies suggested that findings of their investigation can be used by mobile phone designers to design user-friendly mobile handsets.

2.5.1 Texting

Texting on smartphone devices involves looking down at the device and touching the touchscreen display, which may contribute to sustained awkward head posture, repetitive movements, and workplace stress (**Gold et al. 2012, Lee et al. 2015, Xie et al. 2016**). Forward head flexion posture produces excessive external flexion force, resulting in a larger load on neck extensors and adjacent connective tissues of the neck (**Bonney and Corlett, 2002**)

Texting is associated with tenosynovitis (**Ashurst, 2010; Storr et al., 2007**), that is, inflammation of the tendon sheath. Text messaging and browsing activities in smartphones or touchscreen devices require fast movement of thumb and index fingers and awkward hand postures, contributing to musculoskeletal discomfort in fingers. **Ming et al. (2006)** reported a case of prolonged pain at the base of the thumb (first carpometacarpal joint) of a patient due to excessive texting. "BlackBerry thumb" (**Gordon, 2008**) is a relatively new term that was coined to collectively refer to these symptoms. **Karim (2009)** argued that the thumb movements in regular texting on regular cell phones are different from "BlackBerry thumb", and proposed another term "Cellphone thumb" or "Texting thumb".

Balakrishnan and Yeow (2007) found the relationship between hand dimensions and short message service (SMS) satisfaction. They measured hand breadth, thumb length, and thumb circumference of the participants and applied a questionnaire to measure SMS satisfaction. As a result of the study, it is suggested that manufacturing customized mobile phones for people who have larger thumbs can increase customer satisfaction.

Perry and Lee (2007) investigated that between 6 percent and 11 percent of respondents showed symptoms of addiction related to tolerance, withdrawal, displacement of attention to school or work, and the inability to diminish use. Displacement of people was common among a higher percentage of students. The number of messages sent, and the perceived skill at using SMS technology were significant predictors of the number of addiction criteria exhibited by respondents. Among the small percentage who revealed symptoms of addiction, usage of text messaging was double to triple found in most of the rest of the population sample and no gender differences were found for addiction measures, but males were heavier users of text messaging than females.

Ong (2009) conducted a study to determine the thumb motion and typing forces when text messaging on a mobile phone. Thumb motion was captured using a 6-camera reflective marker-based motion capture system. Typing forces were measured using four load cells in a force plate arrangement fitted into the phone. Thumb flexion-extension occurred mainly in the IP and MCP joints. Results show that the incidence of peak force was shown to link to the high flexion angle of the IP joint and in thumb opposition of the MCP joint. No incidence of peak forces was found in the right column of the keypad.

Gustafsson *et al.* (2010) found that young adults with musculoskeletal symptoms had higher thumb movement velocities, fewer pauses in thumb movements, and higher APL activity than those without symptoms. Females showed higher thumb velocities, fewer pauses in thumb movements, and greater muscle activity in the APL and extensor digitorum than males. Those with musculoskeletal symptoms were more likely to sit with the head bent forward, to sit without forearm or back support, and to enter text using only one thumb, compared with those without symptoms.

Jonsson *et al.* (2011) carried out a study to assess the intensive use of mobile phones and other devices and related pain and musculoskeletal disorders in the thumbs and the associated joints. Studies characterizing biomechanical exposures associated with mobile phone use are limited to date and the use of electrogoniometry and EMG was assessed for characterizing thumb-based activities. The results indicated both measures are necessary for characterizing thumb exposure during mobile phone text messaging.

Xiong and Muraki (2013) investigated smartphone operation and muscle fatigue with the use of EMG instruments. The study investigated tapping, moving, and circling as the specific thumb movements, performed on an experimental smartphone mock-up. Abductor pollicis brevis (APB) and first dorsal interosseous (FDI) were the two muscles measured. The conclusion of the study was those touch key size and thumb moving orientation affect the thumb performance. Small buttons and flexion-extension orientation increase muscle fatigue in first dorsal interosseous, which is a prime muscle for thumb movements.

Proma (2014) found that video gaming and texting activities resulted in very high velocities and accelerations at the interphalangeal joints of both the fingers; and extremely high repetitive movements (more than 110, 000 reps/day). Browsing activities showed very rapid motion at the metacarpophalangeal joint of the thumb. Muscular activity was higher at the extensor digitorum muscle for all the tasks.

Inal et al. (2015) examined the flexor pollicis longus (FPL) tendon and median nerve in smartphone users by ultrasonography to assess the effects of smartphone addiction on the clinical and functional status of the hands. One-hundred-two students were divided into 3 groups: Non-users, high and low smartphone-users. Smartphone Addiction Scale (SAS) scores and grip and pinch strengths were recorded. Pain in thumb movement and rest and hand function were evaluated on a visual analog scale (VAS) and the Duruöz Hand Index (DHI) respectively. The cross-sectional areas (CSA) of the median nerve and the FPL tendon were calculated bilaterally with ultrasonography. There were significantly higher median nerve CSAs in the dominant hands of the high smartphone users than non-dominant hands ($P < 0.001$). The SAS scores correlated with the VAS pain for movement and rest, the DHI scores, and pinch strength ($P < 0.05$, $r = 0.345$, 0.272 , 0.245 , and 0.281 respectively). Smartphone overuse enlarges the median nerve, causes pain in the thumb and decreases pinch strength and hand functions.

Xie et al. (2016) conducted a study in which texting was compared between using both hands ('bilateral texting') and with only one hand ('unilateral texting'). Texting tasks were also compared with computer typing. Surface electromyography from three proximal postural muscles and four distal hand/thumb muscles on the right

side was recorded. Compared with healthy controls, young people with neck-shoulder pain showed altered motor control consisting of higher muscle activity in the cervical erector spinae and upper trapezius when performing texting and typing tasks. Generally, unilateral texting was associated with higher muscle loading compared with bilateral texting, especially in the forearm muscles. Compared with computer typing, smartphone texting was associated with higher activity in neck extensor and thumb muscles but lower activity in upper and lower trapezius as well as wrist extensors.

2.6 Psychological problems

Al-Khlaiwi and Meo (2004) carried out a research on 437 subjects regarding detailed history and association of mobile phones with health hazards. The results of the present study showed an association between the use of mobile phones and health hazards. The overall mean percentage for these clinical findings in all groups were headache (21.6%), sleep disturbance (4.0%), tension (3.9%), fatigue (3%) and dizziness (2.4%).

Ha et al. (2008) conducted a study to evaluate the possible psychological problems related to excessive cell phone use in adolescents. Results from 595 participants showed that the potentially excessive user group had a tendency to identify themselves with their cell phones and to have difficulties in controlling usage. They expressed more depressive symptoms, higher interpersonal anxiety, and lower self-esteem. A positive correlation was also observed between excessive cell phone use and Internet addiction.

Thomé et al. (2011) examined a study on a group of young adults 20-24 years old (n = 4156), who responded to a questionnaire at baseline and 1-year follow-up. There were cross-sectional associations between high compared to low mobile phone use and stress, sleep disturbances, and symptoms of depression for the men and women. When excluding respondents reporting mental health symptoms at baseline, high mobile phone use was associated with sleep disturbances and symptoms of depression for the men and symptoms of depression for the women at 1-year follow-up.

Chu et al. (2011) described the clinical features of headache associated with the mobile phone. A 14 item questionnaire was administered to 247 medical students at Hallym University, Korea. Individual telephone interviews were subsequently conducted

with those participants who reported HAMP more than 10 times during the last 1 year on the clinical features of HAMP. They defined HAMP as a headache attack during MP use or within 1 hour after MP use. 86.6 percent students completed and returned the questionnaire. Results showed that 18.9% students experienced HAMP more than 10 times during the last 1 year in the questionnaire survey. In subsequent telephone interviews, 37 (97.4%) interviewed participants reported that HAMP was triggered by prolonged MP use. HAMP was usually dull or pressing in quality (30 of 38, 79.0%), localized ipsilateral to the side of MP use (32 of 38, 84.2%), and associated with a burning sensation (24 of 38, 63.2%).

Acharya *et al.* (2013) conducted a study on 17-23 years students from urban and rural background selected randomly and administered a pre-tested questionnaire. The results revealed that Headache was found to be the commonest symptom (51.47%) followed by irritability/anger (50.79%). Other common mental symptoms included lack of concentration and academic performance, insomnia, anxiety etc.

Hong *et al.* (2013) investigate how the keyboard and smartphone use affect the wrist and hand muscles activity. 26 university students were asked to type a document for three minutes using three different methods: using a keyboard, using a smartphone with one hand, and using it with both hands. The subjects took a 30-second break after finishing each experiment. Changes in muscle activity on their wrists were measured and recorded by EMG and Markers were attached on both sides. The result showed significant differences on the Extensor Digitorum, Extensor Carpi Radialis, Flexor Carpi Radialis on both hands and Lt. Abductor Pollicis Longus muscle($p < .05$). This study demonstrated that musculoskeletal impairment to the wrists and hands caused by an excessive keyboard use rather than a smartphone use.

2.6.1 Nomophobia (No Mobile phone Phobia)

"Nomophobia" is a new term means – 'no mobile phone phobia' defines the fear of being out of mobile phone contact. People, especially teenagers get very anxious when they lose their mobile phone, run out of battery or credit or due to less network coverage. Those who have nomophobia never switch off their mobile phones carry their phones to bed and they will never stay away from their phone even for a second (**Singh, 2008**).

Bivin et al. (2013) conducted a cross-sectional descriptive research study, aimed at evaluating the risk of developing Nomophobia among male Under Graduate students of health sciences. A sample was 547 students of health sciences. There is a significant positive correlation ($r = 0.67$) seen between the overall scores on the pattern of mobile usage to the overall scores on Nomophobia severity.

Cheever et al. (2014) findings revealed that most participants would feel disconnected from others rather than feeling distressed when the mobile phone is absent.

Kaur et al. (2015) conducted a descriptive research on 200 nursing students revealed that majority of nursing students (79%) were at risk of developing nomophobia, followed by normal (15%) and remaining (6%) are nomophobic. Maximum of nursing students were using mobile phones with internet facility (81.5%), sleep with their mobile phone turned on (80.5%), were using smartphone (74%), using mobile phones for playing games (70.5%) and set mobile phone on vibrate mode rather than turning it off during lectures (66%). There was the moderately positive correlation ($r = 0.328$) between the pattern of mobile phone usage and risk of developing nomophobia at $p < 0.05$ level. Gender was found significantly related to the risk of developing nomophobia. It is found that there is a moderately positive correlation (0.328) between the pattern of mobile phone usage and risk of developing nomophobia.

Pavithra et al. (2015) study the population of 200 students comprised of 47.5% females and 52.5% males. About 23% students felt they lose concentration and become stressed when they do not have their mobile around, 79 (39.5%) students were Nomophobic in this study and another 27% were at risk of developing Nomophobia.

Dixit et al. (2010) conducted a cross-sectional study amongst 200 M.B.B.S. students in which 18.5% students were found to be nomophobes. In gender-based observation, 19% males and 18% females were found to be nomophobes. 19.26% hostellers and 17.58% day scholars were found to be nomophobic.

2.6.2 Smartphone Addiction among smartphone users

Addiction is a dangerous psychological influence that can be caused by using smartphones for a long period of time and for continuous periods of time. Such

influence is similar to using drugs for a long period of time. Many behaviors indicating that a user of smartphone is addicted to using his phone include making calls longer than any normal user, like to use cell phone rather than face to face, using cell phones for calling and chatting with his/her family members, annoyed from persons around him when he is using his/her cell phone, feeling depressed and nervous when he is separate/detached from his mobile phone.

Davey and Davey (2014) conducted a study in which a total of 45 articles were considered in systematic-review from the whole world; later on, 6 studies out of these 45 related to Smartphone's addiction in India were extracted to perform a meta-analysis, in which total 1304 participants were enrolled. The smartphone addiction magnitude in India ranged from 39% to 44%. The result shows that Smartphone addiction among Indian teens can not only damage interpersonal skills but also it can lead to significant negative health risks and harmful psychological effects on Indian adolescents.

Babadi et al. (2014) conducted a study on the university students of Shahrekord, based on the six categories of mobile addiction behaviors and they were mostly placed in habitual behaviors (21.49%), addiction (21.49%), and intentional (21.49%) categories. By reviewing mental health indicators, it was found that students were affected by depressive disorder (17.30%), obsessive-compulsive disorder (14.20%), and interpersonal sensitivity (13.80%). The results showed that there was a significant inverse relationship between mental health and habitual behaviors ($r = -0.417$), dependence ($r = -0.317$), addiction ($r = -0.330$), and incontinence ($r = -0.309$) in using mobile phone ($P < 0.001$). Results also showed that with increased and improved mental health, the student's rate of cell phone addiction reduced.

Kibona and Mgya (2015) investigated the impact of smartphone addiction on the academic performance of college students. They revealed that smartphone addiction has a negative relationship with academic performance. The authors assume there is a strong relationship between neglect of work from smartphone usage hours and usage frequency.

Khezhi and Srivastava (2016) explored mobile phone addiction among college students. 60 (30 boys and 30 girls) subjects were purposively selected and

Mobile Phone Addiction Scale was administered to them. Findings revealed that there is a high level of mobile phone addiction among teenagers (Girls & Boys) and there is no gender difference in term of mobile phone addiction.

Haug *et.al* (2015) investigated indicators of smartphone use, smartphone addiction, and their associations with demographic and health behavior-related variables in young people. Smartphone addiction was assessed using a short version of the Smartphone Addiction Scale for Adolescents (SAS-SV). Results revealed that 256 (16.9%) students were addicted out of the 1, 519. Longer duration of smartphone use on a typical day, a shorter time period until first smartphone use in the morning, and reporting that social networking was the most relevant smartphone task were associated with smartphone addiction. Smartphone addiction was more prevalent in younger adolescents (15–16 years) compared with young adults (19 years and older).

Bhulia and Tariang (2016) investigated in a study of 159 college students to find out mobile phone addiction based on gender and the stream by using the Mobile Phone Addiction Scale (MPAS) developed by A. Velayudhan and S. Srividya. Results revealed that the college going students of Shillong are moderately addicted to mobile phone and gender and stream has no impact on the mobile phone addiction of the college going students of Shillong. Another finding of this study is that there is no significant relationship between the availability of pocket money and mobile phone addiction.

2.6.2.1 Smartphone Addiction associated with Social Media usage

Greater accessibility of social networking sites through smartphone may increase such addiction towards not only the internet but also smartphone. 316 Chinese young adults' daily usage of social networking sites was investigated and it was revealed that there was a positive relationship between daily use of social networking sites through smartphones and addictive tendencies to social networking sites. Results illustrates that people who had less self-efficacy related to internet users are more vulnerable and at higher risk of being addicted to the social networking sites as well as impulsive (someone who is impulsive does things without considering the possible conclusions) participants indicated higher addictive tendencies by spending too much time on social networking sites through smartphones.

Salehan and Negahban (2013) found that especially in youths the increase in mobile phone use corresponds with the rapid growth of SNS use. They further discovered a positive correlation between SNS and mobile phone addiction, indicating SNS use is a predictor of mobile phone addiction.

Wu et al. (2013) find in a study that those who spent more time on SNSs also reported higher addictive tendencies. Addictive tendencies were positively correlated with both outcome expectancies and impulsivity but negatively associated with Internet self-efficacy.

2.6.3 Relationship between addiction and depression among smartphone users

Chen (2004) examined the relationship between depression and mobile phone addiction on 519 American students and concluded that there was a significant association between mobile phone addiction symptoms (distraction, withdrawal, and escape) and depression. In addition, he stated that women had significantly higher rates of mobile phone addiction symptoms compared to men.

Kwon and Paek (2016) conducted a cross-sectional survey on 293 undergraduate students out of which 14.7% of participants have a risk group of Smartphone addiction. Depression ($r = 0.407$, $p < 0.001$) was positively related to Smartphone addiction. Depression ($\beta = 0.302$, $p < 0.001$), communication competence ($\beta = -0.148$, $p < 0.01$), daily Smartphone using time ($\beta = 0.144$, $p < 0.01$), grade ($\beta = 0.136$, $p < 0.01$), academic achievement ($\beta = 0.119$, $p < 0.05$) and gender ($\beta = 0.117$, $p < 0.05$) were identified as significant predictors of Smartphone addiction.

2.7 Visual problems among smartphone users

Smartphone technology is based on the blue light; there is a high probability of damaging vision due to the shorter wavelength of light when used for a long period of time (**Kang et al., 2016**). From the research on ocular fatigue induced by multimedia aimed toward the general public, it has been discovered that liquid crystal displays induce dry eye symptoms more frequently than ordinary books and the displays increase the level of visual fatigue from feeling dazzled (**Jang et al., 2012**). If the visual fatigue continues in everyday life, it can affect visual processing and can cause various problems such as ocular pain, damaged corneal epithelial cells, conjunctival hyperemia, and decreased visual acuity.

Meo and Al-Dreess (2005) investigated in a study of 873 (57.04% of males and 39.86% of females) in Saudi population that showed an association between the use of mobile phones and hearing and vision complaints. About 34.59% of problems were related to impaired hearing, earache and/or warmth on the ear, and 5.04% of complaints with the decreased and/or blurred vision.

Nowadays Smartphones are becoming cheaper so that everyone can afford easily. Smartphone display technologies have two types, including TFT-LCD (Thin Film Transistor-Liquid Crystal Display) and AMOLED (Active Matrix Organic Light-Emitting Diode).

Chiu *et.al* (2016) found in the study the time to fatigue while using these two display types to prevent users from visual fatigue after prolonged watching the digital touch screens. 19 young volunteers were selected for the test in which they have to view static and dynamic stimuli. TFT-LCD and AMOLED of display panels were used for the test. Objective eyestrain occurrence time and the subjective maximum time to fatigue were measured here for prolonged viewing the phone screen. The results indicated that the time to fatigue from TFT-LCD was significantly longer than that of AMOLED. Dynamic stimuli caused significantly longer time to fatigue than static stimulus.

2.7.1 Critical flicker fusion

Critical flicker fusion frequency (CFFF) is the frequency at which an intermittent light stimulus appears to be completely steady to the observer (As defined by Encyclopedia of psychopharmacology). The Critical Flickering Fusion frequency (CFFF) test measures the rate at which successively presented light stimuli appear to be steady and continuous. This rate, expressed in Hz, is commonly referred to as the “threshold frequency”. Normal CFFF value is 35-40 Hz (**Yadav *et al.*, 2008**). It is used as an indicator of physical human fatigue, mental workload, and cognitive function as well. In medicine and physiology, experimental evidence demonstrated the relationships between the CFFF level and individual human attributes like age, sex, intelligence and job experience.

Critical Flicker Fusion Frequency has an extensive application in different arenas, generally as an indicator of human workload. CFF effectively discriminates

between subjects with and without retinal/neural disease and CFF thresholds were reduced in retinal/neural disease (**Shanker, 2007**). The relationship between eye movement and flicker perception has received mixed reports. Some researchers have reported that eye movement can enhance threshold perception (**Watson, 2013**) while others have concluded that eye movement does not substantially affect the visibility of motion artifacts or flicker on spatial displays (**Hoffman et al., 2011**).

Maruthy et al. (2015) conducted a study of critical flickering fusion frequency rate in media players who were playing video games since their childhood to examine the effect of video games on CFFFR. The study showed that CFFFR significantly decreases as the age increases and high CFFFR threshold were recorded in media players who played puzzle and brain games than the action adventure and sports games. It was proved that playing video games can develop cognitive skills, high-level thinking skills, problem-solving complex, concentration, logical thinking, imagination, and creativity but on the other side teenagers who spend an ample amount of time playing games experience effects which are not so beneficial at all. **Davranche and Pichon (2005)** studied the Critical flicker frequency threshold increment after an exhausting exercise and found that incremental exhausting exercise increases the sensory sensitivity threshold, thereby suggesting an exercise-induced increase in cortical arousal.

Endukuru et al. (2015) showed that CFFFR threshold increases significantly in media players when compared to non – media players ($p < 0.001$). This study also showed that CFFFR significantly decreases as the age increases and high CFFFR threshold were recorded in media players who played puzzle and brain games than the action adventure and sports games. The gender effect on CFFFR was not significant but higher CFFR values were recorded for men than women.

In a recent study conducted by **Oulakh (2017)** on watch assembly employees compared the CFFFR value of left and right eye of the assembly worker in green and red light source and found that the CFF threshold value of left eye was slightly higher than the right eye in both light source. The t value (2.49243) showed the significant difference between the CFFFR value of left and right eye of the watch assembly employees in green light source whereas under red light t value (0.62638) showed the non-significant difference between the CFFFR value of left and right eye.

2.8 Interventions Developed

Detecting Bad Postures in Smartphone Usage Proposals for new mobile solutions have not only been in terms of interactions but also related to health. RSI is one of the fastest growing occupational illnesses and has even reached epidemic proportions in certain industries (**Yassi 1997**). Health and ergonomics are crucial factors in an era dominated by technology. Thus, there are many studies related to the ergonomics of mobile devices. Use of mobile devices are straining our muscles (**Bachynskyi et al., 2015**), and overuse of smartphones can lead to RSI, such as carpal tunnel syndrome (**Shim 2012**). RSI typically occurs from repetitive motions, and awkward and unnatural postures (**Yassi 1997**). The widespread of smartphones has exposed many people to awkward postures over an extended time.

Researchers have developed different solutions to prevent unhealthy postures, which can cause different musculoskeletal issues. **Lee et al. (2013)** have made a mobile posture-aware system, called Smart Pose, which monitors if the user's neck is bent to prevent a chronic strain in neck and back muscles. It uses the smartphone's internal components to detect a bad posture. The components were the front faced camera, 3-axis accelerometer, and orientation sensor. The user gets notified if a bad posture is detected. An application was developed for Samsung Galaxy S3, which has all the required internal sensors. Official Android application programming interfaces (APIs) were used to face detection and shake and tilt angle calculation. Figure 17 shows a warning message when the system detects a bad posture.

Similar to Smart Pose, **Baek and Yun (2010)** have developed a user posture monitoring system. It is based on a tilt-angle measurement algorithm that uses a two-axis accelerometer and can detect bad postures when sitting, standing, and walking. The system was implemented on a PDA and tested on ten participants. Its intention was to detect bad posture when the participant was watching a movie. The results showed that the recognition rate was greater than 99%.

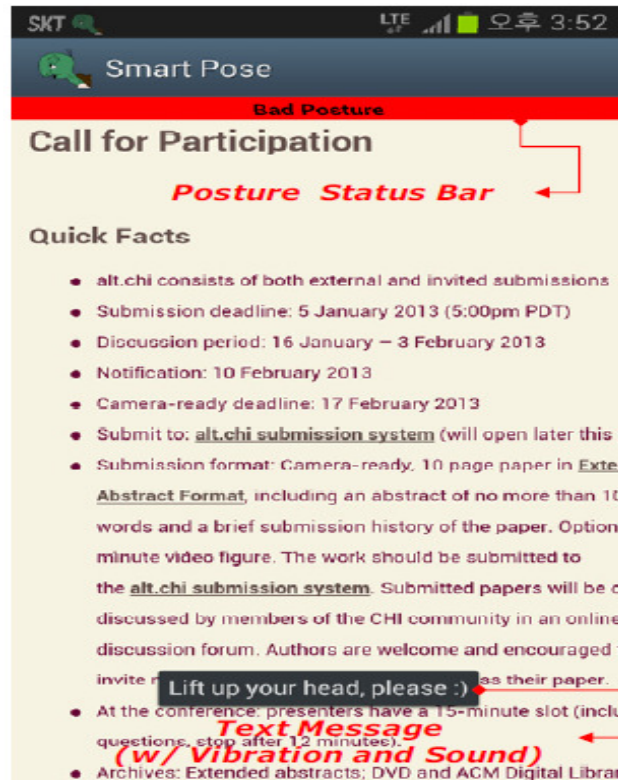


Fig 2.2: Warning message from Smart Pose
Source: Lee et al. (2013)

El-Sayed et al. (2011) have also developed a system to detect bad postures. It has integrated posture sensors and strain sensors to detect spine stress at both the back and the feet. The system notifies the user by use of SMS when bad posture is detected, in addition to emails with a summary of the daily activities. The summary emails contain information about the amount of time spent sitting, standing, or walking, and the daily average posture angle. Unlike the aforementioned posture monitoring systems, their solution requires wearable components to work. This makes it unpractical for everyday use compared to a solution that only uses the smartphone's internal components.

Gupta (2018) proposed a new posture detecting mechanism which does not require any external devices and can be implemented reasonably on every smartphones. This resolution has utilized the built-in 3-dimensional accelerometer of the smartphone and provided an Android Operating System-based application as an evidence of concept that determines the Cervical Spine posture and generates alerts when needed. Additionally, data of the posture could be displayed as graphs to aware the user about his or her posture trend during the week.

According to the recent report of James Rind, a musculoskeletal physiotherapist in the UK, repetitive and regular usage of the smartphone can lead to cumulative damage and musculoskeletal disorders to the user. He warned that the commonly adopted static posture of the neck, shoulders, and upper spine may lead to physical problems later in life. To prevent such health risks, users need to keep the smartphone at eye level, change their posture regularly, and reduce the time of smartphone use. However, users may not recognize such risks, and even when some users do recognize the risks, many of them may not pay enough attention to maintain a correct posture while they are immersed in using the smartphone.

From the overview of the literature received, it is evidenced that the usage of smartphones has become widespread, particularly among youth, and possible impacts on health have been almost clarified. This review of the literature shows high prevalence of pain/discomforts at least in one body part with varying intensity among those individuals, using their smartphone in prolonged static posture. The excessive mobile phone use with active texting had been probably the main cause of the problem. Many, especially youngsters use their phones to text and play games a lot. The researchers stated that increased usage of smartphone leads to various psychological problems including stress, anxiety, social isolation, headache, lack of concentration but addiction, depression and nomophobia became the major concerns in the recent years. Various study demonstrated the linkage between addiction levels, visual problems and musculoskeletal problems with duration of smartphone use. Moreover, frequent use of smartphones may affect hand function and pinch strength, possibly resulting in pain in the thumb. However, the exact clinical application remains to be explored.

In this technological era a smartphone can keep people connected with the world at their fingertips that results in excessive usage of the device and the consequences of heavy smartphone usage are greatly affecting the life of every individual of any age group therefore it becomes an important public health issue. But there is scarcity of studies related to musculoskeletal problems and effective control measures in India. Therefore need was felt to confront with these health related problems which are associated with heavy usage of smartphone. Individuals should be aware of boon and curse of the technologically advanced hand held device. Interventions that addressed these risk factors among smartphone users were also reviewed. Literatures have not found any effective engineering controls that could reduce or prevent postural alteration among smartphone users.



*Materials
and
Methods*



The research methodology enabled the team to organize their efforts into one cohesive and conceptual product idea generation task. The research methodology of the present study was planned keeping in view to scope of the study and time constraints. This chapter provides the detailed description of the procedure adopted for conducting the study on entitled “**PSYCHOLOGICAL ASSESSMENT AND POSTURAL ANALYSIS OF SMARTPHONE USERS**” under the followings sub-headings:

3.1 Research design

3.2 Conceptual framework of the study

3.3 Selection of Variables

3.3.1 Independent Variables

3.3.2 Dependent Variables

3.4 Operational Definitions

3.5 Selection of sample

3.6 Development of tools

3.6.1 Construction of Questionnaire

3.6.2 Development of Standard of living Index

3.6.3 Development of Scales

3.7 Method of data collection

3.7.1 Descriptive data

3.7.2 Experimental data

3.8 Statistical Analysis of data

3.1 RESEARCH DESIGN

A research design is the arrangement of conditions for collecting and analyzing data in a manner that aims to combine relevance to the research purpose with economy in procedure. In order to achieve the objectives of the study descriptive cum experimental design was used. Descriptive designs were adopted to elicit the information about the demographic profile, standard of living, usage pattern of Smartphone, Smartphone Addiction and Depression among the college students due to the usage of a Smartphone. Whereas experimental research design was used to study the actual posture they adopt while using the Smartphone and visual fatigue due to longer duration usage, to measure the different body and hand dimensions, to assess the awkward body posture and to access the relationship of usage and MSDs and physical health risk due to its usage. The preventive measures were developed on the basis of need and urgency.

3.2 CONCEPTUAL FRAMEWORK OF THE STUDY

The conceptual framework of the study represents the relationship of the variables with respect to the objectives of the study. It is an analytical tool with several variations and contents. Due to the advancement of technology mobile phones are transformed into Smartphone that is having integrated mobile phone capabilities that can be used at anytime and anyplace as it is easy to carry and use. Various factors and reasons like advanced features, latest design and applications, social influences and easier way of communication as well as reduced cost of technology tariffs and data packs that increased the frequency and duration of Smartphone usage in daily life and changed practices and usage pattern of the users. Longer duration of Smartphone usage affects users both physically and psychologically. Apart from physical health effects comprising of pain and discomfort in different body regions, awkward postures, change in grip strength and pinch strength and visual problems likewise raised concerns for psychological problems including anxiety, nomophobia, stress, problem of eyesight and hearing , mental fatigue, Smartphone addiction, depression, sleep disturbance, loneliness, social separation, lack of concentration and many other which cannot be ignored as well as it may cause chronic health problems which cannot be treated easily. As it is nearly impossible to avoid the technologies it is necessary to overcome these growing problems that have a large impact globally, there was a need arises to give

intervention i.e. sensitization program that will enhance the awareness and helps to reduce the various physical problems as well as psychological problems. The outcome of the sensitization program help in maintain proper postures, prevention of musculoskeletal disorders, maintaining good mental health, healthy usage of smartphone, and also helps in improving their vision.

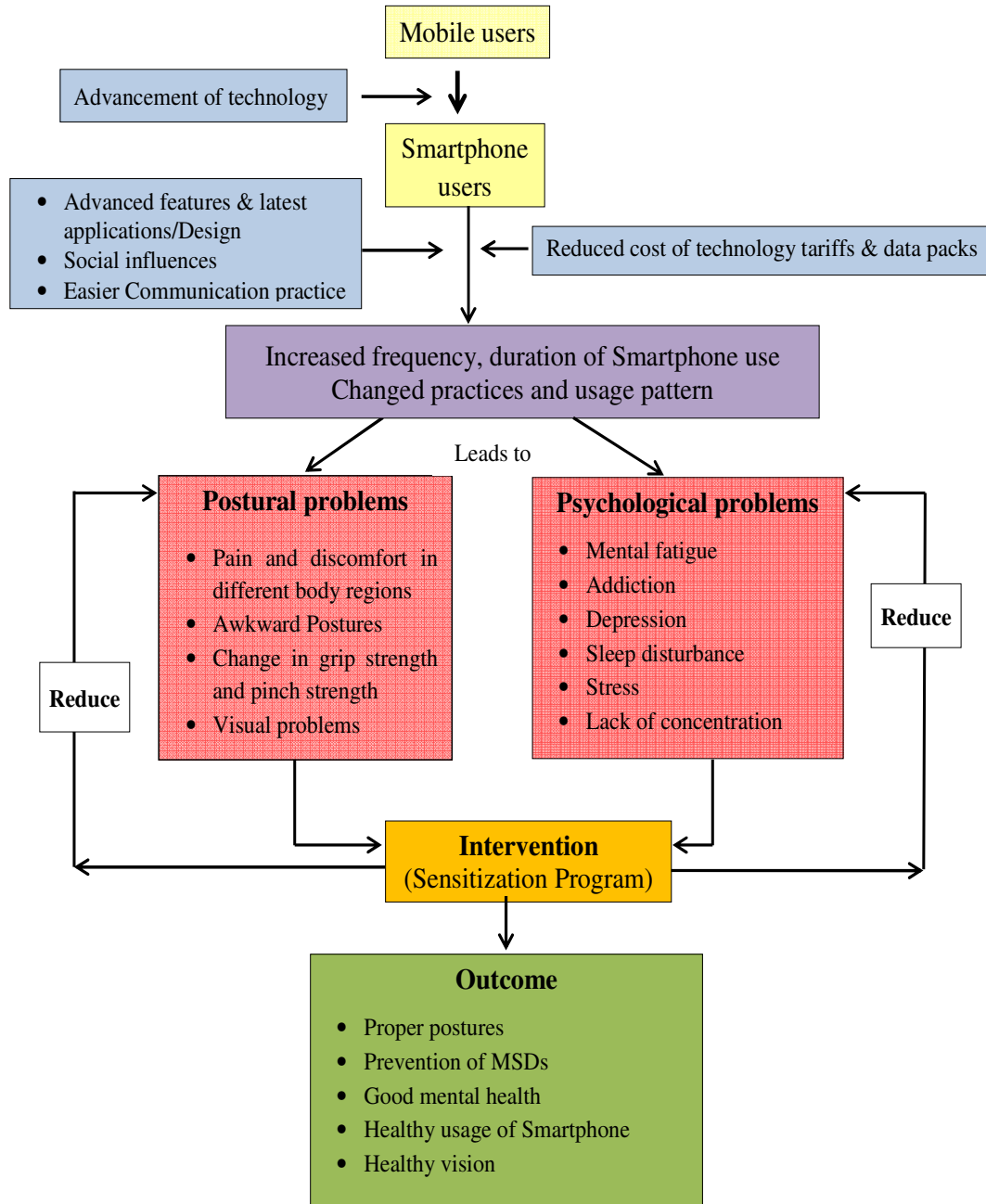


Fig: 3.1 Conceptual Framework of the Study

3.3 SELECTION OF VARIABLES

Variables can be defined as a concept which can take different quantitative values. Qualitative phenomena or attributes are also quantified on the basis of the presence or absence of concerning attributes. The variables can be classified into independent variables and dependent variables.

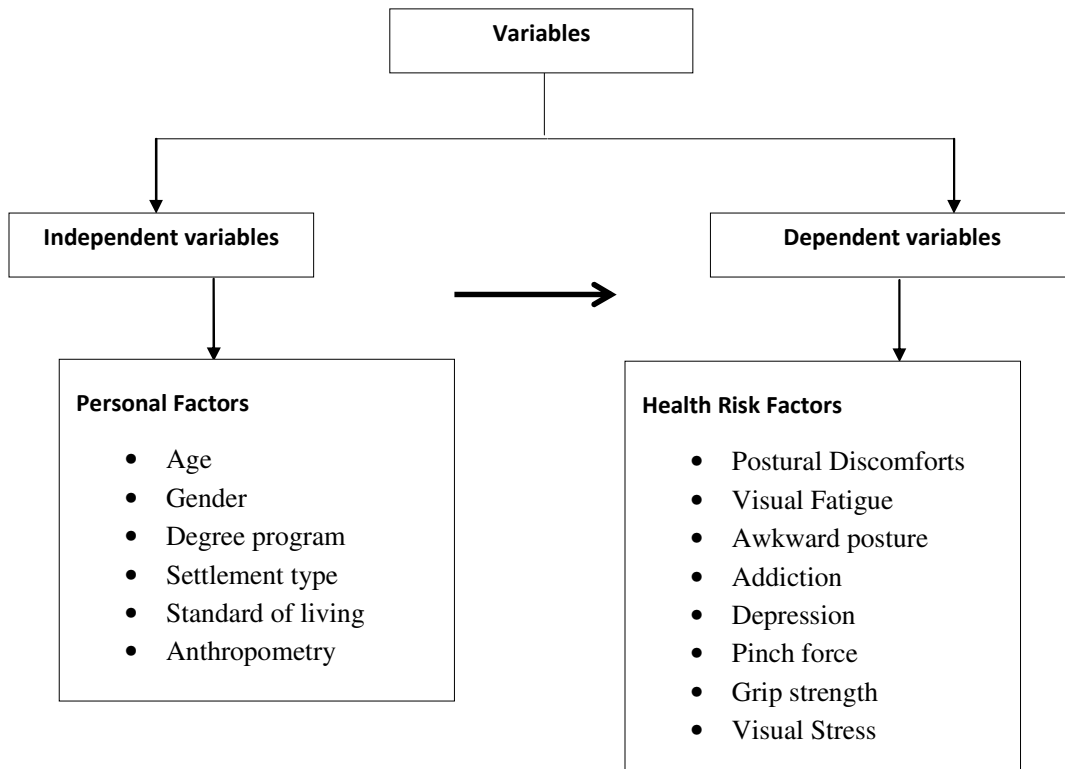


Fig: 3.2 Schematic Presentation of Interaction of Variables

3.3.1 Independent Variables

The independent variables are the one that cannot be manipulated or changed by the researcher. This includes age, sex, relationship status, family type, religion, settlement type and anthropometry.

Personal variables

Independent variables selected for the present study were given below

- **Age:** Age was operationalized as the number of full years completed by the respondent at the time of the study. Based on the minimum and maximum responses obtained, It was categorized in three categories:

Category	Code
18 -20 years	1
21-22 years	2
23 – 24 years	3

- **Gender:** Gender is the range of physical, mental, and behavioral characteristics pertaining to, and differentiating between masculinity and femininity.

Category	Code
Male	1
Female	2

- **Degree Program:** It was important to study the degree program in which respondents are studying because it may influence acquisition, usage pattern and knowledge level of the respondents. It was categorized as follows:

Category	Code
UG	1
PG	2

- **Settlement type:** it indicates the living geographic area of the respondents and divided into three categories urban, semi-urban, rural. It also affects the socio-economic status and living standards. Hence this factor was found useful to the study.

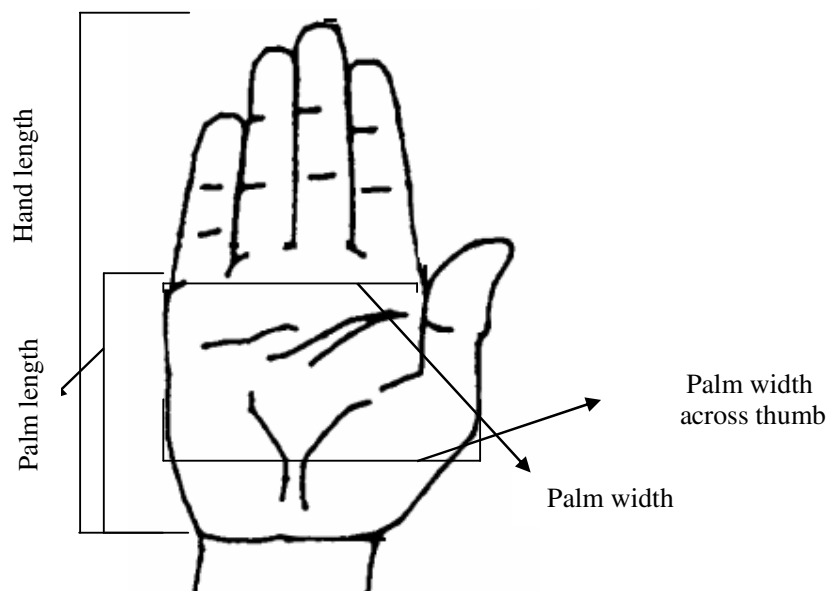
Category	Code
Urban	1
Semi-urban	2
Rural	3

- **Standard of living:** A standard of living is defined as the level of economic wellbeing, comfort, material goods and necessities that are available to a probable socioeconomic class or a certain geographic area. It includes variables like Material possessions, education; economic status means annual income, Housing, clothing, sanitation, food, leisure activities, financial management, etc. The Standard of living index was developed and divided into three categories on the basis of scores:

Standard of living	Scores	Code
Low	40 -72	1
Medium	73 - 105	2
High	106 -138	3

- **Anthropometric measurements:** Different body measurements and dimensions were taken which are as follows:
 - **Body weight:** It may be defined as the mass of a person in kilogram with minimum clothes and without footwear. It was measured by weighing machine.
 - **Height:** It may be defined as the vertical distance from the floor to the top of the head, measured while the subject stands erect, looking straight ahead. It was measured with the help of anthropometric rod.
 - **Eye height:** This is the vertical distance from the floor to the inner canthus (corner) of the eye. The subject sits erect and looks straight ahead.

- **Shoulder height:** This is the vertical distance from the floor to the upper-most point of the lateral edge of the shoulder with the subject sitting erect.
- **Hand length:** Distance (at Palmer surface) from the base of the palm to the tips of the middle finger, when the hand is held straight and stiff with fingers together and extended.
- **Palm length:** Distance from the base of the palm to the base of the middle finger (at the Palmer surface).
- **Thumb length:** The length of the thumb was measured from the second joint of the thumb to the tip of the thumb.
- **Thumb circumference:** Thumb circumference was measured at the widest point of the thumb.
- **Palm width with thumb:** Maximum breath across the palm with the thumb at the right angle to the long axis of the hand.
- **Palm width without thumb:** Maximum breadth across the palm at the distal ends of the metacarpal bones (where the fingers join the palm) of the index and the little finger.



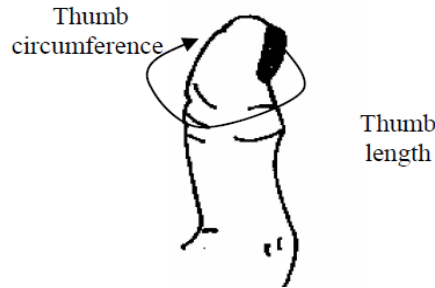


Fig: 3.3 Hand and thumb Measurements

3.3.2 Dependent Variables

The dependent variables are observed or measured in the research. These variables are influenced by independent variables. This includes Postural Discomforts, Visual Fatigue, Addiction, Depression etc.

Health Risk Factors

- **Postural discomforts:** A physical condition in which there is a trouble in normal functioning of or relating to or involving posture of the human body. Adoption of awkward body position while working for the prolonged period causes postural discomfort. It was categorized and weighted as per the scale below.

Pain	Rank	Code
Mild	1-3	1
Moderate	4-6	2
Severe	7-10	3

- **Awkward posture:** It refers to positions of the body that deviate significantly from the neutral position while performing work activities. For assessing postures of the respondent's neck flexion was measured in which flexion (movement in which the chin is lowered down toward the chest) and extension (while performing the task the neck is extended, as in looking upward toward) of the neck was measured by using inclinometer.
- **Visual Fatigue:** The visual fatigue is the kind of fatigue that occurs due to watching the digital screen like Smartphone/laptops/tablets/TV etc. continues

for the longer period of time. For measuring the visual fatigue among students VAS scale was used and the ranks were categorized in 3 categories:

Visual fatigue	Rank	Code
Mild	1-3	1
Moderate	4-6	2
Severe	7-10	3

- **Smartphone Addiction:** Smartphone Addiction is a behavioral addiction that negatively interferes with a person’s life. For assessing the addiction among students the addiction scale was developed and addiction level were further categorized in three level on the basis of the score obtained:

Addiction level	Scores	Code
Low	16-26	1
Medium	27-37	2
High	38-48	3

- **Depression:** Depression is independent risk factor of Smartphone users that have addictive behavior. Incapability to use the Smartphone gives the feeling of depression in students. So it was included in the study and respondents were categorized in three group as having mild, moderate and high depression level .

Depression level	Scores	Code
Mild	12-23	1
Moderate	24-35	2
High	36-48	3

- **Awareness:** Awareness is an understanding and ability to recognize the presence of the risks associated with any factors that are affecting body health. As Smartphone heavy usage was prevalent in youngsters and the lack of awareness regarding various disorders i.e. postural, psychological, visual etc. leads to permanent damage to health. The awareness scale was used with following categories:

Level of Awareness	Scores	Code
Aware	80-110	3
Partially Aware	51-79	2
Not Aware	22-50	1

- **Grip strength:** Grip strength was determined to assess the muscular fatigue before and after the activity with the help of grip dynamometer.
- **Pinch strength:** It is a force to pick up small and tiny parts with the use of three fingers. Pinch gauge is used to measure the pinch strength and the measuring unit is kg.
- **Visual stress:** Visual stress was measured through Critical flicker fusion frequency threshold. If the subjects are unable to perceive flicker and fusion and the decrease in threshold limit leads due to visual stress after screen time.

3.4 OPERATIONAL DEFINITIONS

- **Smartphone:** A Smartphone is a mobile phone with highly advanced features. A typical Smartphone has a high-resolution touch screen display, Wi-Fi connectivity, web browsing capabilities, and the ability to accept sophisticated applications. The majority of these devices run on any of popular mobile operating systems such as Android, Symbian, iOS, BlackBerry OS and Windows mobile.
- **Anthropometry** is the science dealing with measurement of the size, weight, proportion of the human body.
- **Ergonomics** defines as the study of people's efficiency in their working environment.
- **Musculoskeletal disorders:** Musculoskeletal Disorders are injuries and disorders that affect the human body's movement or musculoskeletal system (i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc.).
- **Posture:** Posture is considered as the attitude expected by the body, by support or coordinated muscular activity. Its purpose is to maintain the stability or to form an essential base, constantly adapted to the movement superposed to this base.

- **Text Neck:** It is an overuse syndrome involving the head, neck, and shoulders, usually resulting from excessive strain on the spine from looking in a forward and downward position at any handheld mobile device, i.e. mobile phone/Smartphone, video game unit, computer, e-reader.
- **Nomo phobia:** Nomo phobia is referred to a psychological syndrome in which a person is afraid of being out of mobile or cell phone contact.
- **Anxiety:** anxiety is a feeling of worry, nervousness, or unease about something with an uncertain outcome.
- **Critical flicker fusion:** Critical flicker fusion is the highest frequency at which subjects are unable to perceive flickering.
- **Visual stress:** Visual stress can be caused by viewing a digital screen it often depends on the amount of time spent looking at a digital screen that resulted the high visual demand of digital screen contribute to the development of vision-related symptoms.

3.5 SELECTION OF SAMPLE

3.5.1 Selection of locale

The locale for the present study was Pantnagar, Udham Singh Nagar district of Uttarakhand state. This area was selected due to the availability of sample size and it was convenient for the researcher to contact and collect data.

3.5.2 Sample Design and Sampling Techniques

The study was conducted in G.B. Pant University, Pantnagar where the total population comprised of 4638 students (2544 boys and 2049 girls.) In order to collect reliable data, five percent of the total population was selected by using random sampling method as a sufficiently representative sample for the present study. (Fig.3.4). Sample of 230 respondents was decided to be drawn from the total population.

The selected respondents were then divided equally i.e. 115 boys and 115 girls for the descriptive study. Fifty percent respondents from the total selected sample were taken for psychological assessment (58 girls and 58 boys) and 70 percent of the respondents (80 girls and 80 boys) were randomly selected for experimental data. Out of this 70 percent experimental sample size 50 percent (40 boys and 40 girls) were chosen for postural analysis and 10 percent i.e. 8 girls and 8 boys were selected to assess the impact of Smartphone before and after usage.

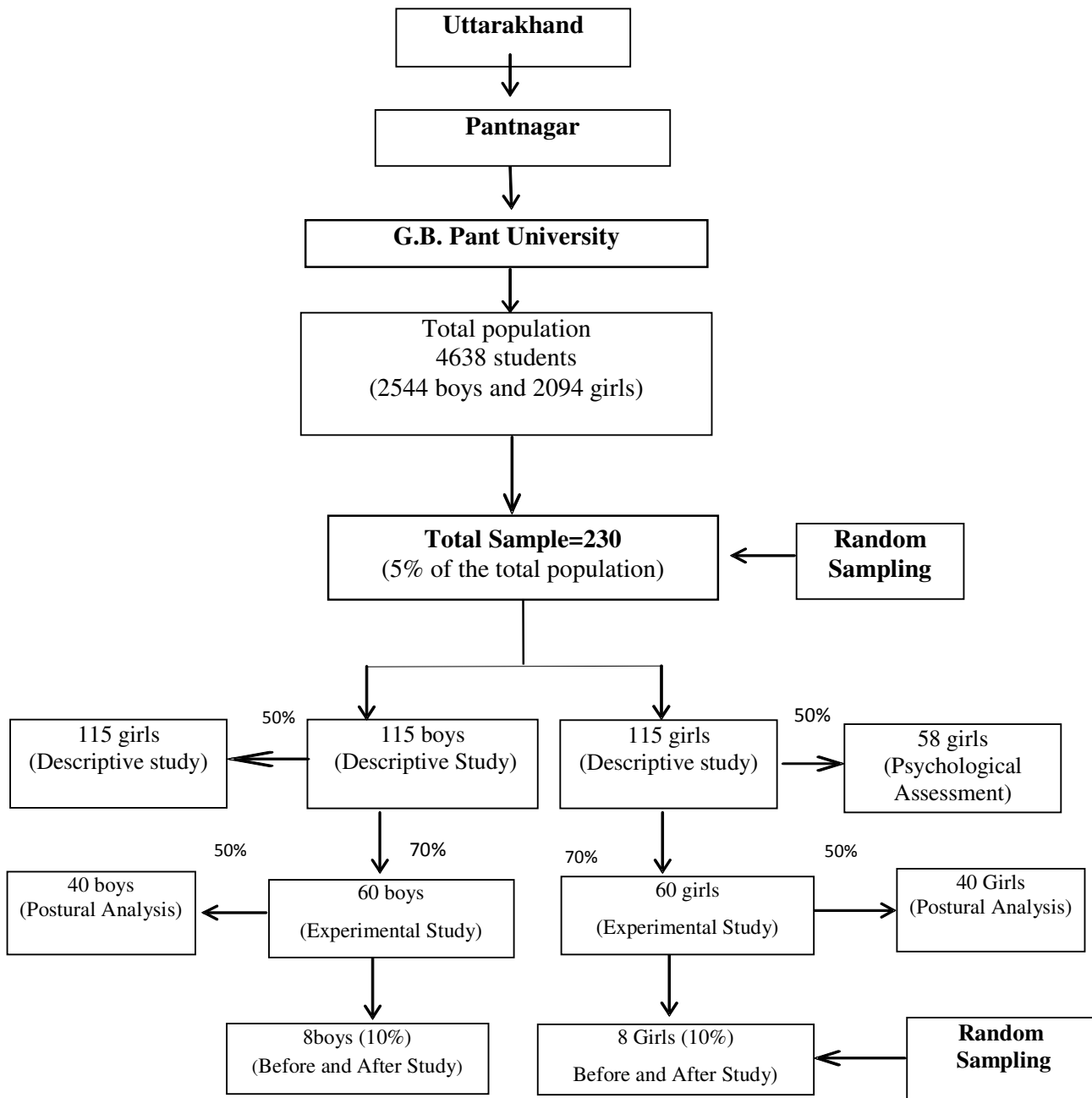


Fig: 3.4 Schematic presentation of Sample and locale selection

3.6 Tools for Data Collection

Various tools for the data collection were developed into three sections (fig. 3.5)

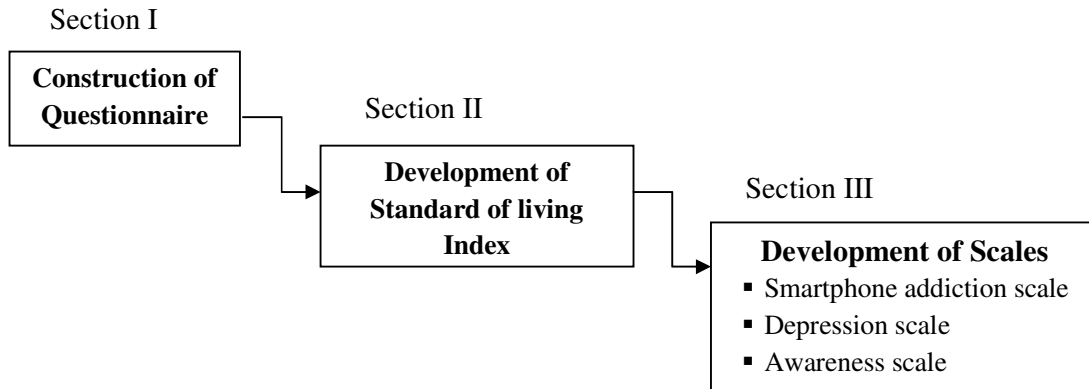


Fig.3.5 Development of tools for data collection

3.6.1 Construction of questionnaire

A pre-coded questionnaire was developed and used as a tool to collect the data with respect to general and specific information of Smartphone users to accomplish the objectives of the study with following reasons:

- To ensure that the data is completely filled in the datasheet
- To safeguard against non-returns of the datasheet
- To establish rapport in order to elicit the correct response and to classify the issues

A preliminary survey was conducted at the college level to check the content validity of the questionnaire. A good rapport was established with the respondents to get the proper insight into the problem associated with the Smartphone usage and physical and psychological problems related to the health of the college students.

Final questionnaire was consists of five sections as follows

Section 1

It comprised ten questions regarding personal information of the college students like age, gender, relationship status, family type etc.

Section 2

Part A consists of 12 questions regarding Acquisition, Ownership and Attitude of the respondent towards smartphone.

Part B consists of 5 statements regarding Smartphone as a personal media device.

Part C consists of 7 statements regarding Smartphone as a social technology.

Section 3

It comprised 24 questions regarding usage pattern of the Smartphone like hours/day spent and purpose of using Smartphone among college students.

Section 4

It consists of protocols for the identification of the symptoms of musculoskeletal disorders. For measuring frequency and intensity of pain a combined scale to measure pain was created for the upper body parts and hands.

Section 5

It includes Visual fatigue scale where Visual fatigue was categorized as none (0), mild (1-3), moderate (4-6) or severe (7-10) on the Likert scale and five questions were also included regarding visual problems faced by Smartphone users.

3.6.2 Development of Standard of living Index

The need to quantify and measure the aspect of living standard of college students led to the formulation of an index for their measurement. It was developed and used to elicit information regarding the standard of living of the respondents on the basis of 10 parameters.

Standard of Living Index:

The standard of living is the number of goods and services produced and available to purchase by a person, family, group, or nation. Non-material aspects, such as relationships, freedom, and satisfaction, are important to a good quality of life but are difficult to objectively measure. Therefore, the standard of living is a measure of the material aspects alone. (Amadeo, 2018)

A standard of living is also defined as the level of richness, comfort, material goods and necessities that are available to a probable socioeconomic class or a certain geographic area.

Standard of living can be thought of as a measure of the quality of life or level of material prosperity enjoyed by individuals, a specific demographic group, or a geographic region such as a country. In economics, the standard of living is usually used to determine the relative prosperity of the population of an entire country and is often compared to the standard of living that populations of other countries enjoy. **(Grimsley, 2018)**

A standard of living (SoL) is one of the most important variables in social science studies/researchers. It also plays a significant role in planning and execution of developmental programs, therefore; the need was felt for the development of a valid and reliable instrument for the measurement of standard of living. In urban India, Standard of living of a family would mean the ranking of the family in the background to which the family belongs, in respect of defined variables viz., Material possessions, education, economic status, Housing, clothing, sanitation, food, leisure activities, financial management, etc.

Sharma and Vashishth (2017) explored the inequality in deprivation of basic standard of living among the 29 states of India by composite index. The higher standard of living states as per composite index include priority-wise the states of Delhi, Goa, Punjab, Kerala, Haryana, Himachal Pradesh, Nagaland, and Karnataka; followed in turn by moderate standard of living including states like Tamil Nadu, Gujarat, Sikkim, Meghalaya, Uttaranchal, and Arunachal Pradesh, Andhra Pradesh, Tripura, Jammu and Kashmir, Maharashtra, and Mizoram; and the states including Chhattisgarh, Jharkhand, Uttar Pradesh, Madhya Pradesh, Assam, West Bengal, Rajasthan, Manipur, Bihar, and Orissa belonging to the lower standard of living status.

McCarthy (2015) in his study used Gallup's Standard of Living Index for a survey in the U.S. and asked the Americans if they are satisfied with their current standard of living. It asks them whether it's getting better or worse. It was an extremely subjective measure since it was an attitudinal measurement.

Birciakova et al. (2015) performed questionnaire survey for the evaluation of alternative indicators of living standards that were classified into eight main groups, i.e., economic area, educational area, place of residence, public life, health care,

environment, interpersonal relations, and personality in different countries focusing on people's opinions about individual determinants that influenced their living standards. Furthermore, the material side of life is not prioritized to spiritual extension by respondents, which determined that GDP per capita is surely not the right measurement for the standard of living.

Concepts of Standard Of Living

The concept of "Standard of Living" has been elaborated by many economists, and now in its wider sense has become tinged with various social and psychological factors. The normal standard governed by an average income is one which conduces to healthy and symmetrical development, physical efficiency and mental and moral growth of a person.

Therefore, we can say that the economic status of any social group is determined by the amount of wealth and sources of income, social position and the mode of living. This economic measure to a great extent determines the standard of living of any group or society. The mode of living in any country depends primarily on the fundamental factors of food, shelter, and clothing. It must be noted that the rise in the standard of living implies, "an increase of intelligence, energy, and self-respect; leading to more care and judgment in expenditure and to avoidance of food and drink that gratify the appetite but afford no strength and of ways of living that are unwholesome physically and morally."

According to **Varghese *et al.* (1985)** standard of living is the combination of the composite of all the goods and services and pattern of consuming considered essential by a person or group.

Parameters of standard of living

There are some indicators or factors for the measurement of levels of living or standard of living. On the basis of given parameters by researchers, ten parameters of the standard of living were set with the help of experts and literature. These parameters were namely Family income, family education, housing, material possession, general health/medical care, clothing, food/Nutrition, sanitation, financial management and leisure activities as discussed under:

(i) Family income

Family income is one of the most important parameters that goes parallel to the standard of living. The level of living, as measured in terms of such items as housing, food consumption, clothing expenditure, and so on, is definitely related to the income of the family. Increase in income of a person means, increase in purchasing power and increase in living standard. With a rise in living standard, people often tend to shift their purchasing habit from cheaper products to expensive products.

Family income is a measure of the combined incomes of all people sharing a particular household or place of residence. It includes every form of income, e.g., salaries and wages, retirement income, near cash government transfers like food stamps, and investment gains. Average household income can be used as an indicator for the monetary well-being of a country's citizens. In this monetized world, it is the purchasing power or earning power of a person which would determine his standard of living. Also, an income of an individual is reflected by his/ her profession. Whereas **Ringen (1991)** supposed that standard of living of individuals does not depend ample on the income they earn as on the entire income of the household to which they belong beside how they use income organizes the household.

(ii) Family Education

Another factor responsible for the standards of living is the level of family education. Educated people tend to have a higher standard of living than the uneducated. It cannot expect a higher living standard from the illiterate and ignorant people.

The level of living is not entirely a function of economic factors. Education is now regarded as important because it provides "the key" to the understanding of the 'wide world' and equips one better to assert one's right and claim one's due from officials and the cunning townspeople. Education helps one to behave properly, to live properly and to understand the problems properly. Therefore, it is generally said that a family can asset a high standard of living if family education status is high.

(iii) Housing

Housing is one of the visible manifestations of a family's standard of living. In a general way, it can be said that a house and its belongings indicate the owner's

standard of living. Most of the village houses are made of mud and further the existing houses in many villages are not almost devoid of proper ventilation and light. It may be generally said that a big house or bungalow which is properly furnished, sufficient number of rooms for different activities according to family size, efficient lighting facilities and modular kitchen considered as high standard in the context of housing.

(iv) Material Possession

Along with the house go the other household possession which is also one of the visible manifestation of standard of living. Various material possessions add to the prestige of a family. It may be generally said that a family having high prestigious items maintains a high standard of material possession. It includes tangible materials in a house like refrigerator, LED, Furniture, cars, Smart phones/mobiles, air conditioner and many more that are bought and use for comfort and convenience.

(v) Health/ Medical care

The word "health" refers to a state of complete emotional and physical well-being. Healthcare exists to help people maintain this optimal state of health. Health is a positive concept emphasizing social and personal resources, as well as physical capacities.” Health has been defined not simply as a state free from disease but as the capacity of people to adapt to, responds to or control life’s challenges and changes. It is also a significant component/indicator for the measurement of levels of living. Generally when one compare standard of health on an international level, health status is being measured in terms of expectation of life at birth, infant mortality rate and crude annual death rate. But if one have to judge health/medical care standard of a family, it may be generally said that family member having good health, very rarely fall sick, immunized children, taking proper treatment from a recognized hospital in case of illness maintain high health/medical care standard. Good health will surely bring about a change in the efficiency he can earn more and, therefore, can raise standard of living to some extent.

(vi) Clothing

Apart from food and shelter, clothing is another basic requirement. Although it can be argued that clothing is more a cultural phenomenon rather than a basic necessity, in today's lifestyle clothing and apparels become the indicator of the standard of living.

At present the clothing is mostly related with the term 'fashion' that reflects the personality of any individual. In general; it is said that if a person is well dressed with branded clothes with the latest fashion trend and having branded sufficient number of clothing for daily different purposes and for any ceremony, etc., he maintains high clothing standard that also reflects the high standard of living.

(vii) Food/Nutrition

The standard of living of a family is judged very often from the quality and quantity of its food. The quantity of food consumption does not offer a true index to the standard of living of any class or group of the people. The quantitative variations are due largely to regional and physiological conditions. The true index, therefore, can only be set by the quality and variety of food consumed by urban people. Milk and fruits are greatly valued, but are difficult to get daily by low food standard and needed at least every people can claim to have them as a part of their everyday diet. It is generally said that the effective consumption of basic foods i.e. fruits, vegetables, milk and milk products, butter or ghee, fruit juices and salads in reasonable combinations result in rational feeding and determines a high standard of living.

(viii) Sanitation

Sanitation is also one of the visible manifestations which reflect one's standard of living. A housewife should maintain proper sanitation of home and surrounding and bright homes will surely bring about a change in the psychology of the family members and make them lead a happy and contented life. To maintain proper sanitation, a house should clean daily, dispose the garbage and wastewater properly and should have proper toilet facility in the house.

(ix) Financial Management

According to Howard and Upton "Financial management is an application of general managerial principles to the area of financial decision-making". In past financial management was only a part of any organization or enterprises but now a day it has been extended to the household level. Financial management is an essential part of overall management. Financial management is a difficult task in family and it is varied from home to home. The income of some families are sufficient enough whereas several families find they run out of financial resources and helpless at emergency

situations. Proper financial management within the family and maintaining the financial health is necessary to be well fulfilling with economical resources when needed. It is important aspect in a family because the financial management affects the living standard of the family.

(x) Leisure activity

In present time, urban families spend time on other activities as well, the most important being paid work, personal care and leisure. Leisure activities vary from household to household and class to class. Spending time in leisure including the different activities that are out of daily job it may be travel trips, extracurricular, games, entertainment, newspaper/magazine reading etc. the family spending extra money for leisure activity can be said the high living standard of the family.

Procedure of measuring standard of living of urban families

An index of standard of living was developed. The standard of family income, education, housing, material possession, health/medical care, clothing food and nutrition and sanitation in combination highlighted the overall standard of living of a family. The steps followed to finalize the index were as discussed under:

- i) All the parameters were set accounted with some general characteristics and by reviewing the literature and consulting experts on the subject. In this way, an index was prepared (Annexure 2).
- ii) The prepared index was distributed to 10 judges. The judges were experts in Economics, Sociology and Home science. They were requested to judge each of the items of all parameters on three-point scale viz. most relevant, relevant and irrelevant. They were also requested to give their own comments or valuable suggestion to modify the prepared index to make it more reliable for its appropriateness. On the basis of their judgment and suggestions, the index was modified and finalized (Annexure 2).
- iii) Each item of high, medium and low standard of each parameter was given weight 3, 2, and 1, respectively. To make three categories of standard of living, the minimum and maximum possible score was calculated and range was divided into three categories. The range of scores assigned to each parameter was as follows:

	Parameter	Standard	Scores
a)	Family income	Low	1
		Medium	2
		High	3
b)	Family Education	Low	1-2
		Medium	2-4
		High	3-6
c)	Housing	Low	1-7
		Medium	2-10
		High	3-18
d)	Material possession	Low	1-6
		Medium	2-22
		High	3-36
e)	Health/ medical care	Low	1-4
		Medium	2-8
		High	3-12
f)	Clothing	Low	1-5
		Medium	2-10
		High	3-15
g)	Food/ Nutrition	Low	1-3
		Medium	2-6
		High	3-9
h)	Sanitation	Low	1-4
		Medium	2-6
		High	3-9
i)	Financial management	Low	1-4
		Medium	2-10
		High	3-15
j)	Leisure activity	Low	1-4
		Medium	2-10
		High	3-15

As the standard of living is the combination of many specific standards (Varghese *et al.*, 1985). Therefore to judge the overall standard of living of a family, minimum and maximum possible score including all parameters in combination was calculated and the range was divided into three to obtain three strata score reflecting the low, medium and high standard of living. The scores assigned to the standard of living were as follows:

Standard of living	Maximum Attainable Scores
Low	40 -72
Medium	73 - 105
High	106 -138

Reliability of the index: The reliability of the standard of living index was attained by using spearman brown split half reliability method. The items of this index were split into two halves on the basis of odd and even numbers of items were determined by the correlation coefficient between them which was found to highly significant ($r = 0.093$). After assessing the reliability, an index was ready for actual administration in the research.

3.6.3 Development of Scales

Three scales i.e. Smartphone Addiction Scale, Depression Scale and Awareness Scale were developed by using the following procedure:

Item collection

As item collection is the first step in developing scale, a large number of statements related to the particular area were gathered from literature, articles, and journals and by holding discussions with the subject matter experts. Tentative lists of the items were drafted keeping in view the applicability or item suited to the area of the study.

In this way,

- In Addiction Scale total 60 statements were framed.
- In Depression Scale total 25 statements were framed.
- In Awareness Scale total 45 statements were framed.

Item selection through Content Validity

Item selection is an important step in constructing a valid and reliable scale. Content Validity refers to the suitability of the sampling of the content that should be measured. **Kerlinger (1964)** defined content validity as the representativeness or sampling adequacy of the content of the measuring instrument. In the present study, content validity of scales was established. After the item collection for these three scales, they were given to 10 experts selected from different colleges of G.B.P.U.A. and T., Pantnagar, researchers, and scientist. All the judges were asked to rate the statements as “Clear” (C) “Not clear (NC)” “Ambiguous” (A). On the basis of consensus of judges, the statements were finalized for respective scales. Statements having agreement by the 80 percent judges were retained in the scale and those statements which were marked not clear were discarded. The judges were requested to add or delete any statement which they deemed fit for the conclusion or deletion. It was noticed in all scales that the selected items represented the universe of the contents and measures the extent for which they were developed.

After the judgment, In Addiction Scale out of 60 statements total 26 statements were selected whereas in Depression Scale out of 25 statements total 20 statements were selected and in Awareness Scale out of 45 statements total 40 statements were selected.

Item Analysis: These scales were administered on a random sample of 33 college students who were more or less identical to the main sample. Their reactions to each item were marked on the three alternative response categories “Agree” (A) “Disagree (DA)” “Neutral” (N) and the numerical values were assigned to the three categories of responses for the items.

Agree = 3, Neutral = 2, Disagree = 1

The total score obtained by all 33 respondents were arranged in descending order. Thirty-three percent (11 respondents), each from top and bottom scores was selected for item analysis as the high and low groups. These were taken as criterion group to evaluate individual statements. Then each item was analyzed to determine

how effectively it differentiated between the high and low groups. The 't' value for each item was computed to find the discriminating power of each item scale.

Item selection after item analysis: Item selection is an important step in constructing valid and reliable scale (**Edward, 1957**). After calculating 't' value of each statement those statements which showed significant t-value (more than 1.75) were retained in the scale after item analysis.

- In Addiction Scale, out of the total 26 items included in this scale, 10 items were discarded and only 16 items were retained in the scale for the assessment of the addiction in Smartphone users.
- In Depression Scale, out of the total 25 items included in this scale, 13 items were discarded and only 12 items were retained in the scale for the assessment of the depression in Smartphone users due to longer Smartphone use.
- In Awareness Scale, out of the total 42 items included in this scale, 20 items were discarded and only 22 items were retained in the final scale for the assessment of the awareness regarding postural disorders due to Smartphone use.

Reliability of the scales

Reliability is the ability of a scale or instrument to give the consistently similar score on repeated measurement. In short, reliability refers to the precision or accuracy of the measurement or score (**Kerlinger, 1964**). A well-defined scientific instrument should yield accurate results, both at present, as well as, over time. The final Addiction scale consisting 26 statements, Depression Scale consisting 20 statements and awareness scale including 40 statements were administered for a random sample of 33 college students who were more or less identical to the main sample. In addiction scale, the reactions of the respondents for each statement were marked on the three alternative response categories "Agree" (A) "Disagree (DA)" "Neutral" (N) and the numerical values from three to one were assigned to the three categories of responses for the items. In Depression scale, the reactions of the respondents for each statement were marked on the four alternative response categories "Mostly", "Frequently", "Occasionally" and "Never" and the numerical values from four to one were assigned

to the four categories of responses for the statements. In Awareness scale, the reactions of the respondents for each statement were marked on the four alternative response categories “Never”, “Occasionally”, “Sometimes”, “Often” and “Always” and the numerical values from one to five were assigned to the five categories of responses for the statements.

The Spearman-Brown split-half reliability method was applied. The items of these scales were split into two halves on the basis of odd and even number of items were determined by the correlation coefficient between them which was found to highly significant.

Formula used:

$$r = \frac{(N \sum XY) - (\sum X \cdot \sum Y)}{\sqrt{[(N \sum Y^2) - (\sum Y)^2] [(N \sum X^2) - (\sum X)^2]}}$$

$$\text{Reliability coefficient} = r^{1/2} \text{ I/II} = \frac{2r}{1+r}$$

Where,

r = reliability coefficient of the whole test.

$r^{1/2} \text{ I/II}$ = reliability coefficient of half test.

(r = range between 0.70 – 0.80)

- The addiction scale indicating the evidence of high reliability with a coefficient of correlation ($r=0.97$).
- In Depression Scale, It was found that correlation was also observed very high ($r=0.95$) it indicated the evidence of high reliability.
- In Awareness Scale, The ' r ' value of 0.97 was found to be significant, thereby the awareness scale indicating the evidence of high reliability.

3.7 METHODS OF DATA COLLECTION

Both descriptive and experimental data were collected from the selected respondents with the use of developed scales and questionnaire.

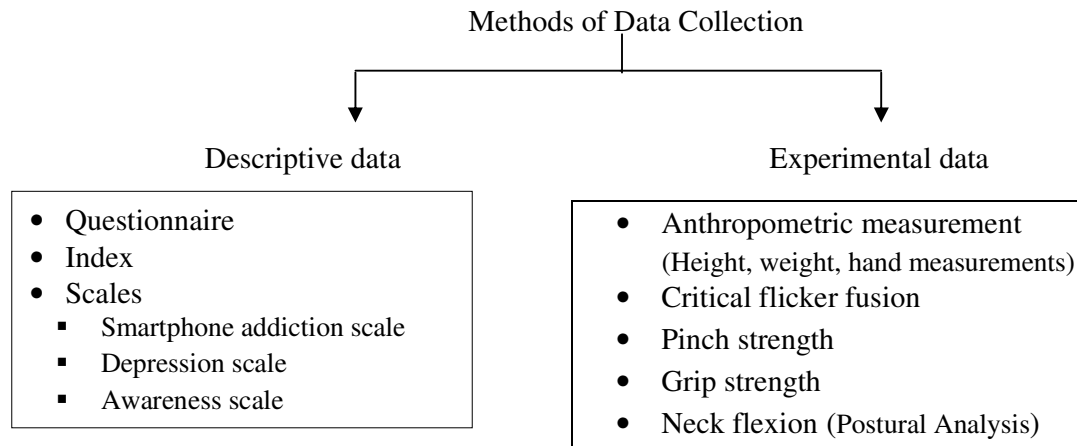


Fig: 3.6 flowchart of Methods used for Data Collection

3.7.1 Descriptive study

For descriptive study, questionnaire method was adopted to collect the data. The data collected from the Smartphone users belonged to personal characteristics, the standard of living.

Assessment of musculoskeletal discomforts was done by using self-reporting scale and respondents were asked to rank different body region and hand areas having discomfort. Developed Smartphone addiction scale, depression scale, and awareness scales were used to record the various data.

3.7.2 Experimental study

For the collection of experimental data, the parameters chosen were body measurements of the students i.e. height, weight, eye height, shoulder height and hand measurement. Critical flicker fusion frequency, grip strength, and pinch strength and neck flexion (postural analysis) was measured by using various instruments that are explained below:

3.7.2.1 Anthropometric measurement

Anthropometric measurement of selected respondents was recorded by using various anthropometric equipments.

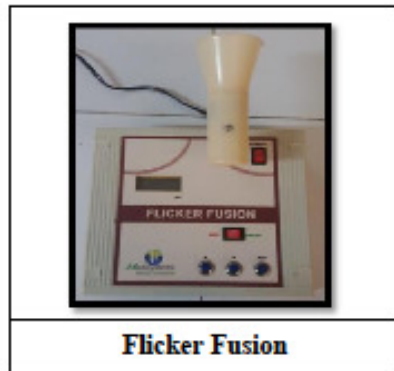
- a) Anthropometric Rod: The height, shoulder height and eye height of the respondents was taken by using an anthropometric rod.
- b) Digital Weighing Balance: It is used for recording the body weight of the respondents.



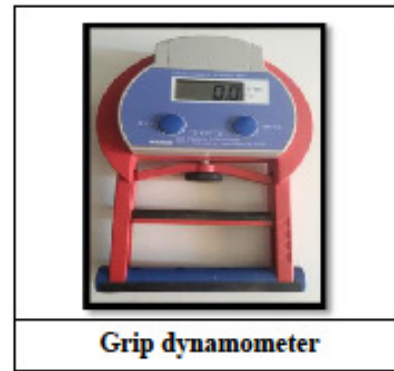
Weighing Balance



Inclinometer



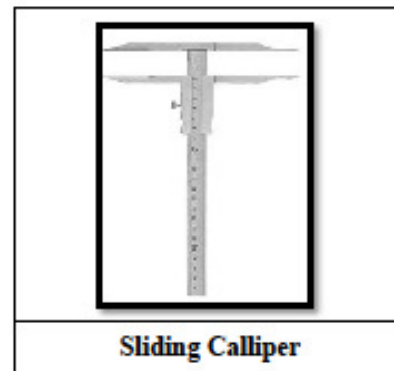
Flicker Fusion



Grip dynamometer



Pinch Force Meter



Sliding Calliper



Anthropometric rod

Plate-1 Instrument used for data collection



Plate 2: Different Measurements of the respondents

- c) Sliding caliper: Sliding caliper is used to measure the distance between two points on a flat surface. Sliding caliper was used for taking the measurement of hand dimensions. Total 6 dimensions were measured in the dominant hand of the respondents i.e. hand length, palm length, palm width without a thumb, palm width with the thumb, thumb length and thumb diameter.

3.7.2.2 Critical Flicker Fusion Test

CFFFR was measured with a Digital Flicker value tester to examine the visual strain. In this tester, the system presents a series of Red/green light stimuli at different frequencies adjusted from 12 – 120 Hz. Red/green light stimuli were surrounded by a white background. After a short practice phase, each participant was seated in front of this tester i.e. 80 cms from the stimulus in a semi-dark room with a single 40-w bulb fixed behind the participant. Once all the pre-requisites were done, the frequency of flicker was gradually increased from a minimum threshold of 12 Hz till the participants reported that they perceived successively presented light stimuli to be "constant" or "fused" or "steady". Performance data was obtained. Data corresponding to the output variable “last frequency presented” was analyzed. This provides an indication of the "critical" frequency, i.e. the highest frequency at which participants are unable to perceive flickering.

3.7.2.3 Grip Strength

Grip dynamometer was used to measure the strength of grip muscles before and after the performance of the activity. It was measured for both right and left hand and the percentage change in the grip strength was calculated using the following formula,

$$\text{Change in Grip Strength (\%)} = \frac{Sr - Sw}{Sw} \times 100$$

Where

Sr = Strength of muscles at rest

Sw = Strength of muscles after work

Decreased grip strength was interrupted as grip fatigue of the muscles.

3.7.2.4 Pinch Strength

Pinch force meter is used to measure the pinch strength of the fingers. The three different types of pinch force were measured namely (Plate 2):

A. Lateral or key pinch: place the pinch meter between the pad of the thumb and the lateral surface of the index finger.

B. Palmer or three jaw chuck pinch: place the pinch meter between the pad of the thumb and pad of the index and middle fingers.

C. Tip pinch: place the pinch meter between the tip of the thumb and the tip of the index finger.

3.7.2.5 Neck flexion

Inclinometer was used to assess the body posture by measuring the neck flexion of the respondents. It consists of primary and secondary inclinometer which was joined with the help of connecting cable; besides this three straps of Velcro were used for tying both the inclinometer to measure the cervical extension and flexion in different activities. The data regarding extension and flexion was recorded in this digital machine which records up to six repetitions per test. For the postural analysis of the Smartphone users, cervical flexion and extension in different positions were recorded with the help of inclinometer and the range of motion of cervical region was compared with the normal range for calculating the range of motion.

Table 3.1: Neck Flexion angle and the force exerted to the cervical spine during Smartphone use

Position	Neutral	15 °	30°	45 °	60 °	90°
Force To Cervical Spine	10-12 lbs.	27 lbs.	40 lbs.	49 lbs.	60 lbs.	Not Measurable

According to American Medical Association’s 5th edition of the guides to the evaluation of permanent impairment, the normal degree for each motion is:

Table 3.2: Normal degree for motion according to American Medical Association

Cervical flexion	Cervical Extension
50°	60°



A: Lateral pinch force



B: Palmar pinch



C: Tip pinch

Plate 2: Measuring different types of pinch force

3.7.3 Pre and Post Study

For assessment of pre and post data, the 10 percent of total sample was selected. In experimental data grip strength, pinch strength, CFF frequency, and neck flexion were included. The grip, pinch and CFF were measured before and 30 minutes after the Smartphone use but the difference in neck flexion was measured in 4 duration i.e. 0 min., 10 min., 20 min. and 30 minutes.

3.8 STATISTICAL ANALYSIS OF DATA

Analysis means critical investigation of the assembled and grouped data for studying the characteristics of the object under study for determining the patterns of relationships among the variables related to it.

The data collected from the survey were tabulated and analyzed with the appropriate statistics to support the current study. Subjective statistics i.e. frequency, percentage, mean, standard deviation, and descriptive statistics i.e. paired t-test, one way ANOVA and chi-square test.

Frequency

It is used to find out the number of the respondents in a particular cell.

Frequency=sum of the responses (in numbers)

Percentage

It is used for making simple comparisons.

$$P=a/b*100$$

Where,

a=Frequency of particular cell

b=Total number of respondents

P=Percentage

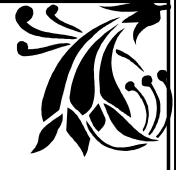
Mean: It also is known as average. It is the sum of all observation divided by the total number of the observation.

Mean= Total sum of the responses/ Total number of the respondents

Standard Deviation: The Standard Deviation is a quantity expressing by how much the members of a group differ from the mean value for the group. The formula is the square root of the Variance.

Hypothesis testing

The hypothesis of the study was tested through chi-square test, paired t-test and one way ANOVA test.



*Results
and
Discussion*



This chapter is most important to present the facts and finding of the study emerged from the statistical treatments of the collected data. These are in concurrence with the said objective and are described under different sub heads as follows:

- 4.1 Demographic profile of the respondents
- 4.2 Standard of living of the respondents
- 4.3 Acquisition, ownership and Attitude of the smartphone users
- 4.4 Usage pattern of the smartphone among respondents
- 4.5 Anthropometric measurement of the respondents
- 4.6 Smartphone dimensions
- 4.7 Assessment of Visual Problems in respondents due to Smartphone use
 - 4.7.1 Visual Discomfort
 - 4.7.2 Visual Fatigue
 - 4.7.3 Critical flicker fusion
- 4.8 Identification of musculoskeletal symptoms experienced in different body parts by the respondents
- 4.9 Muscular fatigue in hands
 - 4.9.1 Grip strength
 - 4.9.2 Pinch Strength
- 4.10 Postural analysis of respondents in different positions (Sitting and Standing)
- 4.11 Assessment of psychological Problems among respondents due to Smartphone use
 - 4.11.1 Smartphone Addiction in respondents
 - 4.11.2 Depression in Respondents
 - 4.11.3 Awareness of the respondents regarding postural and psychological disorders due to smartphone
- 4.12 Testing of Hypothesis
- 4.13 Intervention

4.1 Demographic profile of the respondents

Table 4.1 Demographic profile of the respondents

(N= 230)

S.No.			Girls f (%)	Boys f (%)	
1.	Age	i.	18 -20 years	38 (33.04)	93 (80.87)
		ii.	21-22 years	47 (40.87)	18 (15.65)
		iii.	23 – 24 years	30 (26.09)	4 (3.48)
2.	College	i.	College of Home Science	83 (72.17)	48 (41.74)
		ii.	College of Technology	17 (14.78)	67 (58.26)
		iii.	College of Agriculture	15 (13.04)	0 (0.00)
3.	Degree program	i.	UG	75 (65.22)	112 (97.39)
		ii.	PG	40 (34.78)	3 (2.61)
4.	Relationship Status	i.	Unmarried	112 (97.39)	103 (89.56)
		ii.	Married	2 (1.74)	1 (0.87)
		iii.	In a relationship	1 (0.87)	11 (9.57)
5.	Family type	i.	Nuclear	92 (80)	72 (62.60)
		ii.	Joint	23 (20)	43 (37.39)
6.	Religion	i.	Hindu	111 (95.52)	105 (91.30)
		ii.	Muslim	0(0.00)	5 (4.35)
		iii.	Sikh	1 (0.87)	2 (1.74)
		iv.	Christian	1 (0.87)	0(0.00)
		v.	Others	2 (1.74)	3 (2.61)
7.	Settlement type	i.	Urban	59 (51.30)	49 (42.61)
		ii.	Semi urban	34 (29.57)	35 (30.43)
		iii.	Rural	22 (19.13)	31 (26.96)

The demographic profiles of the respondents are presented in Table 4.1 which indicated that majority of girls (40.86%) were under 21-22 years age group whereas maximum boys 80.86 percent were in 18-20 years. Other girls i.e. 33 percent and 26 percent were in 18-20 and 23-24 years age group respectively. About 16 percent boys were in 21-22 years and few boys were in 23-24 years age group. The majority of boys were younger than the girl respondents.

Less than three quarters of girls were from college of Home science whereas nearly 60 percent boys were from College of Technology. Only few percentages of girls were from College of Agriculture. About 65 percent girls and 97 percent of the boys were pursuing their graduation degree whereas nearly 35 percent girls and only few percent boys were pursuing post-graduation.

With respect to their relationship status, majority of girls (97.39%) were unmarried whereas only 1.73 percent were married and 0.87 percent were in a relationship and maximum boys i.e. 89.56 percent were unmarried, 9.56 were in a relationship and only 1 boy was married.

In the category “family type”, majority of respondents including girls (80%) and boys (62.6%) belongs to nuclear family and almost 20 percent girls and about 38 percent boys were belonged to joint family.

In terms of religion, majority of respondents from both the group belonged to Hindu religion; very few percent of the respondents were from other religions.

In the category “settlement type”, majority of respondent including both girls (51.3%) and boys (42.6%) were from urban areas, about 30 percent of girls and boys were from semi urban and remaining were from rural areas.

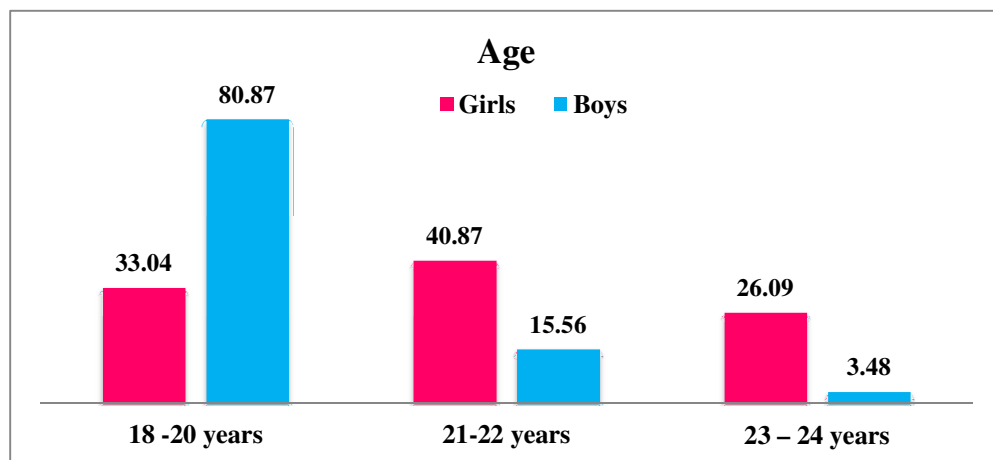


Fig: 4.1. Age of the respondents

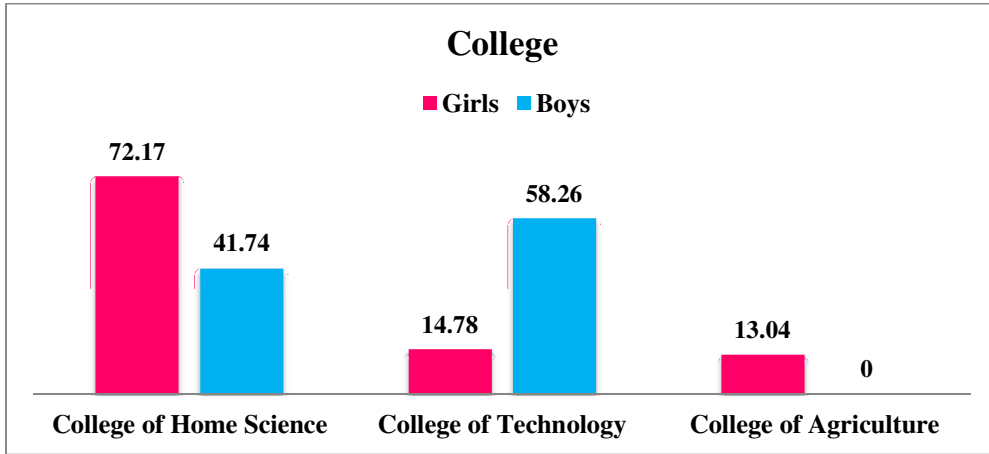


Fig: 4.2. College of the respondents

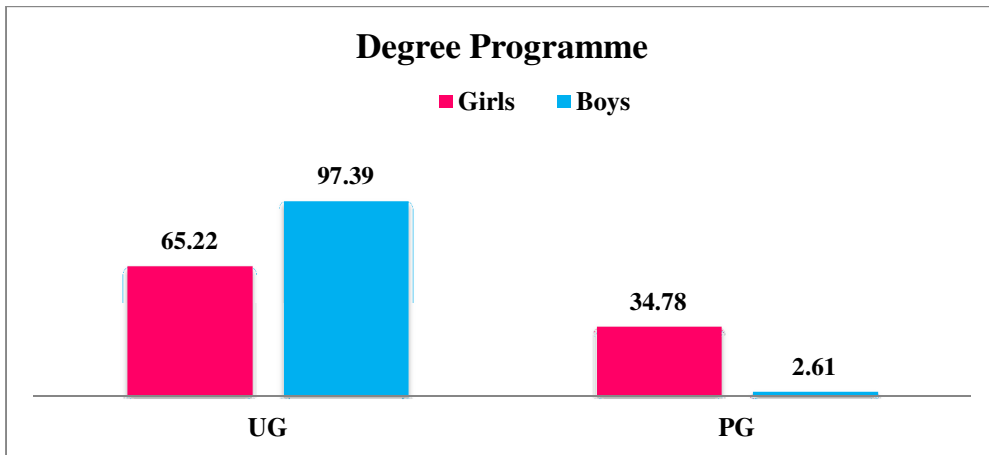


Fig: 4.3. Degree Programme of the respondents

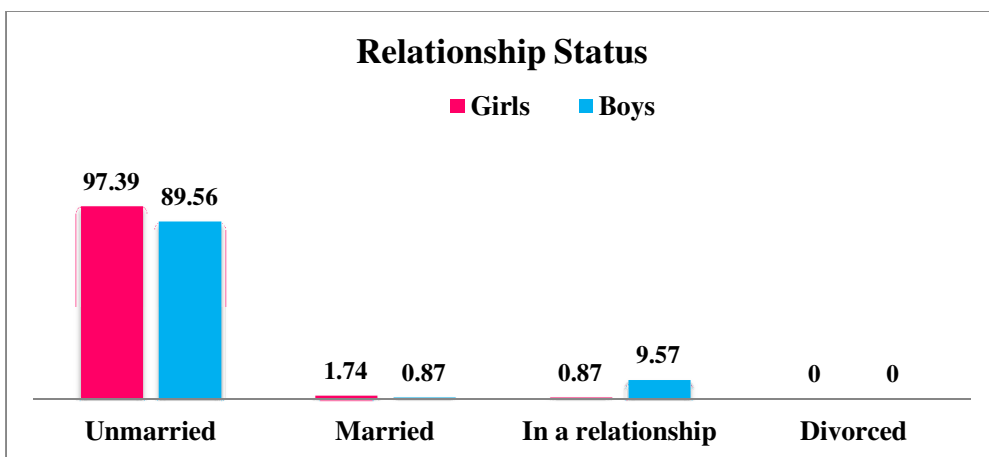


Fig: 4.4. Relationship Status of the respondents

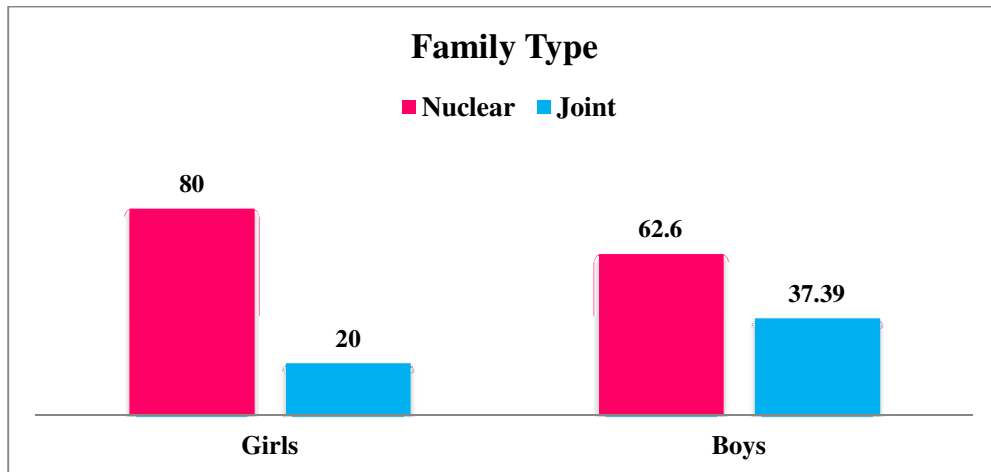


Fig: 4.5. Family Type of the respondents

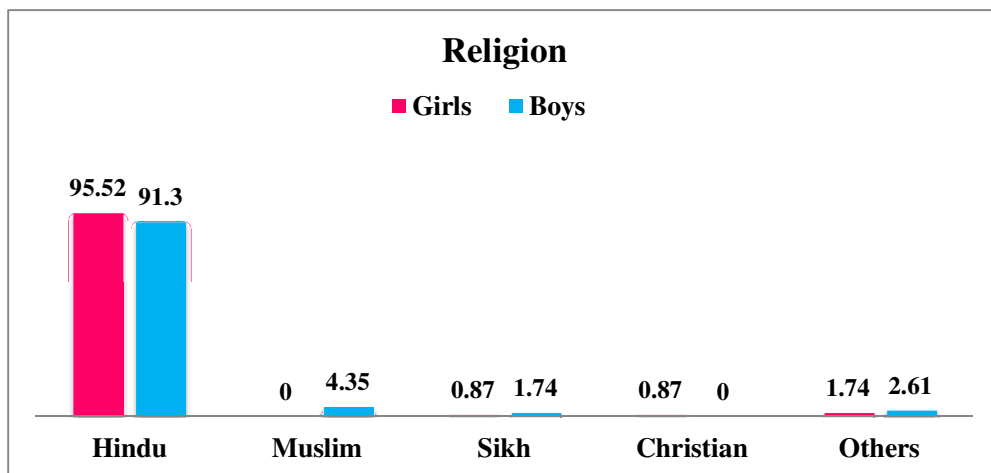


Fig: 4.6. Religion of the respondents

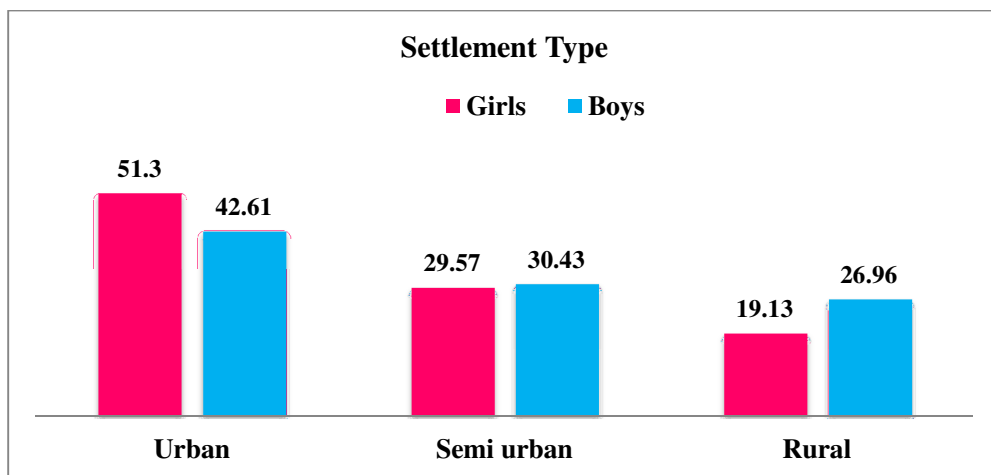


Fig: 4.7. Settlement Type of the respondents

4.2 Standard of living of the respondents

Table 4.2 Distribution of respondents on the basis of Standard of living N=230

S.no.	Category	Scores	Girls f (%)	Boys f (%)	Total f (%)
1.	High	106 -138	34 (29.56)	28 (24.34)	62 (29.95)
2.	Middle	73 - 105	68 (59.13)	67 (58.26)	135 (58.70)
3.	Low	40 -72	13 (11.30)	20 (17.40)	33 (14.34)

The developed standard of living index was used to assess the standard of living of the respondents and the above table depicts the findings in which majority of the girls (59.13%) and boys (58.26%) belonged to the middle standard of living followed by 29.56 percent girls and 24.34 boys who belonged to high standard of living whereas 11.30 percent girls and 17.40 percent boys belonged to low standard of living respectively.

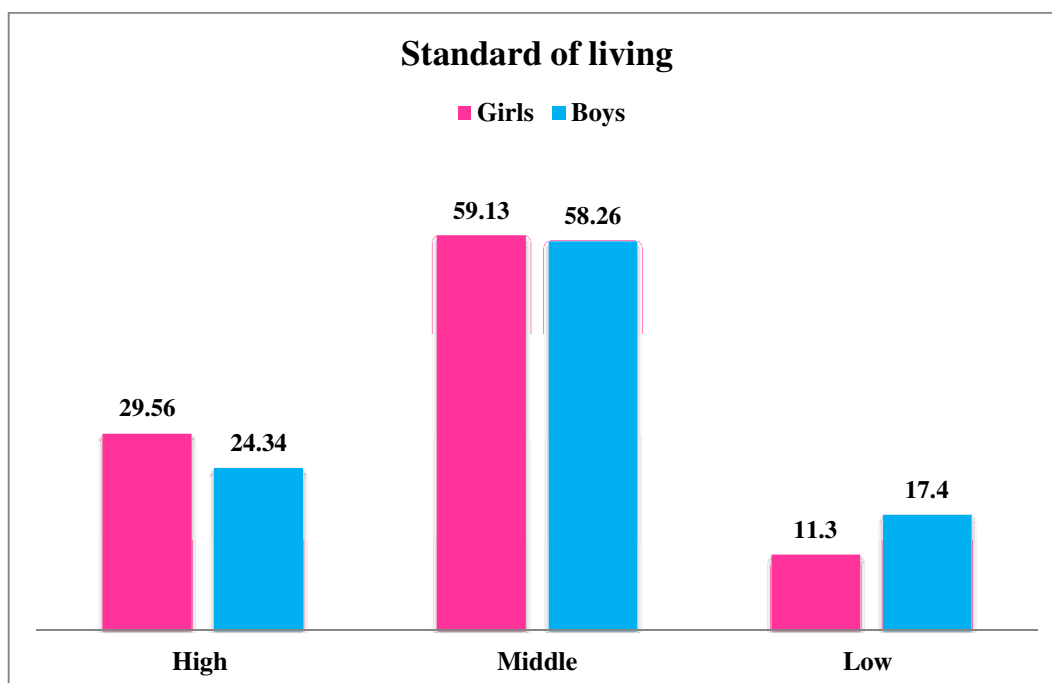


Fig: 4.8. Standard of living of the respondents

4.3 Acquisition, ownership and Attitude of the smartphone users

Table 4.3 Acquisition, Ownership of Smartphone users

N=230

S.no			Girls f (%)	Boys f (%)	
1.	Number of smart phones own at present	i.	One	112 (97.39)	102 (88.70)
		ii.	Two	3 (2.61)	11 (9.57)
		iii.	Three	0(0.00)	2 (1.74)
2.	Number of SIM cards have now	i.	One	22 (19.13)	21 (18.26)
		ii.	Two	90 (78.26)	78 (67.83)
		iii.	Three	3 (2.60)	8 (6.96)
		iv.	Four	0(0.00)	8 (6.96)
3.	Dominant hand	i.	Right hand	104 (90.43)	104 (90.43)
		ii.	Left hand	11 (9.57)	11 (9.57)
4.	Duration of owning smartphone	i.	Less than one year	17 (14.78)	12 (10.43)
		ii.	One year to three year	74 (64.34)	68 (59.13)
		iii.	More than three years	24 (20.86)	35 (30.43)
5.	Payment for first smart phone by	i.	Parents (father/mother)	102 (88.70)	108 (93.91)
		ii.	Self	6 (5.22)	0(0.00)
		iii.	Friend	3 (2.61)	1 (0.87)
		iv.	Sibling	4 (3.48)	6 (5.22)
6.	Prefer to buy smartphone from	i.	Online	22 (19.13)	35 (30.43)
		ii.	By store	93 (80.87)	80 (69.57)

Table 4.3 shows the distribution of respondents on the basis of acquisition, ownership and attitude of the smartphone users and the data revealed that majority of girls (97.39%) and boys (88.69%) owned at least one smartphone and some of the

respondents owned two smartphones. It can be assumed that major reason for keeping more than one smartphone might be the battery, network and personal issues. **Shrestha (2016)** also found that 72.36 percent users were having one mobile phone whereas 22.76 percent were having two mobile phones, 2.44 percent having four and 0.81 percent were having three mobile phones.

It was inferred from the data that majority of girls i.e. 78.26 percent and about 68 percent boys have 2 SIM cards whereas 19.13 percent girls and 18.26 percent boys have one and 2.6 percent girls had 3 SIM cards and about 7 percent boys had 3 and 4 SIM cards respectively. Multi-SIM usage becomes the latest trends among Indian consumers and they are taking advantage of it. This allows them to switch between providers to capitalize on varying price, data and service offers from telecom industry operators.

From the overall respondents including both girls and boys almost 90 percent were right handed. Majority of girls i.e. 64.34 and boys (60%) have been using smartphone for last 1-3 years and nearly quarter of the respondents were using smartphone more than 3 years.

When it was asked about the payment of their first smartphone, about 89 percent girls and 94 percent boys reported that their parents paid for their first smartphone. **Ahmed and Qazi (2011)** in their study entitled “Mobile Phone Adoption and Consumption Patterns of University Students in Pakistan” also reported similar findings that majority of respondents i.e. 46.9 percent of 400 said that their father bought them their first mobile, 26.2 percent said that their brother/sister bought them their first mobile, 19.5 percent replied that they themselves have bought it and 7.2 percent said that others bought them their first mobile. From the above responses it can be said that since during education attainment period, the students are dependent for their expenses to their parents or guardians. Therefore, majority of respondent’s first smartphone was purchased by their parents.

With respect to purchase options, Maximum girls (80.8%) and boys (69.5%) preferred to buy smartphone from stores and few percent of them percent preferred online purchase of smartphone.

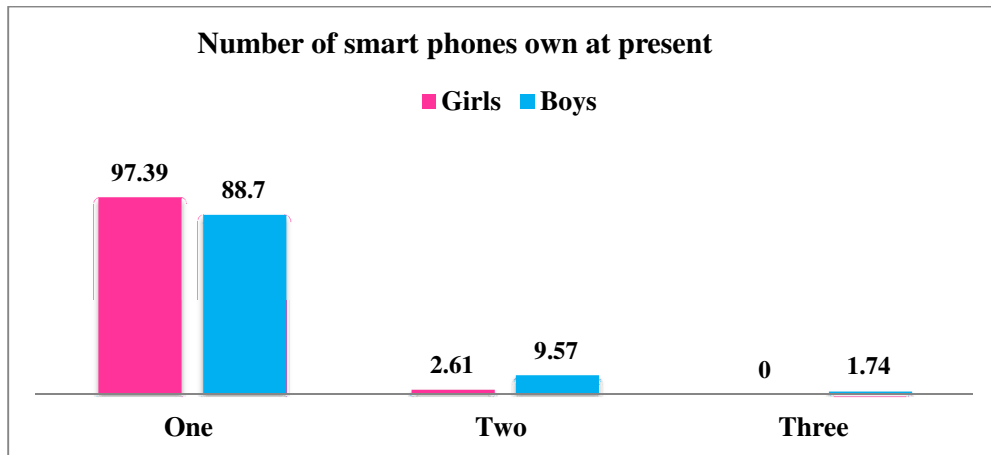


Fig: 4.9.. Number of smart phones respondents own at present

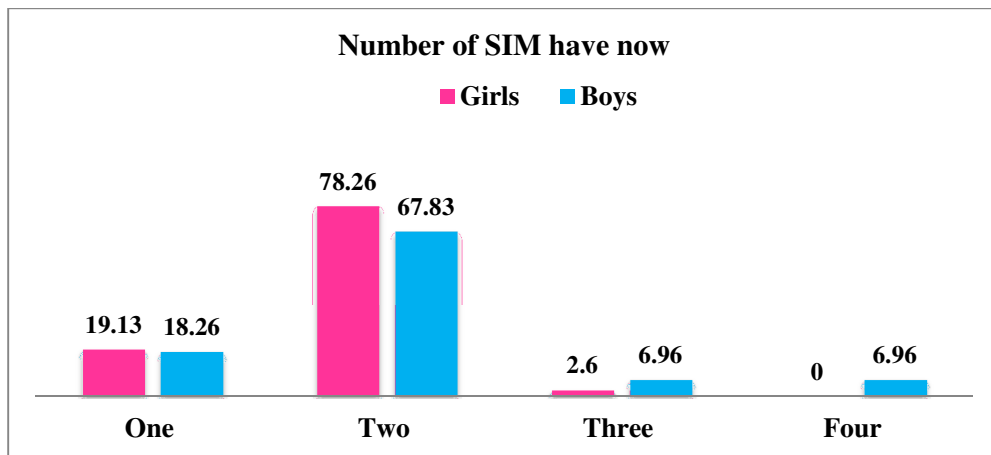


Fig: 4.10. Number of SIM respondents own at present

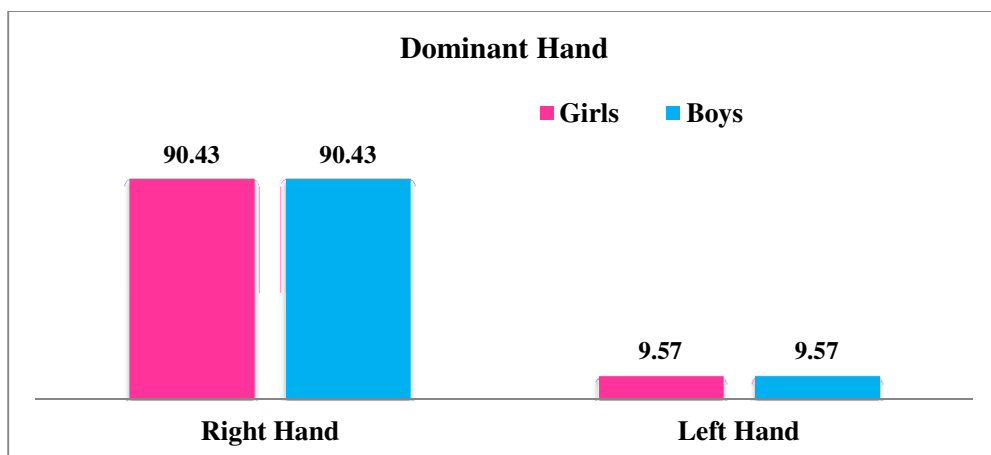


Fig: 4.11. Dominant hand of the respondents

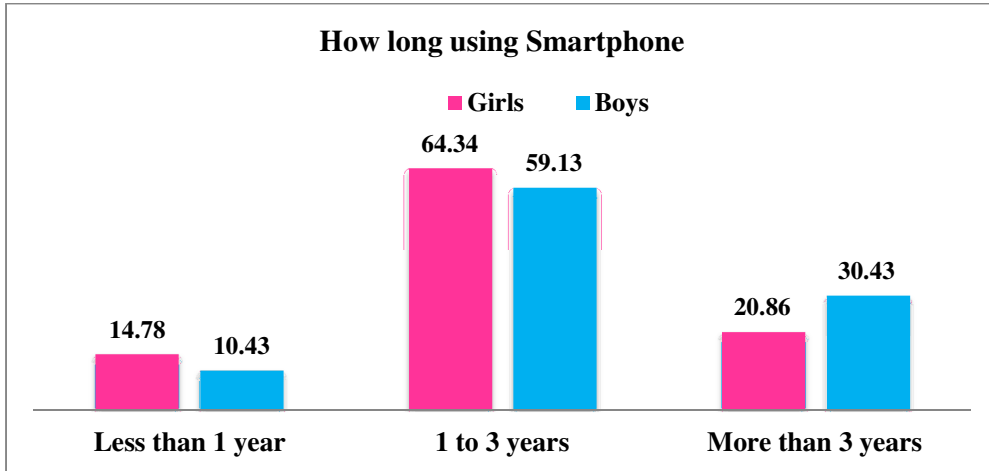


Fig: 4.12. Duration of owning Smartphone by the respondents

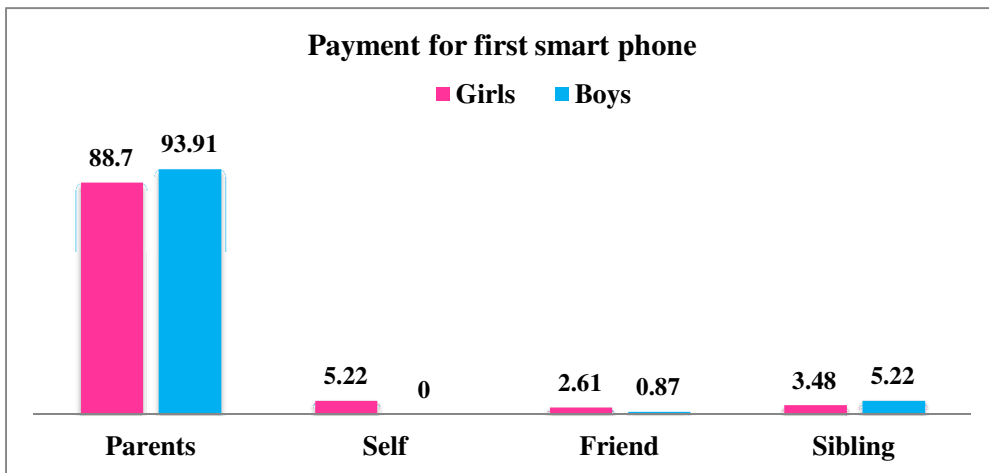


Fig: 4.13. Payment for first smart phone of the respondents

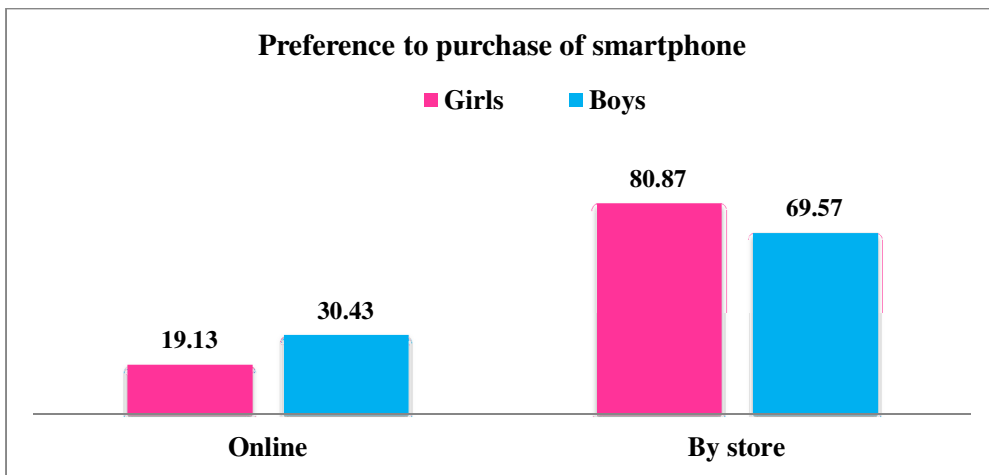


Fig: 4.14. Preference of the respondents for purchasing smartphone

Table 4.4: Distribution of respondents on the basis of reasons for buying a Smartphone N=230

S.no	Items		Very Important f (%)	Fairly Important f (%)	Important f (%)	Not at All Important f (%)
i.	Necessity	Girls	69 (60.00)	25 (21.74)	21 (18.26)	0 (0)
		Boys	64 (55.65)	22 (19.13)	29 (25.22)	0 (0)
ii.	Peer group Pressure	Girls	5 (4.35)	16 (13.91)	41 (35.65)	53 (46.09)
		Boys	7 (6.09)	19 (16.52)	38 (33.04)	51 (44.35)
iii.	Safety/Security	Girls	59 (51.30)	24 (20.87)	27 (23.48)	5 (4.35)
		Boys	27 (23.48)	37 (32.17)	40 (34.78)	11 (9.57)
iv.	Emergency	Girls	70 (60.87)	20 (17.39)	20 (17.39)	5 (4.35)
		Boys	69 (60.00)	26 (22.61)	20 (17.39)	10 (8.70)
v.	Connect with family	Girls	92 (80.00)	12 (10.43)	10 (8.70)	1 (0.87)
		Boys	58 (50.43)	34 (29.57)	19 (16.52)	4 (3.48)
vi.	Communicate with friends	Girls	57 (49.57)	33 (28.70)	24 (20.87)	1 (0.87)
		Boys	44 (38.26)	32 (27.83)	35 (30.43)	4 (3.48)
vii.	Convenient	Girls	56 (48.70)	33 (28.70)	24 (20.87)	2 (1.74)
		Boys	53 (46.09)	30 (26.09)	24 (20.87)	8 (6.96)

For knowing the reasons of buying a Smartphone among respondents, matrix style questions responses were noted in four options like very important, fairly important, important and not at all important.

Smartphones are becoming a necessity for its users because it has ability to perform various tasks at the same time so when it was asked to the respondents about 60 percent girls and 55.6 percent boys said that necessity was the very important reason for purchasing a smartphone. In the same line **Balakrishnan and Raj (2012)** also found in Malaysia, universities students also think mobile phone as a necessity as it alters the learning method at the higher learning institutions.

When asked about the Peer group Pressure nearly 46 percent girls and 44.3 percent boys said that peer group pressure is not an important reason for buying smartphone. With the contradictory results **Ozcan and Kocak (2003)** reported that

some young users believed that using a technologically advanced mobile phone improves their status amongst peers. In addition **Suki and Suki (2013)** reported that Smartphone users especially students depend highly over people surrounding them in order to purchase the smartphones. In the support with previous study **Park et al. (2013)** also indicated that social influence may be a key role in the use of smart phone since the decision to use the smartphones is beyond individuals' independent decision-making.

As mobile phones provide a sense of Safety/Security for the users, it was found from the data that about half of the girls (52%) and about 35 percent boys felt that Safety/Security was very important reason for purchase of new smartphone. Girls were keen to use smartphone for security purpose than boys.

The data revealed that nearly 60 percent each boys and girls said emergency was very important reason for buying smartphone. In case of emergency having a smartphone allow them to reach to the help quickly, hence it is also an important reason for buying smartphone.

As more than the half of the girls believed that security/ safety and emergency are very important reason for buying smartphone. Similar findings were reported by **Carroll et al., (2002)** they reported in their study that young females having mobile phone especially when they are alone at night feels secure as they are able to quickly contact to the near ones in the case of emergency and feels of safe and secure.

There's no doubt that the widespread of mobile technology has made communicating with each other much easier. The main function of smartphone is to connect and communicate with family members and friends. Therefore, when respondents were asked in this context majority of girls i.e. 80 percent said it is a very important reason for buying smartphone. Whilst, half of the boys (50.43%) said it is an important way to connect with their family members. Likewise when inquired about Communication with friends, nearly half of the girls (49.5%) and 38.26 percent boys responded that it was very important reason while purchasing a smartphone. Mobility availed by using cell phones enable busy working parents to keep in touch with their children (**Frissen, 2000; Matthews, 2004**).

It can be concluded from the data that Smartphone provide the various common ways like voice calls; text messaging, instant messaging (IM), email and video calls which helps to communicate with family and friends when they wishes. It provides them a mean to fulfil their family roles and to get emotional and psychic support from their families (**Chen and Katz, 2007**). This reason was mainly considered by the respondents while buying a smartphone.

Convenience in Smartphone may refer to the ability to use the Smartphone at anytime and anywhere, without having to port the Smartphone in a fixed workstation (**Ding et al., 2011**). It enhances the urge of having smartphone in every individual. Findings revealed that 48.70 percent girls and 46.09 percent boys said convenience was major consideration for having smartphone.

Table 4.5 illustrated the distribution of respondents on the basis of important factors for buying a Smartphone.

Table 4.5 Distribution of respondents on the basis of important factors for buying a Smartphone

N=230

S. No.	Items		Very Important f (%)	Fairly Important f (%)	Important f (%)	Not at All Important f (%)
i.	Availability	Girls	55 (47.83)	37(32.17)	22(19.13)	1(0.87)
		Boys	53 (46.09)	31(26.96)	21(18.26)	10(8.70)
ii.	Brand	Girls	63 (54.78)	30(26.09)	18(15.65)	4(3.48)
		Boys	62 (53.91)	33(28.70)	18(15.65)	2(1.74)
iii.	Model	Girls	50 (43.48)	41(35.65)	22(19.13)	2(1.74)
		Boys	58 (50.43)	40(34.78)	14(12.17)	3(2.61)
iv.	Features	Girls	83 (72.17)	25(21.74)	7(6.09)	0 (00.00)
		Boys	92(80.00)	18(15.65)	5(4.35)	0 (00.00)
v.	Cost	Girls	68(59.13)	27(23.48)	20(17.39)	0 (00.00)
		Boys	70(60.87)	36(31.30)	6(5.22)	3(2.61)
vi.	Battery Backup	Girls	91(79.13)	15(13.04)	9(7.83)	0 (00.00)
		Boys	83(72.17)	23(20.00)	7(6.09)	2(1.74)

Availability of the smartphone in the market that we want to buy is the most important factor for buying the smartphone. About 48 percent girls and 46 percent boys give emphasis to this factor for buying a Smartphone (Table 4.6).

Brand name is the first thing that appeals the youth when it comes to buying a new smartphone. For brand, 54.78 percent girls and 53.91 percent boys said it was very important factor. **Khasawneh, (2010)** found in his research that product's brand name influence customers' evaluation and affects their decision of buying. Similarly, **Suki (2013)** also supported that brand name was found to have a significant effect on the demand for smartphones among Malaysian students.

Although model plays an important role in purchasing a smartphone when asked about the importance of model it was found that less than half of the girls (43.4%) and half of the boys (50.43%) said it was very important factor.

When it was enquired about the features of smartphone, maximum girls i.e. 72.17 percent and 80 percent boys considered features as very important factor for buying smartphone. Features of a smartphone includes wireless connectivity, a built-in web browser, application installation, full programmability, a file management system, multimedia presentation and capture, high-resolution displays, several gigabytes of storage and location as well as movement sensors (**Oulasvirta et al., 2011**).

Cost is one of the most important factor which affects consumer's choice to purchase a particular smartphone. When the respondents were asked about the cost, nearly 60 percent of the girls and boys respectively said it was very important factor for buying a phone.

Nowadays, there are many high technology featured smartphones present in the market and people are choosing different features of smartphones which can meet with their needs and desires. Product features can be defined as the attributes of a product that can satisfy consumer's preferences through having the product, using and applying the product (**Kotler and Armstrong, 2007**).

The important features in a smartphone were queried to the respondents, for screen size almost half of the respondents ((53.04% girls and 50.43% boys) said that screen size was not so important feature that they want in their smartphone.

Table 4.6 Distribution of respondents on the basis of important features in a Smartphone N=230

S. No.	Items		Very Important f (%)	Fairly Important f (%)	Important f (%)	Not at All Important f (%)
i.	Screen size	Girls	34 (29.57)	61 (53.04)	19 (16.52)	1 (0.87)
		Boys	41 (35.65)	58 (50.43)	16 (13.91)	0 (0.00)
ii.	Software Features	Girls	81 (70.43)	28 (24.35)	6 (5.22)	0 (0.00)
		Boys	74 (64.35)	29 (25.22)	12 (10.43)	0 (0.00)
iii.	Music player	Girls	62 (53.91)	43 (37.39)	10 (8.70)	0 (0.00)
		Boys	43 (37.39)	48 (41.74)	22 (19.13)	2 (1.74)
iv.	Ease of texting	Girls	62 (53.91)	34 (29.57)	19 (16.52)	0 (0.00)
		Boys	40 (34.78)	44 (38.26)	25 (21.74)	6 (5.22)
v.	Camera	Girls	86 (74.78)	24 (20.87)	5 (4.35)	0 (0.00)
		Boys	87 (75.65)	23 (20.00)	5 (4.35)	0 (0.00)
vi.	Design and Build Quality	Girls	47 (40.87)	48 (41.74)	20 (17.39)	0 (0.00)
		Boys	68 (59.13)	34 (29.57)	15 (13.04)	0 (0.00)
viii.	Screen Resolution and Quality	Girls	77 (66.96)	28 (24.35)	10 (8.70)	0 (0.00)
		Boys	79 (68.70)	28 (24.35)	6 (5.22)	2 (1.74)
ix.	Memory (RAM) and Processing Power	Girls	99 (86.09)	15 (13.04)	1 (0.87)	0 (0.00)
		Boys	92 (80.00)	18 (15.65)	5 (4.35)	0 (0.00)

When enquired about the software, 70.43 percent girls and 64.35 percent boys said that Software availability was very important in a smartphone. Based on previous study done by **Lay-Yee *et al.* (2013)**, 31 percent of users prefer software compare to hardware (17.6%). This indicates consumers will look more on software rather than hardware in purchase the smartphone.

Smartphones allow us easy access to music and music player in a smartphones work as stress reliever for students. When asked about music player, maximum girls i.e. 53.91 percent said it was a very important feature whereas maximum boys (41.74%) said that music player was fairly important feature for them.

One of the most obvious advantages of any smartphone is the ability to text therefore the ease of texting is also important feature kept in mind while purchasing a smartphone. When asked, 53.9 percent girls gave importance to ease of texting as compared to boys which accounted for 38.2 percent.

The millennial are considered more active on social media and through camera they present themselves on social media. Camera is also used to capture the every special moments by everyone. Hence, the smartphone having good camera quality is the preferred feature for the youngsters. For this context, overall three quarter girls and boys said that camera was very important feature while selecting smartphone.

Design and Build quality of a smartphone is all about the appearance and durability that may be of metal or plastic, it is mainly chosen by the users as the way they want to use. In this regard, majority of girls (41.7%) said build quality was fairly important whereas about 60 percent boys said design and build quality was very important feature for them while purchasing a smartphone.

For screen resolution and size, about 67 percent girls and 68.7 percent boys reported that it is an important feature and that should be present in a smartphone. Hence, the screen resolution and size are regarded as two key factors while choosing a smartphone. As much upgraded smartphone we choose to buy higher screen resolution/quality we get with preferable viewing experience.

When enquired about the memory and processing power, maximum girls i.e. 86.09 percent and about 80 percent boys answered that is one of the important features while purchasing a smartphone.

Data yielded from the table 4.6 indicates that memory/processing, camera, software features, screen resolution, design and build quality, music player and ease of texting except screen size was the very important features that make smartphone very popular among people and they considered it while purchasing a smartphone.

Table 4.7 Distribution of respondents on the basis of their opinion regarding Smart phones as a personal media device

N=230

S.No	Items		Agree f (%)	Undecided f (%)	Disagree f (%)
i.	Smartphone as personal property	Girls	98(85.22)	10(8.70)	7(6.09)
		Boys	103(89.57)	9 (7.83)	3(2.61)
ii.	Possessive about smart phone	Girls	55(47.83)	28 (24.35)	32(27.83)
		Boys	60 (52.17)	34 (29.57)	21(18.26)
iii.	Emotional attachment to the smart phone	Girls	47(40.87)	28 (24.35)	40 (34.78)
		Boys	40 (34.78)	39 (33.91)	36 (31.30)
iv.	Conscious about the privacy Smartphone	Girls	62 (53.91)	20 (17.39)	33 (28.70)
		Boys	65 (56.52)	18 (15.65)	32 (27.83)
v.	Prefer to lock Smartphone with a security code	Girls	68 (59.13)	10 (8.70)	37 (32.17)
		Boys	85 (73.91)	9 (7.83)	22 (19.13)

Table 4.7 indicates the distribution of respondents on the basis of their opinion regarding Smart phones as a personal media device. Findings revealed that most of the respondents including girls (85.22%) and boys (89.57%) both considered smart phone as a personal property whereas very few were disagree with this.

When respondents were asked about possessiveness about their Smartphone, more than half of the girls and boys showed their agreement for this sentiment. It can be said that young people become so attached just because the features offered by devices and all time availability that make them sleep with their phone just under their pillows and only thought of losing their smartphone is far more dramatic than other things. Some researcher also found it in their study that new generation seem to be much possessed for their phone that they use their mobile phones even at places where usage is prohibited such as planes, hospitals and petrol stations (**Bianchi and Phillips, 2005; Palen et al. 2008**).

When they were asked about the privacy of their smartphone usage more than half of the girls and boys (53.9% and 56.5%) respectively showed their agreement for privacy of their smartphone, In addition, six out of ten girls and about third fourth of boys also agreed that they lock smart phone with a security code so that no one can go through the contents of their smart phone. **Jain (2016)**, in UK 21 percent from the total smartphone users are now using their fingerprints for authentication-based applications, for unlocking their phones to approving transactions. Whereas 76 percent used fingerprint scanner the most popular biometric identifier used by smartphone owners only 2 percent used either voice or facial recognition.

Table 4.8 depicts the distribution of respondents on the basis of their opinion regarding Smart phone as a social technology from which the following can inferred:

More than three quarters girls and about 84 percent boys said that “*All friends their friends have a smartphone.*” whereas some of them (12.17% girls and 10.43% boys) shows disagreement. It can be said that this reason motivated youngsters for owning a smartphone because they are very much keen about their acceptance in peer groups and they use mobile phone as a medium to get that recognition (**Cova, 1994**).

With respect to the second question, “*Smart phone allows to attract new friends.*” Majority of girls (65.22%) and less than half of the boys (46.96%) were disagree, whereas 18.26 percent girls and 28.70 percent boys were showing there agreement.

The difference in responses was found for the statement “*Smartphone helps to create a positive impression on people from opposite sex.*” Where 67.8 percent girls were disagree while maximum boys (47.83%) were agreed for that.

Majority of respondents including both girls (77.39%) and boys (86.09 %) were agreeing when asked about co-ordinating plans with friends through smartphone whereas some of them were disagree also.

The social media platforms made communication easier in youngsters’ life and it is helping them to mix with the friends and others, when they were asked in this regard majority of girls (84.35%) and boys (86.09%) both were agree and very few percent respondents showed their disagreement.

Table 4.8 Distribution of respondents on the basis of their opinion regarding Smart phone as a social technology

N=230

S.No.	Items		Agree f (%)	Undecided f (%)	Disagree f (%)
i.	All friends have smartphone	Girls	90 (78.26)	11 (9.57)	14 (12.17)
		Boys	96 (83.48)	7 (6.09)	12 (10.43)
ii.	Having a smartphone allows to attract new friends	Girls	21 (18.26)	19 (16.52)	75 (65.22)
		Boys	33 (28.70)	25 (21.74)	54 (46.96)
iii.	Smartphone helps to create a positive impression on people from opposite sex	Girls	14 (12.17)	23 (20.00)	78 (67.83)
		Boys	55 (47.83)	37 (32.17)	23 (20.00)
iv.	Smartphone use to co-ordinate plans with friends	Girls	89 (77.39)	15 (13.04)	11 (9.57)
		Boys	99 (86.09)	0 (0.00)	16 (13.91)
v.	Smartphone use to socialize with friends	Girls	97 (84.35)	11 (9.57)	7 (9.57)
		Boys	100 (86.96)	11 (9.57)	4 (3.48)
vi.	Smartphone helps to create friendships with people	Girls	61 (53.04)	28 (24.35)	26 (22.61)
		Boys	68 (59.13)	20 (17.39)	27 (22.61)
vii.	Smartphone used to maintain relationship with a girlfriend/ boyfriend or other persons.	Girls	50 (43.48)	15 (13.04)	50 (43.48)
		Boys	58 (50.43)	24 (20.87)	32 (27.83)

When it was enquired about creating friendships with people through Smart phones, Majority of girls (53.04%) and 59.13 percent boys were agreed and 22.61 percent of from both girls and boys were exhibited disagreement. It allows youngsters to develop new relationships and to sustain the older ones (**Power and Horstmanshof, 2004**).

Majority of girls (43.48%) and 27.83 percent boys were disagreeing for the statement “*Smartphone used to maintain relationship with a girlfriend/ boyfriend or other persons.*”

From the above responses, it can be determined that the all the respondents were inclined towards the statements that presenting smartphone as a social technology and they agreed that they use their smartphone as everyone is having and it makes more easier way to communicate with friends and gives feeling of connectedness.

4.4 Usage pattern of the smartphone among respondents

Table 4.9 envisages the distribution of respondents on the basis of their smartphone usage pattern in which about 34 percent girls and nearly half of the boys used their phone 2-4 hours whereas 23.48 percent girls used their device for more than 6 hours and 20 percent boys said they used their phone for 4- 6 hours.

It was clearly evident from the data that about one quarter of girls used the smartphone more (>6 hours) than boys. **Beaver (2010)** stated that females had higher cell phone use than males. In contradictory, **Devis et al. (2009)** reported that time spent on using mobile phone by boys was far more than the girls.

When enquired about the first instance of smartphone in a day, half of the respondents replied that they checked first their smartphone as soon as they used to wake up followed by 23.47 percent girls and 20.87 percent boys who checked their phone when they used to get a message and some of them used their smartphone when they were on the way to work/college and during breakfast.

Most of the girl respondents indicated that they used their smartphone for couple of times a day and maximum boys i.e. 34.78 percent checked their smartphone every hour whereas 17.39 percent girls and 23.47 percent boys checked their phone in every thirty minute whereas **Markowetz (2015)** indicated that smartphone users shows such checking behaviour as often as every 18 min. Recent work by **Montag et al. (2015)** revealed that many smartphone users check their phones in the first five minutes after waking and the last five minutes before sleeping this short, frequent “checking” behaviours account for much smartphone use (**Oulasvirta et al., 2012**).

When enquired about the location of smartphone while sleeping, majority of girls (68.69%) and boys (58.26%) used to kept their smartphone beside the bed, followed by 26.08 percent girls and 23.48 percent boys used to keep their phone under the pillow.

Table 4.9 Distribution of respondents on the basis of their Smartphone Usage Pattern

N=230

S.No.			Girls	Boys	
			f (%)	f (%)	
1.	Duration of Smartphone usage per day	i.	Less than two hours	24 (20.87)	18 (15.65)
		ii.	Two to four hours	39 (33.91)	57 (49.57)
		iii.	Four to six hours	25 (21.74)	23 (20.00)
		iv.	More than six hours	27 (23.48)	17 (14.78)
2.	First instance of checking smartphone in a day	i.	As soon as wake up	63 (54.78)	55 (47.83)
		ii.	During breakfast	11 (9.57)	15 (13.04)
		iii.	On the way to work	14 (12.17)	21 (18.26)
		iv.	When get a message	27 (23.48)	24 (20.87)
3.	Frequency of checking smartphone	i.	Every five minutes	7 (6.09)	19 (16.52)
		ii.	Every thirty minutes	20 (17.39)	27 (23.48)
		iii.	Every hour	14 (12.17)	40 (34.78)
		iv.	Couple of times a day	56 (48.70)	29 (25.22)
4.	Location of Smartphone while sleep	i.	Under the pillow	30 (26.09)	27 (23.48)
		ii.	Beside the bed	79 (68.70)	67 (58.26)
		iii.	Other side of the room	6 (5.22)	19 (16.52)
		iv.	In another room	0 (0.00)	2 (1.74)
5.	Frequency of taking phone to the bathroom	i.	Usually	13 (11.30)	4 (3.48)
		ii.	Sometimes	33 (28.70)	35 (30.43)
		iii.	Considered it	3 (2.61)	1 (0.87)
		iv.	Never	66 (57.39)	75 (65.22)
6.	Purpose of using Smartphone	i.	Social Networking	46 (40.00)	36 (31.30)
		ii.	Emails	0(0.00)	1 (0.87)
		iii.	Music and games	26 (22.61)	44 (38.26)
		iv.	Texts and calls	43 (37.39)	31 (26.96)
		v.	Educational purpose	0(0.00)	3 (2.61)

7.	Preference for mode of communication	i.	Message	34 (29.57)	28 (24.35)
		ii.	Call	81 (70.43)	87 (75.65)
8.	Time spent on voice call per day	i.	Less than one hours	75 (65.22)	85 (73.91)
		ii.	One to two hours	29 (25.22)	19 (16.52)
		iii.	Two to three hours	9 (7.83)	6 (5.22)
		iv.	More than three hours	2 (1.74)	5 (4.35)
9.	Time spent on Social Networking Site per day	i.	Less than one hours	50 (43.48)	44 (38.26)
		ii.	One to three hours	45 (39.13)	62 (53.91)
		iii.	Three to six hours	16 (13.91)	8 (6.96)
		iv.	More than six hours	4 (3.48)	1 (0.87)
10.	Time preferred to use smartphone	i.	Day time	6 (5.22)	15 (13.04)
		ii.	Night time	52 (45.22)	71 (61.74)
		iii.	Leisure time	57 (49.57)	29 (25.22)
		iv.	During college time	0(0.00)	0(0.00)
11.	Smartphone usage during exams	i.	Less than one hours	60 (52.17)	65 (56.52)
		ii.	One to two hours	36 (31.30)	35 (30.43)
		iii.	More than two hours	19 (16.52)	15 (13.04)
12.	Has Smartphone usage time increased in comparison to the normal multimedia phone?	i.	Yes	98 (85.22)	107 (93.04)
		ii.	No	17 (14.78)	8 (6.96)
13.	Smartphone has made work very easy	i.	Yes	107 (93.04)	96 (83.48)
		ii.	No	8 (6.96)	19 (16.52)
14.	Smartphone saves energy and time	i.	Yes	88 (76.52)	85 (73.91)
		ii.	No	27 (23.48)	30 (26.09)
15.	Smartphones increases productivity	i.	Yes	94 (81.74)	93 (80.87)
		ii.	No	21 (18.26)	22 (19.13)

Majority of respondents said that they had never taken their smartphone to the bathroom whereas more than one quarter of girls (28.70%) and boys (30.43%) had taken it sometimes to the bathroom, few of them also considered for taking their smartphone in bathroom.

The gender difference was found regarding the use of smartphone, about 40 percent girls used their Smartphone mostly for Social Networking, followed by 37.39 percent for texts and calls whereas maximum boys i.e. 38.26 percent used their Smartphone mostly for music and games, followed by 31.30 percent for Social Networking. Earlier studies demonstrated that girls are more likely to use smartphone in social contexts whereas boys use them for matters of other things. **Markowitz et al. (2016)** also found that women spend more time in communication and social apps while men spend more time playing games on average. The males tend to use their phones for business or professional purpose whereas females prefer to use smartphone for social networking (**Lenhart et al., 2010**).

There was general agreement between respondents among both girls and boys (70.43 and 75.65 percent) respectively, they prefer communication through calling whereas 29.56 percent girls and 24.34 percent boys preferred communication through messaging. With the same responses **Stalin et al. (2016)** also reported in their study that most of the respondents in their study used calling facility (94.2%) than SMS facility (67.6%).

When asked about the time spent on voice call per day, majority of respondents including girls (65.2%) and boys (73.9%) spent less than 1 hour on voice call. One quarter of girls and nearly 17 percent boys used it for one to two hours. Some of them spent 2- 3 hours on voice call and more than 3 hours on voice call also.

Likewise when inquired about time spent on social networking sites, maximum girls i.e. 43.48 percent spend less than 1 hour on Social networking site, followed by 39.13 percent used for 1 to3 hours whereas more than half of the boys (53.9%) spend 1 to 3 hours, followed by 38.26 percent who spent less than 1 hour on Social networking sites.

Almost half of the girl respondents preferred to use smartphone in leisure time, followed by 45.21 percent whereas 6 out of 10 boys preferred to use smartphone at night, followed by one quarter (25.2%) boys liked to use their phone in leisure time. None of the respondents use smartphone during college time as reported by them. **Jain (2016)** analysed 74 percent respondents look into their mobile phones about 15 minutes before preparing to sleep.

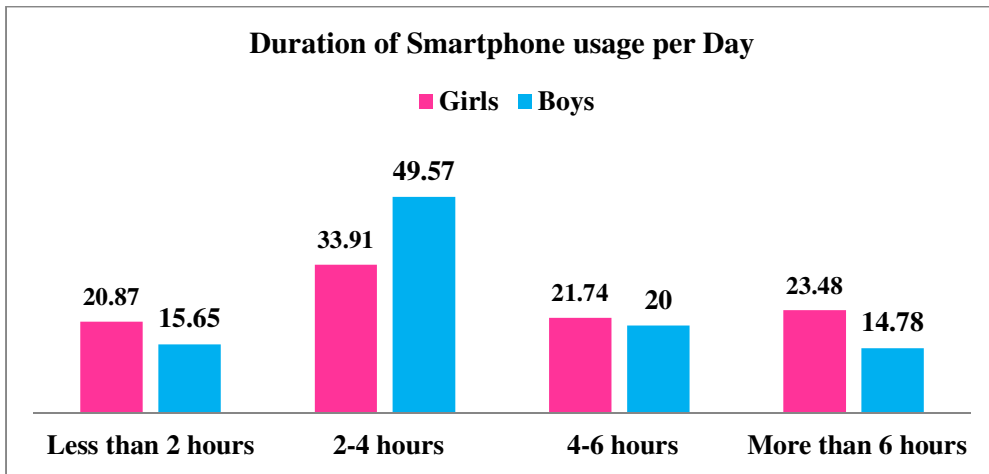


Fig: 4.15. Distribution of respondents on the basis of Smartphone use per day

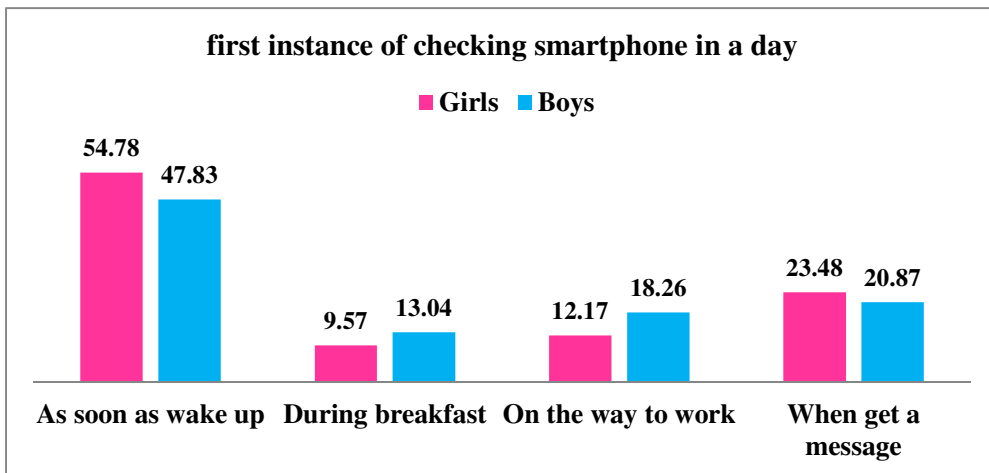


Fig: 4.16. First instance of Smartphone check in a day

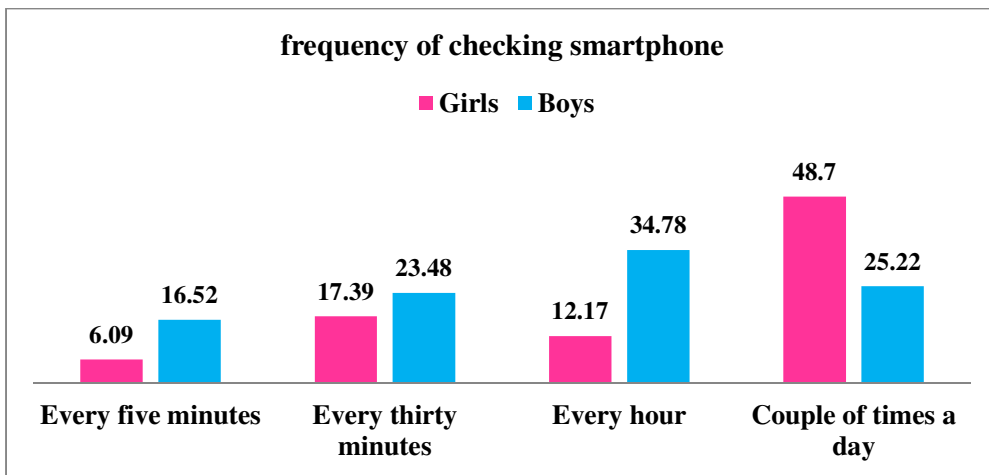


Fig: 4.17. Frequency of checking Smartphone by the respondents

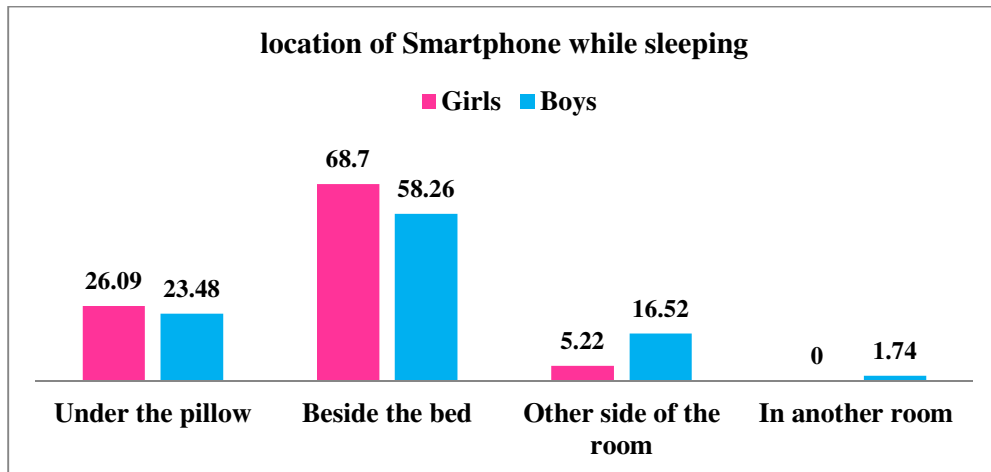


Fig: 4.18. Location of Smartphone while sleep

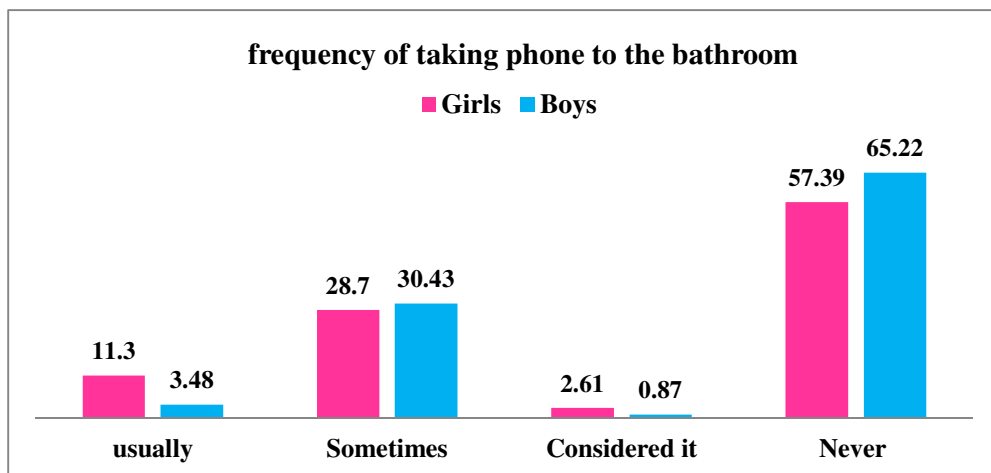


Fig: 4.19. Frequency of taking phone to the bathroom

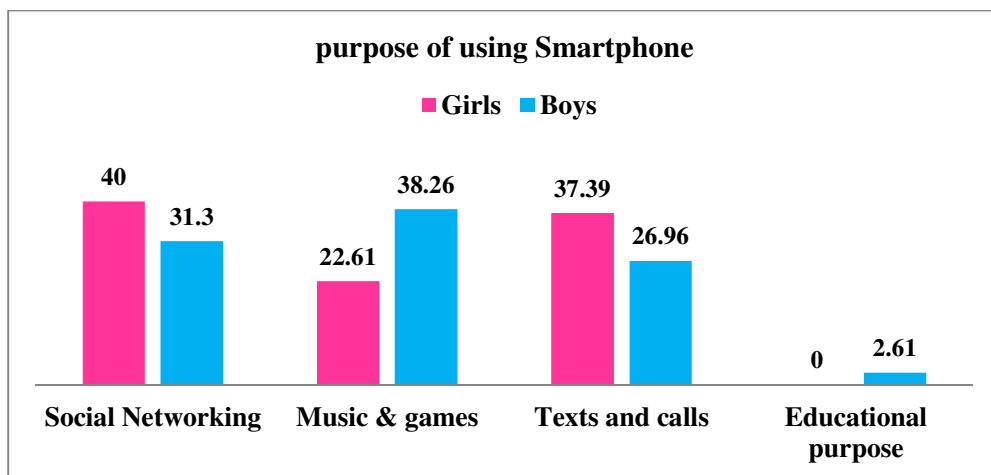


Fig: 4.20. Purpose of using Smartphone by the respondents

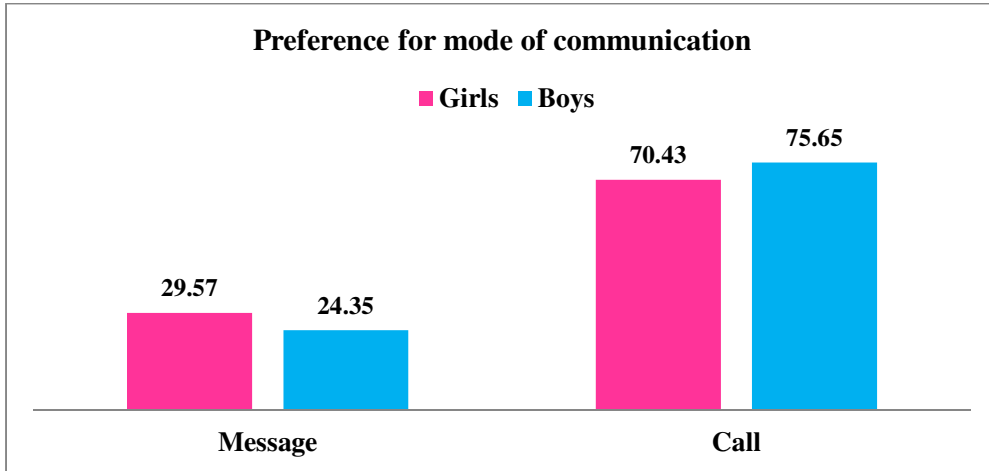


Fig: 4.21. Preference for mode of communication by the respondents

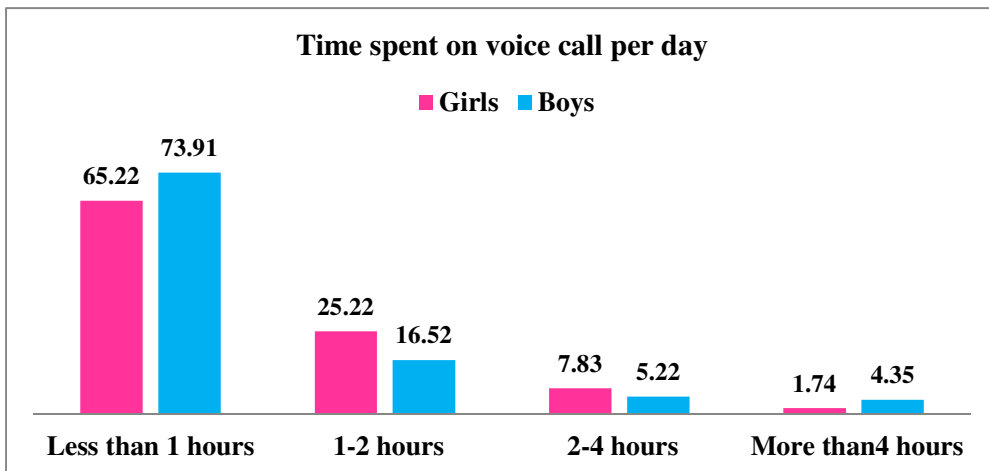


Fig: 4.22. Time spent on voice call per day by the respondents

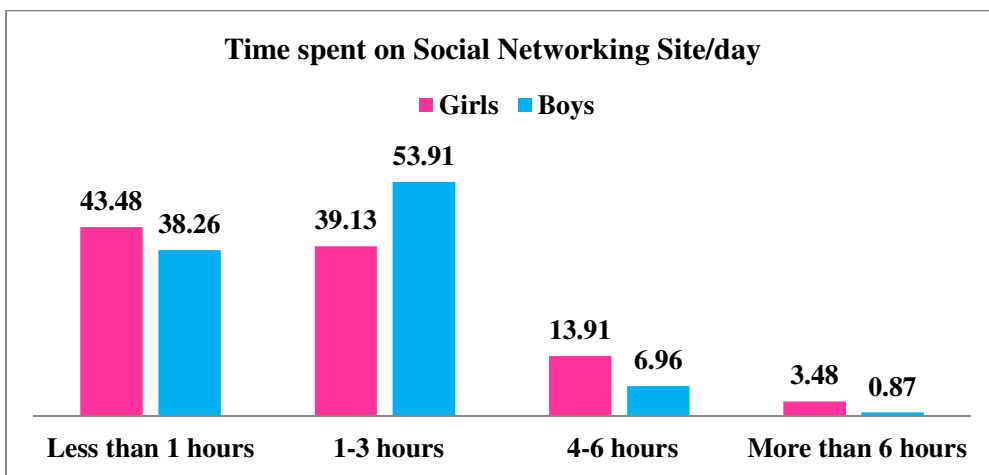


Fig: 4.23. Time spent on Social Networking Site per day by the respondents

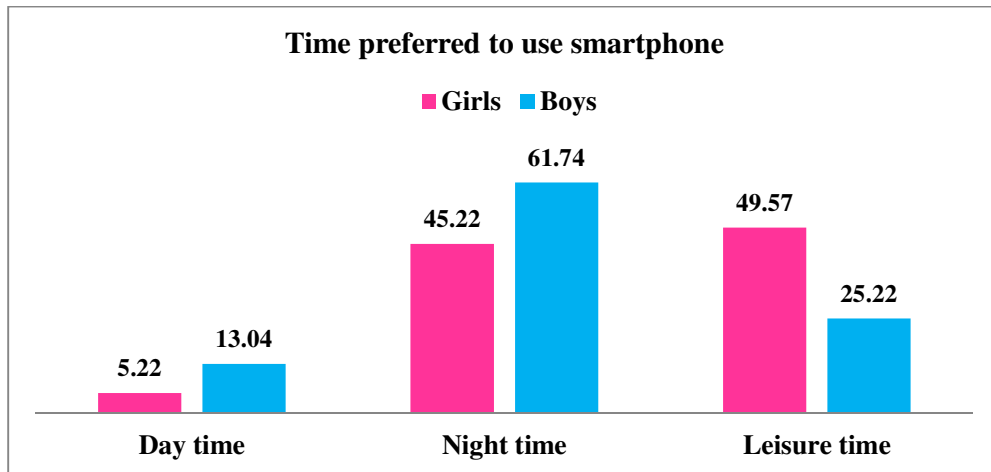


Fig: 4.24. Time preferred to use smartphone by the respondents

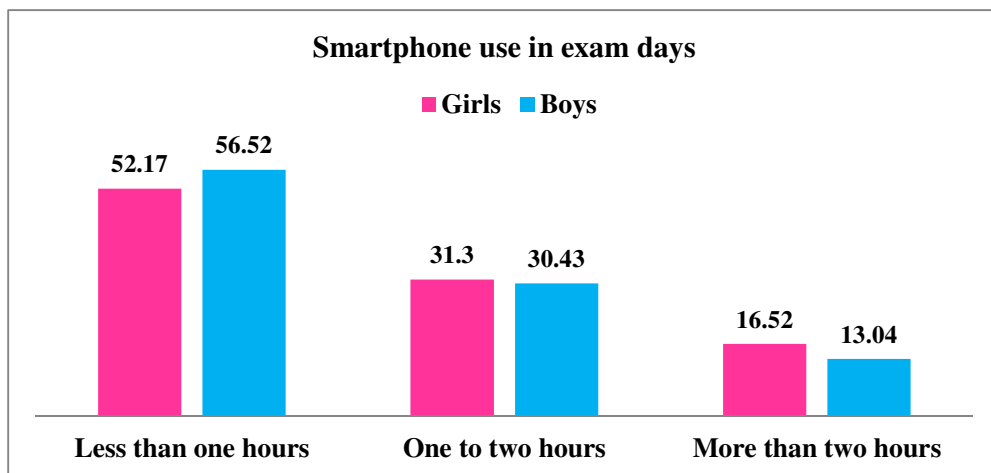


Fig: 4.25. Smartphone usage during exam time by the respondents

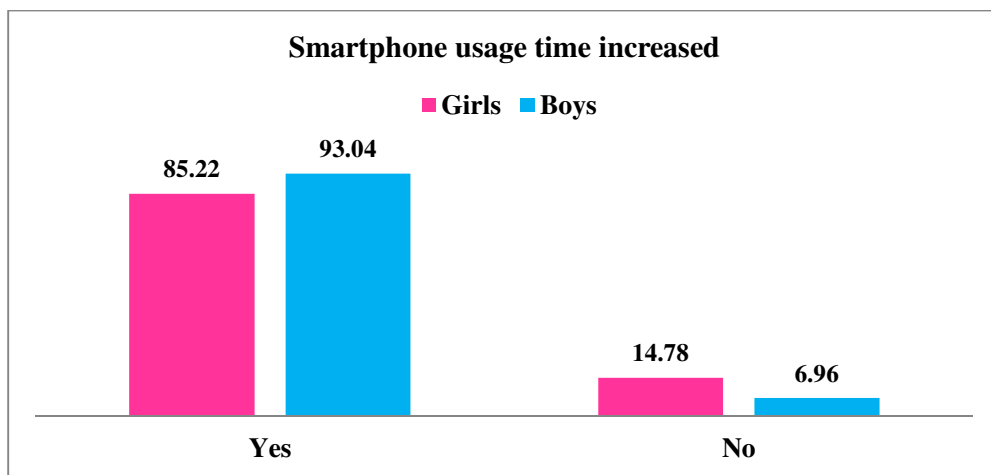


Fig: 4.26. Responses for Smartphone usage time increased

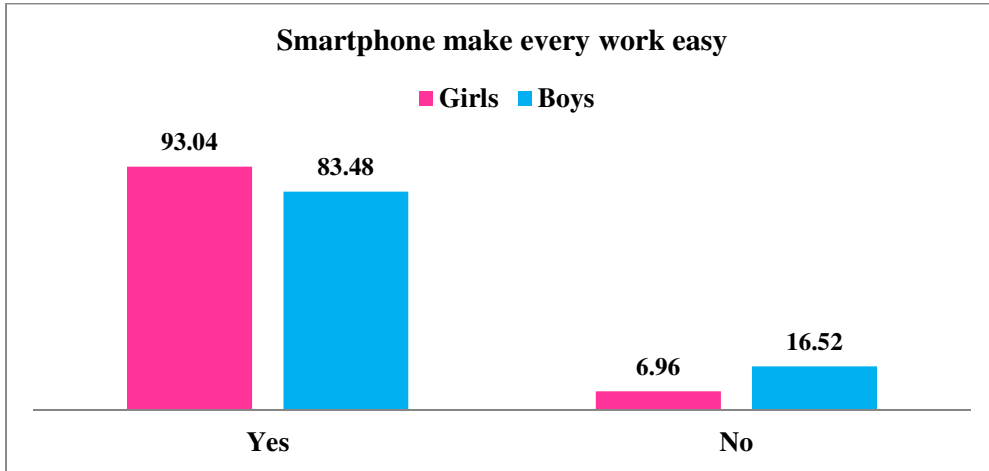


Fig: 4.27. Responses for Smartphone make every work very easy

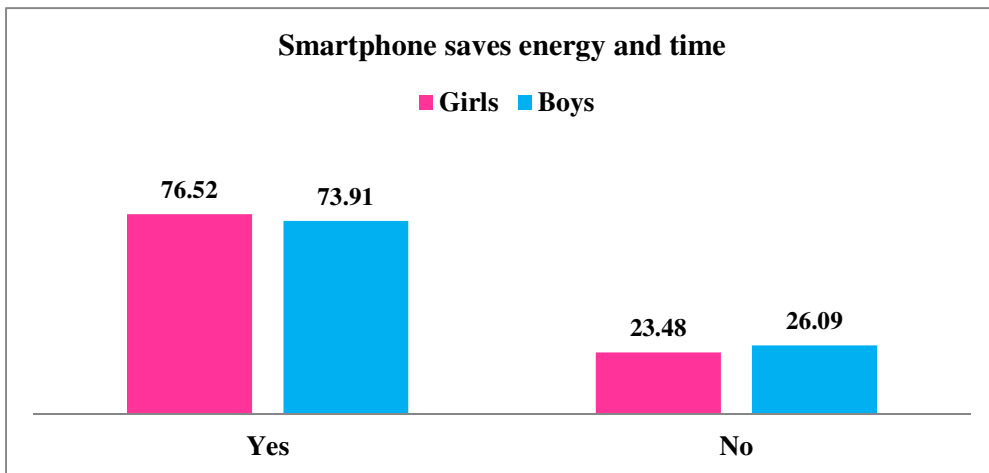


Fig: 4.28. Responses of respondents on Smartphone saving energy and time

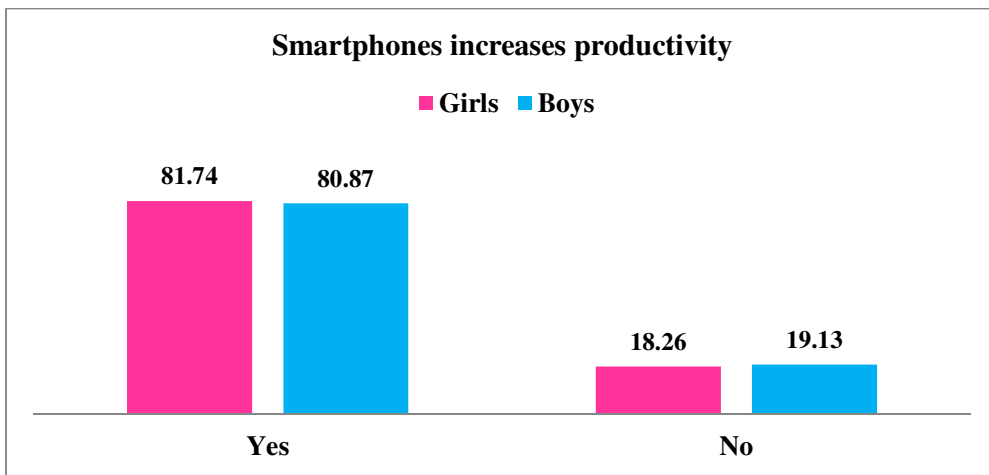


Fig: 4.29. Distribution of the respondents for increased productivity through Smartphone

For the youngsters it is hard to stay away from their smartphone whether they have important work or exams they somehow manage for using smartphone to stay in touch and updated. When asked, more than half of the girls (52.1%) and boys (56.52) used their smartphone less than 1 hour during exams.

When they were questioned that time of usage has increased with smartphone compared to the normal multimedia phone, most of the girls (85.21%) and boys (93.04%) were agreed for this. Majority of respondents also opined that smartphone has made work very easy.

Out of total respondents, three quarters stated that smartphone saves energy and time where as one quarter denied for it. Most of girls (81.7%) and boys (80.8%) also agreed that Smartphones increase productivity Effective communication enhances the productivity and mobile phone usage provides with transformed ways of communication among colleagues, family members and peer groups as also reported by **Ling and Yttri (2002)**.

Table 4.10 Distribution of respondents on the basis of with whom they mostly communicated through smart phones

N=230

S.no	Person		Text	Call	Text and call Both	None
			f (%)	f (%)	f (%)	f (%)
1.	Parents	Girls	1 (0.87)	81 (70.43)	33 (28.70)	0 (0.00)
		Boys	3 (2.61)	68 (59.13)	45 (39.13)	0 (0.00)
2.	Siblings and cousins	Girls	25 (21.74)	23 (20.00)	63 (54.78)	4 (3.48)
		Boys	34 (29.57)	18 (15.65)	58 (50.43)	8 (6.96)
3.	Relatives	Girls	14 (12.17)	47 (40.87)	37 (32.17)	17 (14.78)
		Boys	8 (6.96)	63 (54.78)	30 (28.70)	14 (13.39)
4.	Friends	Girls	32 (27.83)	7 (6.09)	76 (66.96)	0 (0.00)
		Boys	62 (53.91)	8 (6.96)	45 (39.13)	0 (0.00)
5.	Special one	Girls	9 (7.83)	17 (14.78)	52 (45.22)	37 (32.17)
		Boys	10 (8.70)	37 (32.17)	43 (37.39)	25 (21.74)
6.	Others (work related)	Girls	10 (8.70)	42 (36.52)	45 (39.13)	18 (15.65)
		Boys	18 (15.65)	56 (48.70)	20 (17.39)	21 (18.26)

The data of table 4.10 depicts the distribution of respondents on the basis of with whom they mostly communicated through smart phones in this the maximum girls (70.43%) and boys (59.13%) preferred call for communicating to the parents.

For siblings and cousins, more than half of the respondents including girls (54.7%) and boys (50.4%) preferred to text and call both whereas for relatives most of them preferred call for communication.

Data also revealed that, most of the girls (40.8%) and boys (54.7%) preferred to call only. Whereas when asked about friends, responses were varied between both most of the girls (66.9%) preferred to text and call both while texting was more prevalent among the boys (53.9%).

When asked about the mode of communication with special one, majority of girls (45.2%) and boys (37.3%) boys preferred text and call both. About 32.1 percent of boys said they preferred to call for communicating to the special person. It was observed that few respondents were not comfortable to disclose their personal matters.

Finding revealed that majority of girls (39.1%) preferred text and call both whereas majority of boys (48.7%) preferred call to communicate with the person for other work.

Table 4.11 Distribution of respondents on the basis of frequency of making call to the contact person

N=230

S. no.	Persons	Daily			Occasionally	Rarely	Never	
		Once a day	Twice a day	More than twice a day				
		f (%)	f (%)	f (%)				
1.	Parents	Girls	73 (63.48)	19 (16.52)	11 (9.57)	9 (7.83)	3 (2.61)	0 (0.00)
		Boys	61 (53.04)	29 (25.22)	14 (12.17)	11 (9.57)	0 (0.00)	0 (0.00)
2.	Siblings and cousins	Girls	25 (21.74)	2 (1.74)	12 (10.43)	55 (47.83)	14 (12.17)	2 (1.74)
		Boys	26 (22.61)	7 (6.09)	4 (3.48)	60 (52.17)	13 (11.30)	5 (4.35)
3.	Relatives	Girls	7 (6.09)	0 (0.00)	0 (0.00)	60 (52.17)	38 (33.04)	10 (8.70)
		Boys	15 (13.04)	6 (5.22)	0 (0.00)	47 (40.87)	33 (28.70)	14 (12.17)
4.	Friends	Girls	15 (13.04)	11 (9.57)	15 (13.04)	45 (39.13)	17 (14.78)	2 (1.74)
		Boys	22 (19.13)	12 (10.43)	30 (26.09)	46 (44.00)	5 (4.78)	0 (0.00)
5.	Special one	Girls	29 (25.22)	13 (11.30)	24 (20.87)	7 (6.09)	4 (3.48)	38 (33.04)
		Boys	23 (20.00)	13 (11.30)	25 (21.74)	7 (6.09)	9 (7.83)	38 (33.04)
6.	Others	Girls	12 (10.43)	3 (2.61)	0 (0.00)	51 (44.35)	35 (30.43)	13 (11.30)
		Boys	7 (6.09)	9 (7.83)	10 (8.70)	58 (50.43)	20 (17.39)	11 (9.57)

The data of table 4.11 depicts the distribution of the respondents on the basis of frequency of communication through calling having four options i.e. daily, occasionally, rarely and never. About 64 percent girls and more than half of the boys communicate with parents once a day. Most of the respondents communicate with siblings and cousins, relatives and friends occasionally.

When enquired about communication with special one 21.74 percent boys communicate more than twice a day whereas 20 percent communicate once a day. In case of girls, one quarter of them talked to the special person once a day while 20.8 percent more than twice a day. Almost half of the respondents including girls (44.3%) and boys (50.4%) communicate to others occasionally through calling.

Table 4.12 Distribution of respondents on the basis of frequency of texting to the contact person

N=230

S. no.	Persons		Daily				Occasionally	Rarely	Never
			<1 hour	1-2 hours	2-4 hours	>4 hours			
			f (%)	f (%)	f (%)	f (%)			
1.	Parents	Girls	40 (34.78)	3 (2.61)	0 (0.00)	0 (0.00)	29 (25.22)	20 (17.39)	23 (20.00)
		Boys	53 (46.09)	7 (6.09)	0 (0.00)	0 (0.00)	4 (3.48)	10 (8.70)	41 (35.65)
2.	Siblings/ cousins	Girls	38 (33.04)	18 (15.65)	4 (3.48)	1 (0.87)	31 (26.96)	15 (13.04)	9 (7.83)
		Boys	44 (38.26)	14 (12.17)	0 (0.00)	0 (0.00)	38 (33.04)	10 (8.70)	9 (7.83)
3.	Relatives	Girls	15 (13.04)	3 (2.61)	0 (0.00)	0 (0.00)	32 (27.83)	42 (36.52)	23 (20.00)
		Boys	24 (20.87)	9 (7.83)	0 (0.00)	0 (0.00)	32 (27.83)	23 (20.00)	27 (23.48)
4.	Friends	Girls	32 (27.83)	37 (32.17)	10 (8.70)	10 (8.70)	20 (17.39)	4 (3.48)	2 (1.74)
		Boys	48 (41.74)	27 (23.48)	5 (4.35)	14(12.17)	24 (20.87)	0 (0.00)	7 (6.09)
5.	Special one	Girls	28 (24.35)	20 (17.39)	10 (8.70)	10 (8.70)	4 (3.48)	0 (0.00)	43 (37.39)
		Boys	19 (16.52)	13 (11.30)	19 (16.52)	12 (10.43)	8 (6.96)	3 (2.61)	41 (35.65)
6.	Others	Girls	20 (17.39)	4 (3.48)	0 (0.00)	0 (0.00)	45 (39.13)	28 (24.35)	18 (15.65)
		Boys	29 (25.22)	10 (8.70)	1 (0.87)	2 (1.74)	35 (30.43)	17 (14.78)	21 (18.26)

The data of table 4.12 envisages the distribution of the respondents on the basis of frequency of communication through chatting.

Findings revealed that maximum girls (34.7%) and boys (46%) communicate to parents and Siblings/cousins through chatting less than one hour per day. Most of girls (36.5%) communicate to the relatives rarely whereas maximum boys (27.8%) communicate to the relatives occasionally through chatting.

Table 4.13 Distribution of respondents on the basis of internet usage via smartphone

N=230

S.No.				Girls f (%)	Boys f (%)
1.	Factors affecting voice call for	i.	Cost	34 (29.56)	18 (15.65)
		ii.	Nature of friendship	46 (40)	37 (32.17)
		iii.	Convenience	28 (24.34)	30 (26.08)
		iv.	Topic of conversation	60 (52.17)	44 (38.26)
		v.	None of the above	3 (2.60)	17 (14.78)
2.	Download through smartphone	i.	Featured Apps	71 (61.73)	78 (67.82)
		ii.	Educational content	92 (80)	77 (66.95)
		iii.	Wall papers	35 (30.43)	37 (32.17)
		iv.	Games	37 (32.17)	67 (58.26)
		v.	Music / Songs	93 (80.86)	94 (81.73)
		vi.	Pictures	55 (47.82)	54 (46.95)
		vii.	Videos	46 (40)	85 (73.91)
		viii.	Don't download	2 (1.73)	0 (0.00)
		ix.	Other	0 (0.00)	0 (0.00)
3.	Uploaded through smartphone	i.	Educational content	38 (33.04)	41 (35.65)
		ii.	Pictures	77 (66.95)	81 (70.43)
		iii.	Videos	32 (27.82)	49 (42.608)
		iv.	News	22 (19.13)	22 (19.13)
		v.	Others	3 (2.60)	5 (4.34)
		vi.	I don't upload	27 (23.47)	14 (12.17)
4.	Messaging Apps mostly used	i.	WhatsApp	107 (93.04)	108 (93.91)
		ii.	Facebook	34 (29.56)	21 (18.26)
		iii.	Hike	27 (23.47)	19 (16.52)
		iv.	Hangout	11 (9.56)	2 (1.73)
		v.	Skype	10 (8.69)	7 (6.08)
		vi.	Other	0 (0.00)	0 (0.00)

For communicating to friends, 32.1 percent girls communicate through calling 1 to 2 hours per day while most of the boys (41.7%) communicate friends through calling less than 1 hour per day.

When enquired about communication to special person, Girls (37.3%) said rarely and boys (35.6%) said they occasionally communicate to them through chatting. About 40 percent girls and 30.4 percent boys communicate to others through chatting.

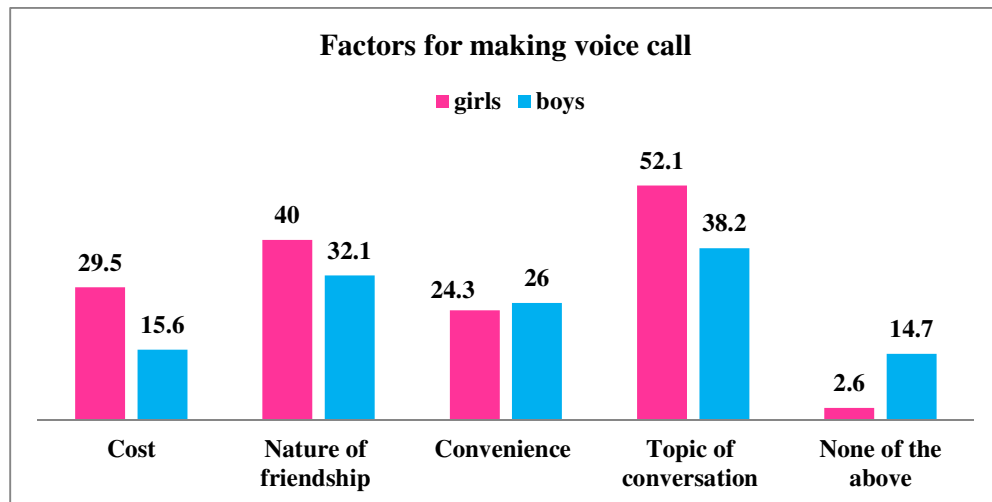


Fig: 4.30. Factors affecting decision for making voice call

Data from the table 4.30 depicted major factor which affect the decision of making voice call that shows topic of conversation, nature of friendship and convenience for both of the respondents.

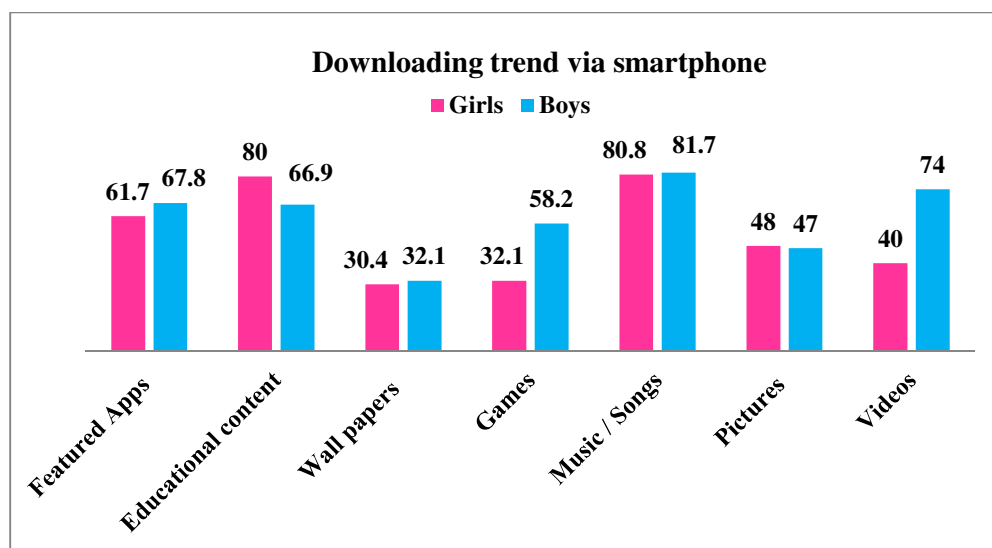


Fig: 4.31. Downloading trend via smartphone among respondents

When enquired about trend of downloading, it was found that girls mostly download Music/Songs, Educational content, and Featured Apps than pictures, videos, games and wallpapers while boys mostly download music/songs, videos and featured Apps than educational content, games, pictures, and wallpapers via their Smartphone.

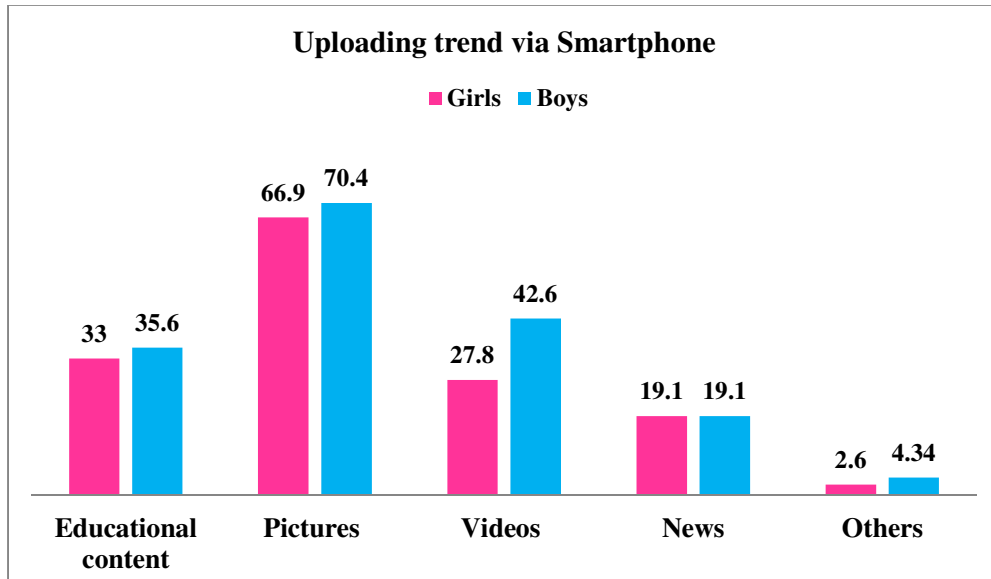


Fig: 4.32. Uploading trend via smartphone among respondents

The figure 4.32 depicts uploading trend of respondents, it was found that boys and girls both mostly upload pictures, videos and educational content than news and others via their smartphone.

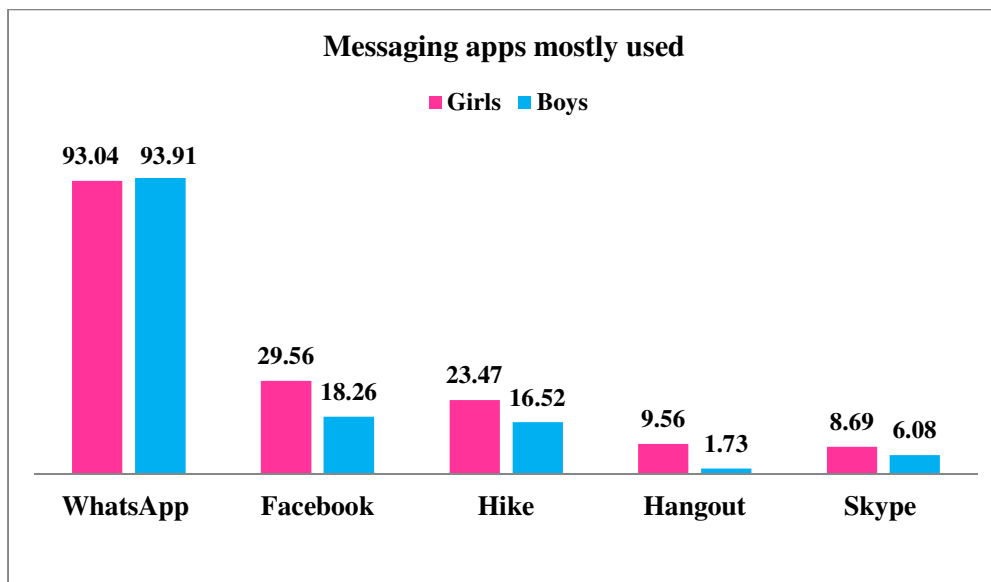


Fig: 4.33. Apps mostly use by the respondents for messaging

Figure 4.33 represents messaging app mostly used by the respondents, it was clearly found that both respondents including boys and girls used mostly WhatsApp followed by Facebook and hike. Skype and hangout were less used apps for messaging via smartphone.

Table 4.14: Distribution of respondents on the basis of purpose of using Smartphone

N=230

S.no	Items		Very Frequently	Sometimes	Rarely	Never
			f (%)	f (%)	f (%)	f (%)
i.	Making voice calls	Girls	66 (57.39)	35 (30.43)	14 (12.17)	0 (0.00)
		Boys	55 (47.83)	53 (46.09)	7 (6.09)	0 (0.00)
ii.	Chatting	Girls	81 (70.43)	26 (22.61)	8 (6.96)	0 (0.00)
		Boys	72 (62.61)	37 (32.17)	6 (5.22)	0 (0.00)
iii.	For sending MMS	Girls	4 (3.48)	12 (10.43)	28 (24.35)	71 (61.74)
		Boys	0 (0.00)	15 (13.04)	39 (33.91)	61 (53.04)
iv.	Listening to music	Girls	85 (73.91)	26 (22.61)	3 (2.61)	1 (2.61)
		Boys	84 (73.04)	26 (22.61)	5 (4.35)	0 (0.00)
v.	Clicking pictures	Girls	68 (59.13)	32 (27.83)	15 (13.04)	0 (0.00)
		Boys	53 (46.09)	43 (37.39)	17 (14.78)	2 (1.74)
vi.	Playing games	Girls	23 (20.00)	20 (17.39)	38 (33.04)	34 (29.57)
		Boys	51 (44.35)	32 (27.83)	26 (22.61)	6 (5.22)
vii.	Web surfing	Girls	94 (81.74)	20 (17.39)	1 (0.87)	0 (0.00)
		Boys	98 (85.22)	17 (14.78)	0 (0.00)	0 (0.00)
viii.	Watching TV	Girls	16 (13.91)	33 (28.70)	32 (27.83)	34 (29.57)
		Boys	12 (10.43)	23 (20.00)	48 (41.74)	32 (27.83)
ix.	Listening to radio	Girls	9 (7.83)	18 (15.65)	37 (32.17)	51 (44.35)
		Boys	5 (4.35)	12 (10.43)	35 (30.43)	63 (54.78)
x.	For micro blogging	Girls	6 (5.22)	13 (11.30)	20 (17.39)	76 (66.09)
		Boys	5 (4.35)	21 (18.26)	28 (24.35)	61 (53.04)

Data pertaining to the information related to the usage of smartphone showed in table 4.14 and it was clear from the table that majority of respondents use their Smartphone very frequently for making voice calls, chatting listening music, clicking pictures and web surfing. In a study, **Eapen et al. (2010)** also found that 69.8% respondents use their phone for making calls and 59.1% respondents use their phone for playing games. In addition, **Kushwaha (2017)** reported that highest numbers of respondents i.e. 84.84% were found using internet via cell phone for internet searching for the information they need and the similar trend was found in the present study.

Gender variation was found in responses about playing games in which 44.3 percent boys said they use their phone very frequently while 33.04 percent girls use smartphone rarely for playing games. **Shrestha (2016)** also reported that out of 116 respondents 94.31% do the web surfing on a daily basis. With a difference of just 2 respondents, second highest participants (92.68%) answered that they use social networking sites daily in their smartphones. Listening to music (80.49%), Email (61.79%) and video or movies watching (56.91%) are other functions used by the respondents on a daily basis. In contrast to above mentioned functions, MMS/video call was rarely used by 56.91% respondents. The second rarely used function was maps/GPS (31.15%). According to **Alfawareh and Jusoh, (2014)** Smartphone usage includes making calls, checking emails, sending text messages, taking pictures, downloading software, listening to music, taking video, watching movies, and browsing internet

Table 4.15: Distribution of the respondents on the basis of ranking for preferring messaging apps

N = 230

S.no.	Preferences	Girls f (%)	Boys f (%)
1	Photo sharing	27 (23.48)	19 (16.52)
2	Staying in touch	55 (47.83)	58 (50.43)
3	Group messaging	12 (10.43)	18 (15.65)
4	Emoticon	17 (14.78)	5 (4.35)
5	Cost	4 (3.48)	15 (13.04)

Distribution of the girl respondents on the basis of ranking for preferring messaging apps indicated in table 4.15 in which 5 preferences were given for ranking on the basis of their own choice.

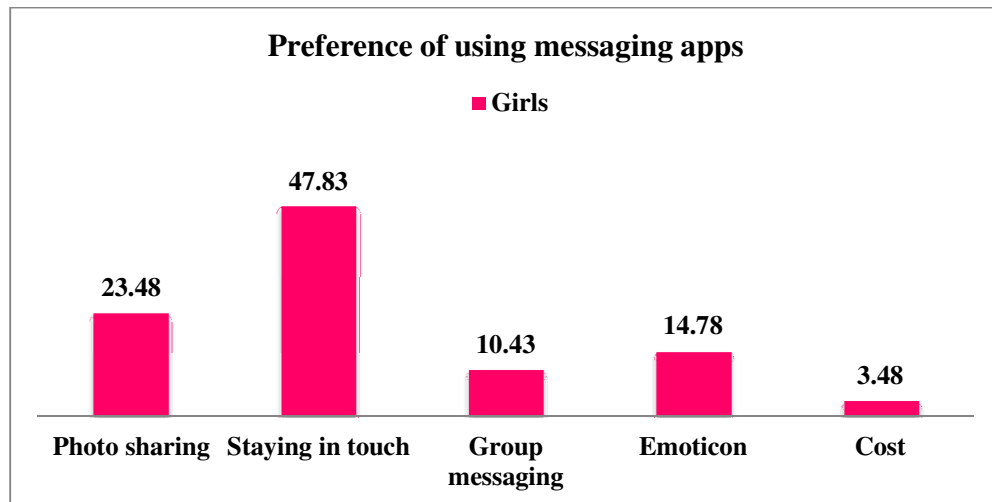


Fig: 4.34. Distribution of girl respondents on the basis of ranking for messaging apps

The data presented by the figure 4.34 showed that more than half of the girls ranked first to the staying in touch however cost was least preferred reason for using messaging apps. In this present study staying in touch got the first rank by all the respondents. **Chakraborty S. (2006)** also found staying in touch with friends or family were the highest ranked common usage scenarios in India.

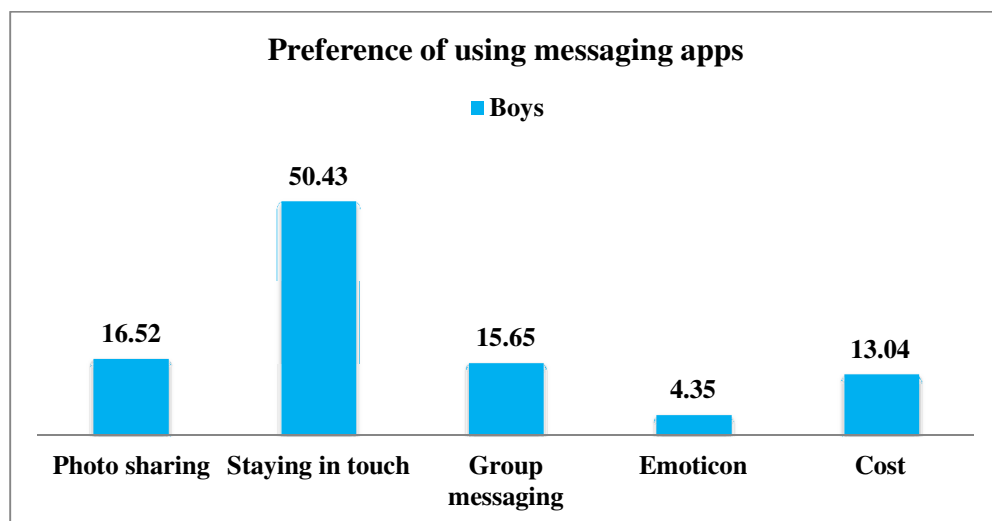


Fig: 4.35. Distribution of the boys on the basis of ranking for preferring messaging

The data presented by the figure 4.35 represented that half of the boys ranked first to the staying in touch by using messaging app while emoticons were the least preferred reason for using messaging apps

Table 4.16: Distribution of respondents on the basis of problems faced due to Smartphone

N=230

S.no			Girls f (%)	Boys f (%)	
1.	Notice pain/discomfort in body part while using a Smartphone	i.	Chatting for longer periods	24 (20.87)	21 (18.26)
		ii.	Sitting in one posture for longer period while using smartphone	73 (63.48)	65 (56.52)
		iii.	Excessive gaming	16 (13.91)	23 (20.00)
		iv.	Not at all	2 (1.74)	6 (5.22)
2.	Psychological Discomfort	i.	Stress	17 (14.78)	21 (18.26)
		ii.	Fatigue	37 (32.17)	21 (18.26)
		iii.	Dizziness	21 (18.26)	15 (13.04)
		iv.	Lack of sleep	32 (27.83)	44 (38.26)
		v.	No Discomfort	8 (6.96)	14 (12.17)
3.	Daily activity or work affected by smartphone usage	i.	Yes	57 (49.57)	75 (65.22)
		ii.	No	58 (50.43)	40 (34.78)
4.	Sleep disturbance due to excessive smartphone use	i.	Yes	54 (46.96)	56 (48.70)
		ii.	No	61 (53.04)	59 (51.30)
5.	Taken any medical prescription for these problems	i.	Yes	4 (3.48)	9 (7.83)
		ii.	No	111 (96.52)	106 (92.17)
6.	Hearing problem while talking on smartphone	i.	Yes	34 (29.57)	32 (27.83)
		ii.	No	81 (70.43)	83 (72.17)
7.	If yes, reason for pain	i.	Poor adjustable earphone	10(8.70)	8 (6.96)
		ii.	loud volume	5(4.35)	13(11.30)
		iii.	Due to long conversation	13 (11.30)	6 (5.22)
		iv.	Any other problem	6 (5.22)	5 (4.35)

Data related to other problems of respondents due to smartphone (Table 4.16) depicted most of the respondents (girls 63.4% and 56.5% boys) notice pain/discomfort in body part when sitting in one posture for longer period while using smartphone either for gaming or chatting.

When respondents were asked about psychological discomfort, Majority of girls (32.1%) experienced fatigue followed by lack of sleep (32.1%) although maximum boys (38.2%) reported for lack of sleep followed by stress and fatigue. **Al-Khlaiwi and Meo (2004)** in his study showed an association between the use of mobile phones and health risks where overall mean percentage for these clinical findings in all groups were headache (21.6%), sleep disturbance (4%), tension (3.9%), fatigue (3%) and dizziness (2.4%).

Majority of girls i.e. 50.43 percent and 34.78 percent boys from the total sample said that daily activity or work was not affected by smartphone usage whereas 49.57 percent girls and 65.22 percent boys said that daily activity or work was affected by smartphone usage.

More than half of the girls (53.04 %) and boys (51.30 %) not experienced sleep disturbance due to excessive smartphone usage although 46.9 percent girls and 48.7 percent boys experienced sleep disturbance due to excessive smartphone usage. Students tend to get engaged in text messaging and feel anxious when not receiving replies from their friends even during the night when they are supposed to be sleeping this could lead to disturbance in sleeping pattern of the students (**Ogunyemi, 2010**).

When inquired about the daily activity disturbance distinction of responses were exhibited, majority of girls (50.43) disagreed for it although boys showed agreement that smartphone use affected the daily wok/activity.

In addition, most of respondents including girls (70.4%) and boys (72.1%) do not encounter hearing problems whereas 29.57 percent girls and 27.83 percent boys had hearing problem while talking on smartphone in which 11.30 percent due to long conversation followed by 8.7 and 4.35 due to poor adjusted earphone and loud volume respectively whereas 11.3 percent boys experienced hearing problem due to loud volume followed by 6.96 and 5.22 percent due to poor adjusted earphone and long conversation. Only 5.22 percent girls and 4.35 percent boys said they had hearing problem but due to other reasons.

As per the findings about sleep disturbance 46.6 percent girls and 48.7 boys said that they felt disturbance in sleep. Data also revealed that most of the girls (96.5%) and boys (92.1%) have not taken any medical prescription for these problems.

When asked about the hearing problems due to smartphone use it was also found that more than one quarter students (29.5% girls and 27.8% boys) that experienced due to long conversations in girls whereas boys faced it due to loud volume.

From the data it can be concluded that respondents notice pain/discomfort in different body parts while sitting in one posture for longer period furthermore stress and fatigue were common psychological symptoms expressed by the respondents. Hearing problems were also faced by the some of the respondents due to loud volume and long conversations.

4.5 Anthropometric measurement of the respondents

Table 4.17: Anthropometric measurements of the Respondents **n=160**

S.No.	Parameters	Boys Mean±SD	Girls Mean±SD
1.	Weight (in kg)	60.97±9.94	51.79±8.81
2.	Height (in cm)	168.99±6.55	156.65±5.30
3.	Eye height (in cm)	157.04±6.24	145.46±5.26
4.	Shoulder height (in cm)	141.28±5.97	130.53±4.91

Anthropometric data of the respondents showed that the average weight of girls was 51.79±8.81 kg and boys were 60.97±9.94. The average height of girls was 156.65±5.30 cm and boys were 168.99±6.55. The average eye height of girls was 145.46±5.26 cm and boys were 157.04±6.24. The average shoulder height of girls was 130.53±4.91 cm and boys were 141.28±5.97.

Hand measurements

Table 4.18: Hand Measurements of the respondent's dominant hand

n=160

S.no.	Hand Measurements (in mm)	Girls			Boys		
		Mean± SD	95th percentile	5th percentile	Mean± SD	95th percentile	5th percentile
1.	Hand Length	160.7±7.8	172	162	173.3±9.7	189	173
2.	Palm width across thumb	81.7±4.5	89	82	93.1±4.8	102	92
3.	Palm Length	88.8±4.7	96	89	96.4±6.0	105	96
4.	Palm Width	67.2±4.1	73	61	77.6±5.5	85	77
5.	Thumb Length	53.8±4.4	67	54	55.9±3.9	63	55
6.	Thumb Circumference	47.2±4.0	52	48	54.8±6.1	65	55

The table 4.18 showed the mean and percentile value of the hand dimensions in respondents which showed that the mean values of hand length in girls and boys was 160.7±7.8 and 173.3±9.7 respectively. Palm width across thumb in girls was 81.7±4.5 and 93.1±4.8 was in boys. Palm length was 88.8±4.7 in girls whereas 93.1±4.8 in boys, mean value of palm width in girls was 67.2±4.1 and 77.6±5.5 in boys. Thumb length mean value was 53.8±4.4 of girls and 55.9±3.9 of boys. Whereas mean values of thumb circumference was 47.2±4.0 and 54.8±6.1 in girls and boys respectively.

Since hand length, Palm breath across thumb, palm length, hand breadth, thumb length and thumb circumference were found to affect hand grip of the users so manufactures should keep it in mind while designing the smartphones. Various smartphone dimensions and then by comparing with the estimated anthropometric values of target users, it can be seen which hand dimensions are well suitable for which kind of smartphones.

All these factors are to be considered for designing the mobile handsets/ customized mobile handsets that cater to a particular group of users. This would encourage more users to switch over to SMS as users satisfaction results in usage.

Balakrishnan et al. (2005) provided insight to the relationship between hand anthropometry, handgrips, keypad design, and SMS satisfaction of the mobile phone users. Thus providing a better understanding of mobile phone designing problems related to hand grips, and SMS plus the important keypad design factors that affect the users' satisfaction.

Jain and Pathmanathan (2012) amongst various factors hand length, hand breadth, palm length, index finger length, middle finger length, thumb length, and thumb circumference were found to affect the users' grip of mobile handset. They also recommended an improvement is to have larger keys with more space between them for those with large hand-size.

4.6 Smartphone dimensions

Table 4.19: Smartphone Specifications

S.No.	Brand	Dimension (mm) (Length x Width x Thickness)
1	Apple	132.7 x 64.8 x 7.9
2	Google Nexus	151.2 x 73.9 x 8
3	HTC	141.9 x 70.7 x 9.1
4	Lenovo	143.2 x 70.5 x 7.7
5	Motorola	136.6 x 69.6 x 10.5
6	One Plus	149.3 x 73.3 x 7.8
7	Samsung	136.9 x 69.3 x 8.5
8	Sony Xperia	139.8 x 70.2 x 8.7
9	Redmi Xiomi	151.9 x 75.9 x 7.9
10	Micromax	144.6 x 72.8 x 8.7
	Average (mm)	142.81 x 71.1 x 8.48
	Average (cm)	14.281 x 7.11 x 0.84

The respondents were asked for the models they were currently using and the dimensions were taken in terms of length, width and thickness. The length ranges from 132.7-151.9 mm, the width from 64.8-75.9 mm and the thickness from 7.7-10.5 mm.

Table 4.19 presents the physical dimensions of different smartphones that have been in used by the respondents. The average length, width and thickness of the smartphones were measured to be 14.28 cm, 7.11cm and 0.84 cm respectively. As far as size of the screen was concerned, it ranged from under three inches to over six inches in height.

Although there are no specific standards defined for physical dimensions of the smartphone, telecom industries have their own dimensions for smartphone presumably according to the perceived market demand. As these industries making smartphone more advanced day by day and customers choosing preferably one that are having features like OS, battery backup, storage camera and software than the size of a smartphone. The design and dimensions of smartphone affects the usage of the respondents. It is necessary to make standards of dimension of the smartphones because size of the device might leads to fatigue and pain in hands and wrist while carrying or using it for longer duration. **Sharan *et al.* (2012)** also found relationship between the design of the devices and anthropometry then reported that it will lead to discomfort and fatigue in hand, elbow, and shoulder of user while using the hand held devices. If the design of smartphone is not suitable to size of palm it will be very heavy to hold. On the basis of above dimensions it can be stated that smartphones of apple brand is best suited for the most of the users and the Redmi xiami handset is least suitable for the users to carry or usage.

4.7 Assessment of visual problems in respondents due to Smartphone use

4.7.1 Visual Discomfort

Table 4.20 characterized the distribution of respondents on the basis of visual problems arising in respondents due to Smartphone use. A higher percentage of boys (52.1%) and girls (53.0%) faced visual problems due to Smartphone use out of which most of the respondents (45.2% girls and 32.1% boys) complained for strain on eyes followed by watery eyes (26% girls and 21.7% boys). Eye strain is obvious due to focusing on the screen or due to continuous texting and playing games. In a study **Kim *et al.* (2017)** found that viewing smart mobile devices for 1 hour significantly increased mean total eye strain score from 19.59 ± 8.58 to 22.68 ± 9.39 ($p < 0.001$). Specifically, the scores for five items (tired eyes, sore/aching eyes, irritated eyes, watery eyes, and

hot/burning eye) were significantly increased by viewing smart mobile devices. They also concluded that visual fatigue and discomfort were significantly induced by viewing smart mobile devices. **Baria (2014)** reported in an article that ophthalmic surgeon Dr Keiki Mehta (New Delhi) identified that holding smartphone very close to the eye is the major problem. Prolonged near-point activities on Smartphones can lead to symptoms like pain in the eyes, blurred vision, dry eyes from inadequate blinking and headaches. When inquired about the use of spectacles more than half of girls (61.74%) and boys (53.04%) were not using spectacles and rest 38.26 percent girls and 46.96 percent boys were using spectacles.

Table 4.20: Distribution of respondents on the basis of Visual problems arising in respondents due to Smartphone use

(N=230)

S.no.				Girls f (%)	Boys f (%)
1.	Visual discomfort by using smartphone	i.	Yes	61 (53.04)	60 (52.17)
		ii.	No	54 (46.96)	55 (47.83)
2.	If yes, which of the visual discomforts	i.	Blurred vision	17 (14.78)	19 (16.52)
		ii.	Double vision	8 (6.97)	6 (5.22)
		iii.	Watery eyes	30 (26.09)	25 (21.74)
		iv.	Dry eyes	3 (2.61)	8 (6.96)
		v.	Strain on eyes	52 (45.22)	37 (32.17)
3.	Using Spectacles	i.	Yes	44 (38.26)	54 (46.96)
		ii.	No	71 (61.74)	61 (53.04)

The data from table 4.21 envisages the distribution of respondents on the basis of frequency of Visual discomfort experienced by respondents due to various activities on Smartphone.

The majority of respondents reported that they experienced visual discomfort sometimes when they continue watch videos (39.1% girls and 40% boys) followed by constant chatting (40% girls & 31.3% boys).

As the gaming in smartphone is much popular among youths consequently in context of continuous gaming on smartphone responses were vary from girls to boys.

Maximum girls (53.9%) experienced rarely any discomforts due to continuous gaming however most of boys (35.6%) felt it sometimes to very frequently (20%). Most of the respondents rarely feel any discomfort when do online shopping for longer time on the smartphone.

Table 4.21: Distribution of respondents on the basis of frequency of Visual discomfort experienced by respondents due to various activities on Smartphone

S.No.	Activity		Very frequently f (%)	Sometimes f (%)	Rarely f (%)	Never f (%)
a.	Continuous watching videos	Girls	27 (23.48)	45 (39.13)	25 (21.74)	18 (15.65)
		Boys	27 (23.48)	46 (40.00)	17 (14.78)	25 (21.74)
b.	Continuous chatting	Girls	19 (16.52)	46 (40.00)	33 (28.70)	17 (14.78)
		Boys	24 (20.87)	36 (31.30)	29 (25.22)	26 (22.61)
c.	Continuous gaming	Girls	15 (13.04)	15 (13.04)	62 (53.91)	23 (20.00)
		Boys	23 (20.00)	41 (35.65)	26 (22.61)	25 (21.74)
d.	Online shopping	Girls	6 (5.22)	24 (20.87)	62 (53.91)	23 (20.00)
		Boys	1 (0.87)	15 (13.04)	73 (63.48)	26 (22.61)

4.7.2: Visual Fatigue

Table 4.22: Distribution of respondents on the basis of severity of Visual fatigue

(N=230)

S.No.	Visual fatigue	Rank	Girls	Boys
			f (%)	f (%)
1.	Mild	1-3	38 (33.04)	43 (37.39)
2.	Moderate	4-6	53 (46.09)	52 (45.22)
3.	Severe	7-10	24 (20.87)	20 (17.39)

The visual fatigue was measured by using self-reported 10 point ranking scale in which the respondents ranked on the basis of intensity of pain experienced by them. Table 4.22 shows the Distribution of respondents on the basis of severity of visual fatigue. The numerical rating of the respondents indicated that majority of the respondents including girls (46.0%) and boys (45.2%) reported moderate level of visual fatigue further 33 percent girls and 37.3 percent boys accounted for mild visual fatigue whereas only 20.8 percent boys and 17.3 percent of girls experienced severe visual fatigue. The occurrence of visual fatigue in respondents might be due to prolonged usage of smartphone. In this context **Kim et al. (2013)** argued that a downward gaze showed higher muscle activity in the upper trapezius compared to an upward gaze and an eye-level gaze, suggesting that gaze by itself could generate high muscle activity and a downward gaze easily leads to fatigue.

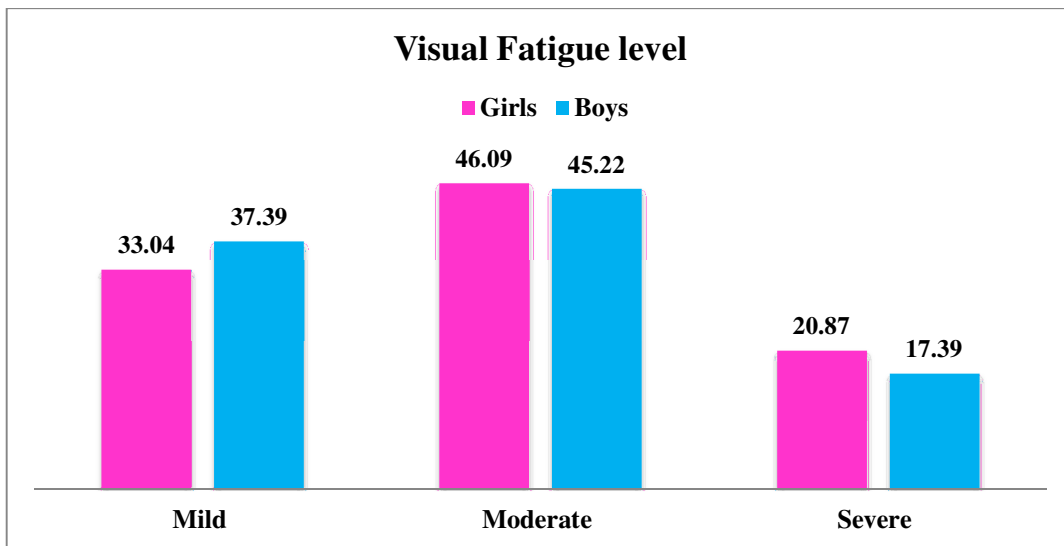


Fig: 4.36 Visual Fatigue level in the respondents

4.7.3: Critical flicker Fusion

4.11 Critical flicker fusion frequency Rate

Human eye can detect flickering light for certain frequency, as the frequency get higher reach the threshold, human cannot see the flickering light for longer duration of time, and then light appear as continues. This process of detection is known flicker fusion. This is commonly referred to as the “threshold frequency” and it is expressed in Hz. Identifying human capability in detection of the threshold where human cannot differentiate flicker and fusion is important, particularly in designing electronic devices

where light is used (**Bharathi and Reddy, 2015**) whereas in another study **Gangopadhyay et al. (2013)** reported that normal human eye can perceive a frequency of 60 Hz. This test is widely used to study the human behaviour, visual fatigue and visual strain since it is easy to administer and relatively non-invasive (**Green and Bavelier, 2006**). The critical flicker fusion threshold (CCFT) is often used as measure for current state of the central nervous system of an individual.

Table 4.23: Critical Flicker Fusion frequency Rate in green light

	Green Light			
	Left Eye		Right Eye	
	Fusion frequency	Flicker frequency	Fusion frequency	Flicker frequency
Girls	38.5±2.75	35.8±2.71	38.5±2.46	35.9±2.53
Boys	38.4±3.29	35.7±3.27	38.3±2.97	35.8±3.16

The above table shows the CFF frequency rate of the respondents in green light girls and boys have 38.5±2.75 and 38.4±3.29 fusion frequency in left eye whereas 38.5±2.46 and 38.3±2.97 in right eyes. Girls and boys have 35.8±2.71 and 35.7±3.27 flicker frequency in left eye whereas 35.9±2.53 and 35.8±3.16 in right eyes.

Table 4.24: Critical Flicker Fusion frequency Rate in red light

	Red Light			
	Left Eye		Right Eye	
	Fusion frequency	Flicker frequency	Fusion frequency	Flicker frequency
Girls	39.5±2.58	36.3±4.26	39.5±2.55	36.8±2.74
Boys	39.0±2.98	36.3±3.29	39.2±3.13	36.2±3.44

The above table shows the CFF frequency rate of the respondents in red light girls and boys have 39.5±2.58 and 39.0±2.98 fusion frequency in left eye whereas 39.5±2.55 and 39.2±3.13 in right eyes. Girls and boys have 36.3±4.26 and 36.3±3.29 flicker frequency in left eye whereas 36.8±2.74 and 36.2±3.44 in right eyes.

Bharathi and Reddy (2015) reported that normal adult Critical flicker frequency reportedly is around 36 to 39 Hertz. The range of critical flicker fusion frequency is similar to the present study.

Table 4.25: Before and after mean values of Critical Flicker Fusion frequency Rate of girls in green light

n* = 8

	Left Eye		Right Eye	
	Fusion frequency	Flicker frequency	Fusion frequency	Flicker frequency
Before	39.86±3.36	37.86±2.95	39.60±2.44	37.74±1.68
After	36.90±2.17	35.28±2.35	36.49±1.91	35.20±1.82

The above table shows before and after mean values of Critical Flicker Fusion frequency Rate of girls in green light in left eye fusion frequency was 39.86±3.36 and flicker frequency was 37.86±2.95 and in right eye fusion frequency was 39.60±2.44 and flicker frequency was 37.74±1.68. After continues use of the smartphone for 30 minutes in left eye fusion frequency was 36.90±2.17 and flicker frequency was 35.28±2.35 and in right eye fusion frequency was 36.49±1.91 and flicker frequency was 35.20±1.82. The above data clearly shows the decrease in both frequencies in after case that indicates the visual fatigue in the respondents due to smartphone use for longer period.

Table 4.26: Before and after mean values of Critical Flicker Fusion frequency Rate of girls in Red light

	Left Eye		Right Eye	
	Fusion frequency	Flicker frequency	Fusion frequency	Flicker frequency
Before	39.38±3.09	36.98±2.21	39.64±2.63	37.68±2.23
After	37.75±2.64	36.34±2.60	37.75±2.35	36.28±2.42

The table 4.26 shows before and after mean values of Critical flicker fusion frequency Rate of girls in red light. In left eyes, Fusion frequency was 39.38±3.09 and flicker frequency was 36.98±2.21 before use while after continues use of the smartphone for 30 minutes fusion frequency was 37.75±2.64 and flicker frequency was 36.34±2.60. In right eyes, Fusion frequency was 39.64±2.63 and flicker frequency was 37.68±2.23 before use while after continues use of the smartphone for 30 minutes fusion frequency was 37.75±2.35 and flicker frequency was 36.28±2.42. The above data clearly shows there was no decline in both frequencies in red light that not depicts any visual fatigue in the respondents after using smartphone continues.

Table 4.27: Before and after mean values of Critical Flicker Fusion frequency Rate of boys in Green light

	Left Eye		Right Eye	
	Fusion frequency	Flicker frequency	Fusion frequency	Flicker frequency
Before	37.89±1.82	35.08±3.32	38.38±2.83	36.06±3.49
After	36.95±1.62	34.28±2.70	37.15±1.90	34.30±2.86

The table 4.27 shows before and after mean values of Critical Flicker Fusion frequency Rate of boys in green light in left eye fusion frequency was 37.89±1.82 and flicker frequency was 35.08±3.32 and in right eye fusion frequency was 38.38±2.83 and flicker frequency was 36.06±3.49. After continues use of the smartphone for 30 minutes in left eye fusion frequency was 36.95±1.62 and flicker frequency was 34.28±2.70 and in right eye fusion frequency was 37.15±1.90 and flicker frequency was 34.30±2.86. The above data clearly shows the decrease in both frequencies in after case that depicts the visual fatigue in the respondents after using smartphone continues. **Gangopadhayay *et.al* (2013)** also reported in his study that decline in CFF frequency threshold shows marked fatigue in the individual.

Table 4.28: Before and after mean values of Critical Flicker Fusion frequency Rate of boys in Red light

	Left Eye		Right Eye	
	Fusion frequency	Flicker frequency	Fusion frequency	Flicker frequency
Before	38.95±3.56	35.96±3.85	38.75±2.48	36.09±3.43
After	39.24±2.69	35.98±3.26	39.21±2.08	36.18±2.90

The table 4.28 shows mean values of Critical flicker fusion frequency rate of boys in red light before and after use of smartphone. In left eyes, Fusion frequency was 38.95±3.56 and flicker frequency was 35.96±3.85 before use while after continues use of the smartphone for 30 minutes fusion frequency was 39.24±2.69 and flicker frequency was 35.98±3.26. In right eyes, Fusion frequency was 38.75±2.48 and flicker frequency was 36.09±3.43 before use while after continues use of the smartphone for 30 minutes fusion frequency was 39.21±2.08 and flicker frequency was 36.18±2.90. The above data clearly shows there was no decline in both frequencies in red light that not depicts any visual fatigue in the respondents after using smartphone continues.

4.8 Identification of musculoskeletal symptoms experienced in different body parts by the respondents

Table 4.29 revealed the distribution of respondents on the basis of pain experienced in different body regions in different durations i.e. during last 24 hours, during last 1 week and during last 1 month.

When asked about pain in hand/wrists, it was found that 4.3 percent girls and 7 percent were experienced pain wrist during last 1 month followed by 8.7 percent girls and 10.4 percent boys in last 1 week and rest 9.5 percent girls and 10.4 percent in last 24 hours experienced pain in their right hand/wrist. It might be due to majority of respondents were right handed so the right side was much affected than left.

When enquired about the pain felt in elbows, both the respondents i.e. girls (2.6%) and boys (5.2%) experienced pain in last 1 month followed by girls (3.4%) and boys (4.3%) sensed pain in right elbows and 7 percent girls experienced pain in both elbows whereas 5.2 percent boys experienced pain in right elbows.

When queried about incidents of pain in shoulders, lower back and upper back, it was found that in the last 1 month about 9 percent girls and 7 percent boys experienced pain in both shoulders. In last 1 week, the parentage of respondents was increased up to 13 percent and 21.7 percent among girls and boys respectively while in last 24 hours it increased in 16.5 percent girls and 22.6 percent boys in both shoulders/neck.

At the same time in lower back, about 7 percent girls and 10.4 percent boys felt pain in last 1 month followed by 11.3 percent of girls as well as of boys experienced pain during last 1 week that was increased more in girls (19.1%) and boys (11.3%) and it was extended in last 24 hours up to 8.7 percent and 10.4 percent amongst girls and boys respectively.

In the upper back, 8.7 percent girls and 10.43 percent boys experienced pain while in last 1 week the percentage i.e. 10.43 of respondents was equal for both girls and boys however in last 24 hours the percentage of the both respondents was increased up to 20 percent.

Table 4.29: Distribution of respondents on the basis of pain experiencing in different body regions

N=230

S.no	Body Parts	Not responded (45.2 % girls and 37.4 % boys)	No pain	During last 24-hour			During last 1 week			During last 1 month		
				Left	Right	Both	Left	Right	Both	Left	Right	Both
1.	Hands/ Wrists	Girls	11 (9.57)	-	11 (9.57)	7 (6.09)	1 (0.87)	10 (8.70)	3 (2.61)	2 (1.74)	5 (4.35)	3 (2.61)
		Boys	19 (16.52)	4 (3.48)	12 (10.34)	10 (8.70)	3 (2.61)	12 (10.43)	3 (2.61)	1 (0.87)	8 (6.96)	3 (2.61)
2.	Elbows	Girls	36 (31.30)	-	5 (4.35)	8 (6.96)	1 (0.87)	4 (3.48)	4 (3.48)	-	3 (2.61)	2 (1.74)
		Boys	31 (26.96)	4 (3.48)	6 (5.22)	2 (1.74)	3 (2.61)	5 (4.35)	1 (0.87)	3 (2.61)	6 (5.22)	1 (0.87)
3.	Shoulders/ Neck	Girls	10 (8.70)	-	5 (4.35)	19 (16.52)	-	-	15 (13.04)	3 (2.61)	3 (2.61)	10 (8.70)
		Boys	2 (1.74)	1 (0.87)	5 (4.35)	26 (22.61)	1 (0.87)	9 (7.83)	25 (21.74)	2 (1.74)	7 (6.09)	8 (6.96)
4.	Lower back	Girls	20 (17.39)	-	-	22 (19.13)	-	-	13 (11.30)	-	-	8 (6.96)
		Boys	26 (22.61)	-	-	15 (13.04)	-	-	13 (11.30)	-	-	12 (10.43)
5.	Upper Back	Girls	16 (13.91)	-	-	24 (20.87)	-	-	12 (10.43)	-	-	10 (8.70)
		Boys	32 (27.83)	-	-	23 (20.00)	-	-	12 (10.43)	-	-	12 (10.43)

*multiple responses were given by the respondents

*values given in parentheses indicate Percentage

Studies on the prevalence of smartphone use have reported that the distribution of musculoskeletal symptoms or pain of any severity was most common in the neck, followed by the upper back and then the shoulders. These results showed that the total time spent using a smartphone was significantly associated with any pain in the neck and shoulder **Chang et al. (2007) and Berolo et al. (2011)**.

Therefore, the results of the present study are consistent with studies mentioned above, which reported that increased usage of smartphone will lead to musculoskeletal pain/discomforts in upper body regions i.e., neck, shoulders and upper back. The findings of these studies are consistent with the present work which revealed that frequency of pain experienced by the respondents increased in almost every body part, since the last one month to 24 hours of usage. Further, amongst the total surveyed respondents, 45.2 percent girls and 37.4 percent boys stated that they were not experiencing any kind of pain in any part of body.

To assess the subjective musculoskeletal symptoms among students, a table of such musculoskeletal symptoms was made including body parts and different durations (during last 1 month, during last 1 week and during last 24 hours). The respondents ranked the pain they were experiencing by giving multiple ranks using VAS scale which was categorized in slight (1-3), moderate (4-6) and severe (7-10) categories. (Table 4.21)

Based on the responses, about 8 percent girl and 9.57 percent boys had suspected moderate pain in last 1 month and 10 percent girls and 14.78 percent boys experienced pain during last 1 week while nearly 14 percent girls experienced moderate pain and 21 percent boys experienced severe pain in last 24 hours in Neck region.

The neck pain that is experienced by smartphone users has often been referred to 'text neck', has received more attention recently due to the increasing use of smartphones in head forward flexion postures. Smartphone users typically hold the device using one or two hands below their eye height, look down at the device and type or touch the touch-screen display mostly using the thumb (**Gold et al., 2012**). They tended to maintain the head forward flexion posture even with the existence of pain symptoms or discomfort on the neck (**Maniwa et al., 2013**), and it has been suggested that the prolonged and/or frequent use of the smartphone with the severe head flexion posture could be one of main contributing factors to the prevalence of neck pain symptoms in smartphone users.

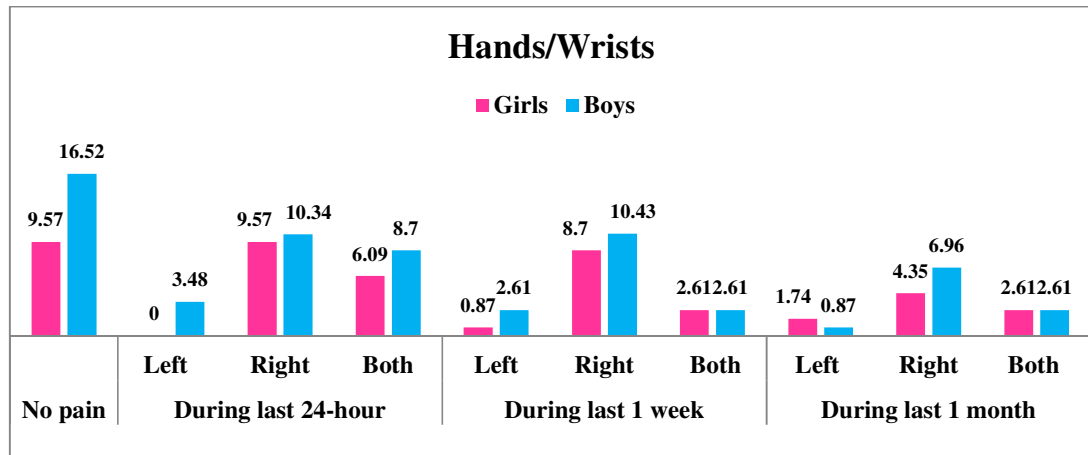


Fig: 4.37. Distribution of respondents on the basis of pain experiencing in Hands/Wrists

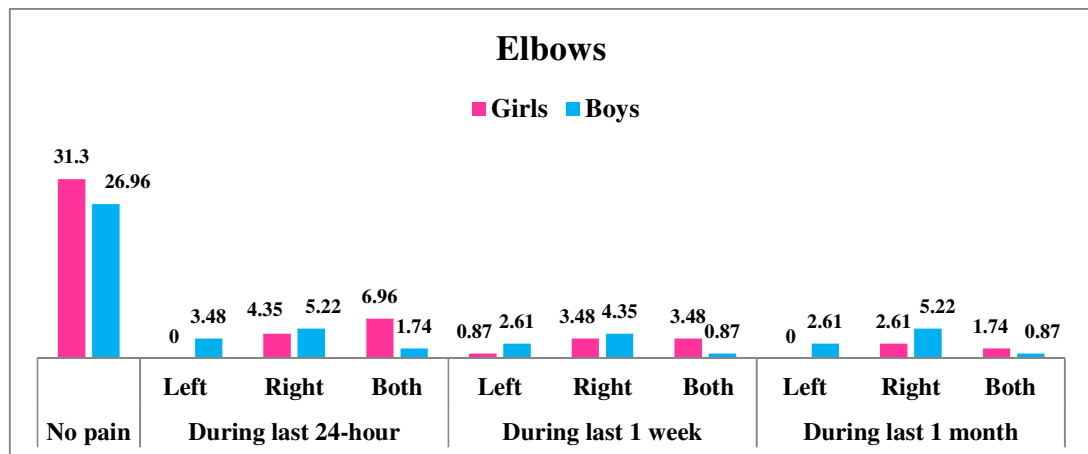


Fig: 4.38. Distribution of respondents on the basis of pain experiencing in Elbows

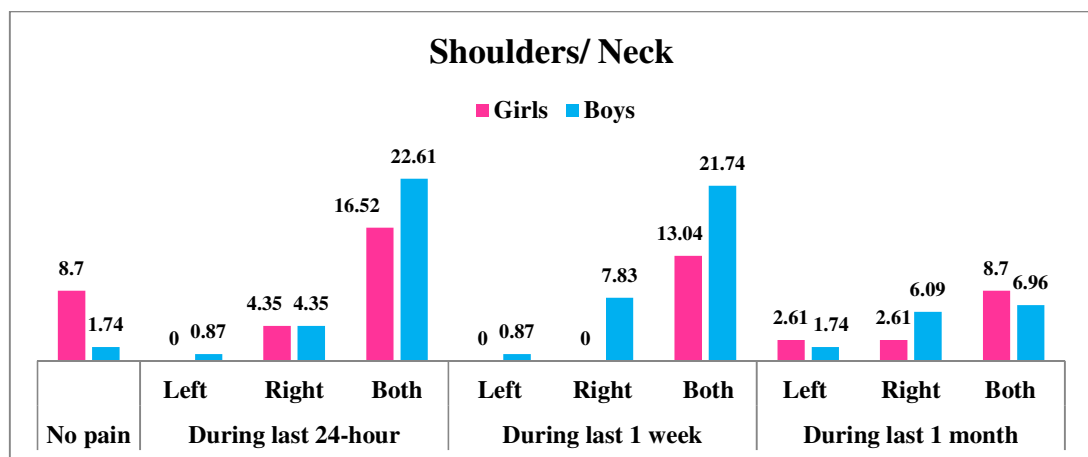


Fig: 4.39. Distribution of respondents on the basis of pain experiencing in Shoulders/ Neck

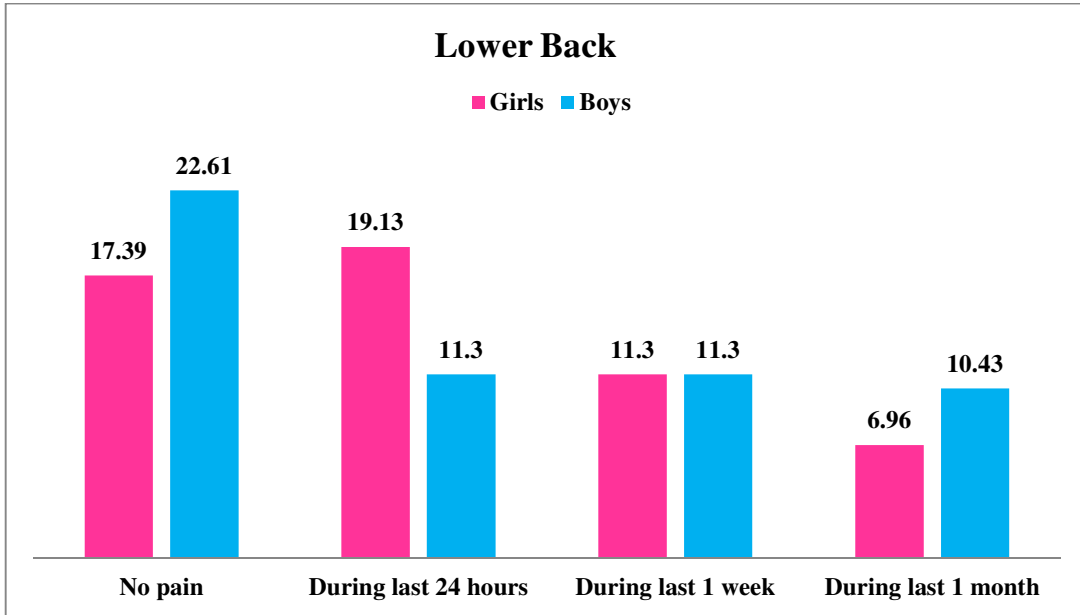


Fig: 4.40. Distribution of respondents on the basis of pain experiencing in Lower Back

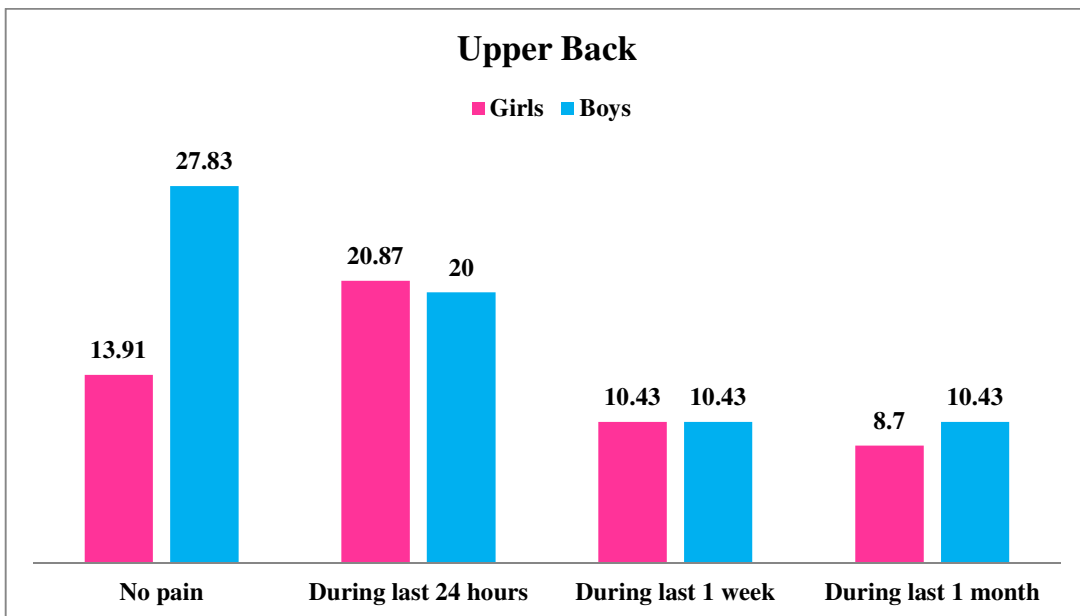


Fig: 4.41. Distribution of respondents on the basis of pain experiencing in Upper Back

Table 4.30: Distribution of respondents on the basis of musculoskeletal symptoms experienced in different body parts

N=230

S.no.	Body part	Rank for pain							
		None (0)		Slight(1-3)		Moderate (4-6)		Severe (7-10)	
		Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
i.	Neck								
	During last 24-hour	-	1 (0.87)	3 (2.61)	3 (2.61)	16 (13.91)	17 (14.78)	7 (6.09)	24 (20.87)
	During last 1 week	3 (2.61)	6 (5.22)	4 (3.48)	14 (12.17)	11 (9.57)	17 (14.78)	2 (1.74)	7 (6.09)
	During last 1 month	6 (5.22)	21 (18.26)	3 (2.61)	11 (9.57)	9 (7.83)	11 (9.57)	-	2 (1.74)
ii.	Shoulders								
	During last 24-hour	-	5 (4.35)	3 (2.61)	3 (2.61)	10 (8.70)	18 (15.65)	10 (8.70)	19 (16.52)
	During last 1 week	4 (3.48)	6 (5.22)	3 (2.61)	13 (11.30)	12 (10.43)	23 (20)	3 (2.61)	3 (2.61)
	During last 1 month	7 (6.09)	20 (17.39)	3(2.61)	14 (12.17)	8 (6.96)	10 (8.70)	-	1 (0.87)
iii.	Elbows								
	During last 24-hour	2 (1.74)	33 (28.70)	15 (13.04)	9 (7.83)	9 (7.83)	3 (2.61)	-	-
	During last 1 week	4 (3.48)	35 (30.43)	11 (9.57)	10 (8.70)	5 (4.35)	2 (1.74)	-	-
	During last 1 month	9 (7.83)	37 (32.17)	8 (6.96)	6 (5.22)	-	2 (1.74)	-	-
iv.	Upper back								
	During last 24-hour	2 (1.74)	21 (18.26)	1 (0.87)	5 (4.35)	14 (12.17)	12 (10.43)	7 (6.09)	7 (6.09)
	During last 1 week	6 (5.22)	22 (19.13)	3(2.61)	7 (6.09)	8 (6.96)	14 (12.17)	2 (1.74)	1 (0.87)
	During last 1 month	9 (7.83)	29 (25.22)	2(1.74)	11 (9.57)	8 (6.96)	5 (4.35)	1 (0.87)	1 (0.87)
v.	Lower Back								
	During last 24-hour	5 (4.35)	26 (22.61)	3 (2.61)	6 (5.22)	13 (11.30)	10 (8.70)	4 (3.48)	3 (2.61)
	During last 1 week	7 (6.09)	30 (26.09)	2 (1.74)	7 (6.09)	10 (8.70)	5 (4.35)	-	3 (2.61)
	During last 1 month	7 (6.09)	34 (29.57)	3 (2.61)	4 (3.48)	8 (6.96)	6 (5.22)	-	1 (0.87)

*multiple responses were given by the respondents

*values given in parentheses indicate Percentage

When enquired about shoulder region, about 7 percent girls' experienced moderate pain and 12.17 percent boys experienced slight pain in last 1 month and 10.43 percent girls and 20 percent boys suffered from moderate pain during last 1 week while in last 24 hours the severity of pain was increased as severe in 8.70 percent girls and 16.52 percent boys. The data revealed that intensity of shoulder pain was increased with the time among both the respondents.

Recently, a few epidemiological studies reported a high prevalence of neck shoulder symptoms among mobile device users. A study by **Berolo et al. (2011)** indicated rates of 46-52 percent in shoulder symptoms among 140 individuals and 68 percent in neck symptoms another study by **Shan et al. (2013)** reported over 40 percent of neck shoulder pain among 2575 young mobile phone users. A similar pattern has also been reported by **Kim and Kim (2015)** in their study that 55.8 percent participants felt neck pain and 54.8 percent felt shoulder pain; these were the most commonly experienced pain after the use of smartphones.

In elbows, most of the respondents including boys and girls suffered from slight pain. In last 1 month nearly 7 percent girls and 5.22 percent boys experienced slight pain that was continued to 9.5 percent in girls and 8.7 percent in boys in last one week whereas in last 1 day 13.4 percent girls and 7.83 percent boys were experiencing slight pain.

In upper back, about 7 percent girl sensed moderate pain and 9.57 percent boys felt slight pain in last 1 month consequently 6.96 percent girls and 12.17 percent boys were experiencing moderate pain during last 1 week. Majority of respondents counting (12.17%) girls and boys (10.43%) were experiencing moderate pain in last 24 hours.

In lower back, 6.96 percent girls and 5.22 percent boys felt moderate pain in last 1 month. During last 1 week, 8.7 percent of girl experienced moderate pain besides 6.09 percent boys' experienced slight pain. In last 24 hours, 11.30 percent girls and 8.70 percent boys were experienced moderate pain.

The table data indicated that incidence of pain has risen considerably since last 1 month to last 1 day amongst both girls and boys. The data also provided evidences that as the time of the smartphone use increases the severity of the symptoms also increases that is the major point for concern. Majority of respondents experienced moderate pain in every body parts in different durations and only elbow was less affective area in respondents. As per the findings, youngsters using smartphone for longer duration are more prone to high risk of developing musculoskeletal disorders

(MSDs). In a study, **Eom *et al.* (2013)** reported that 18.8% of the subjects experienced musculoskeletal symptoms at least at one of body parts. Specifically, 8.1%, 5.6%, 4.1%, and 11.3% of the subjects experienced musculoskeletal symptoms at neck, shoulder, elbow, and hand respectively they also found that the symptoms of musculoskeletal disorders were also associated with amount of text message and time for daily usage of smartphone. In addition with previous studies, **Kleinert (2011)** also revealed in their study that the combination of repetitive movements, poor posture and over-use of mobile phones for texting or playing games, without taking rest breaks, can cause damage to the nerves, muscles, and tendons in the fingers, hands, wrists, arms, elbows, shoulders, and neck, which if ignored, may lead to long-term damage.

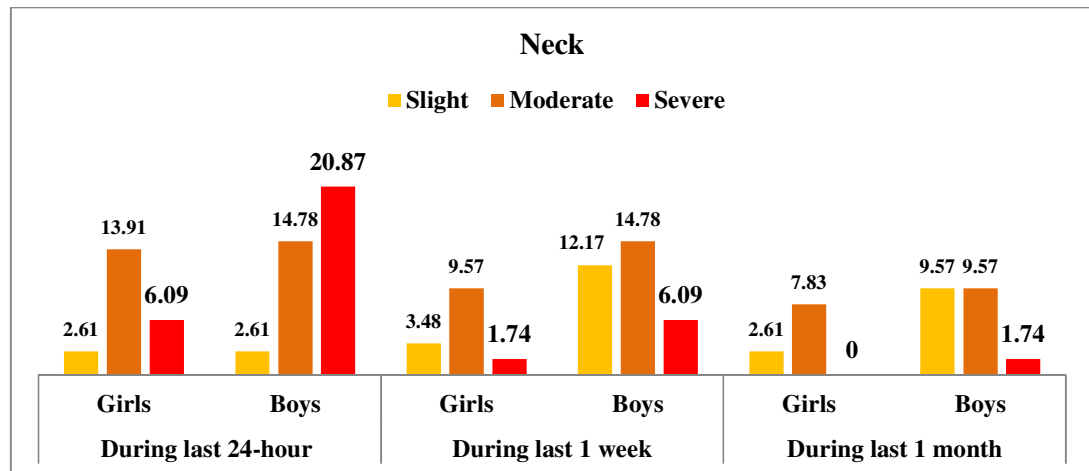


Fig: 4.42. Distribution of respondents on the basis of ranking for musculoskeletal symptoms experienced in Neck

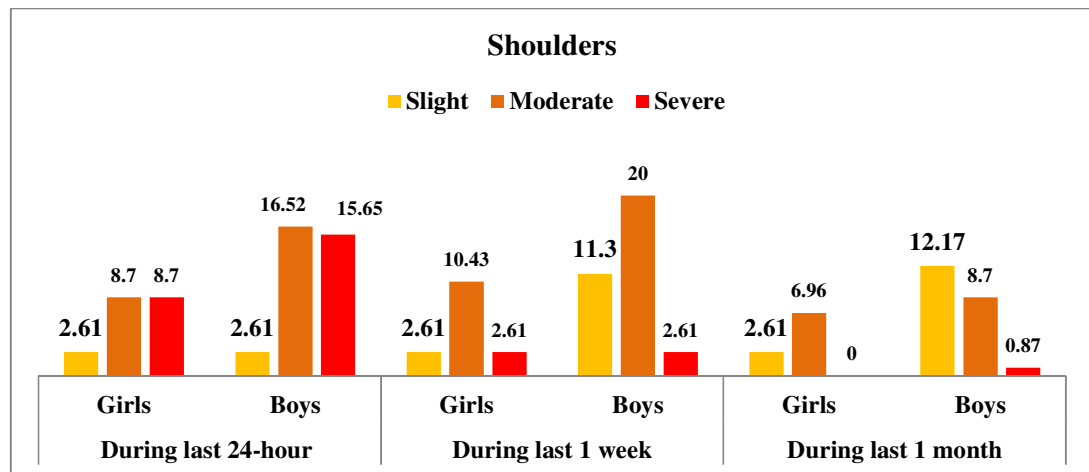


Fig: 4.43. Distribution of respondents on the basis of ranking for musculoskeletal symptoms experienced in Shoulders

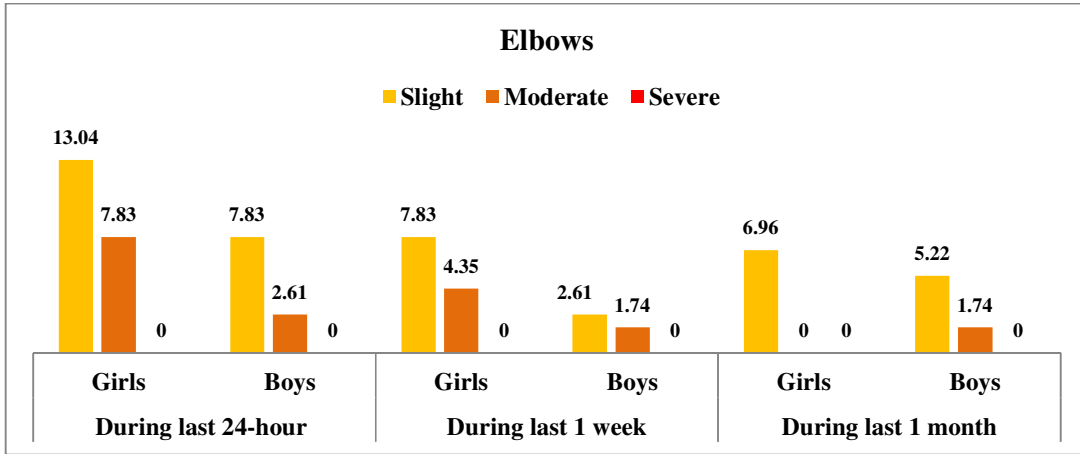


Fig: 4.44. Distribution of respondents on the basis of ranking for musculoskeletal symptoms experienced in Elbows

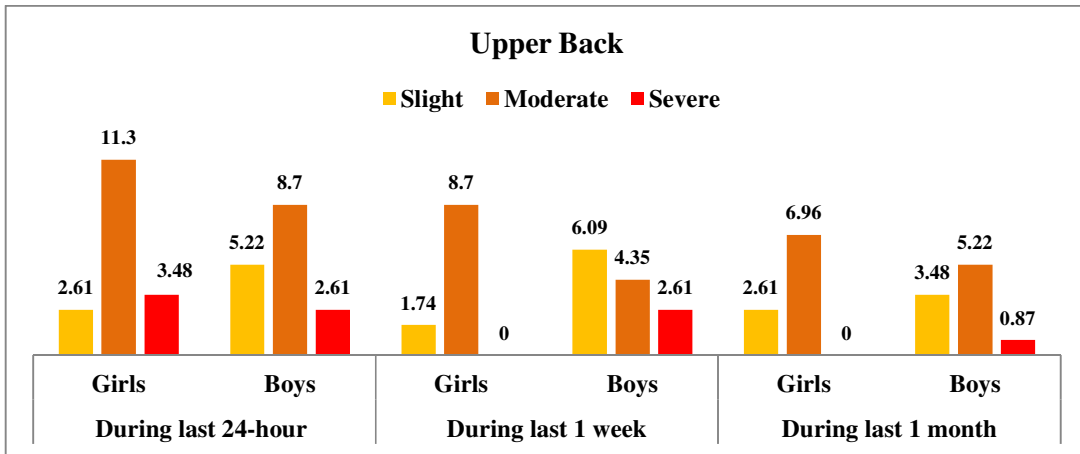


Fig: 4.45. Distribution of respondents on the basis of ranking for musculoskeletal symptoms experienced in Upper Back

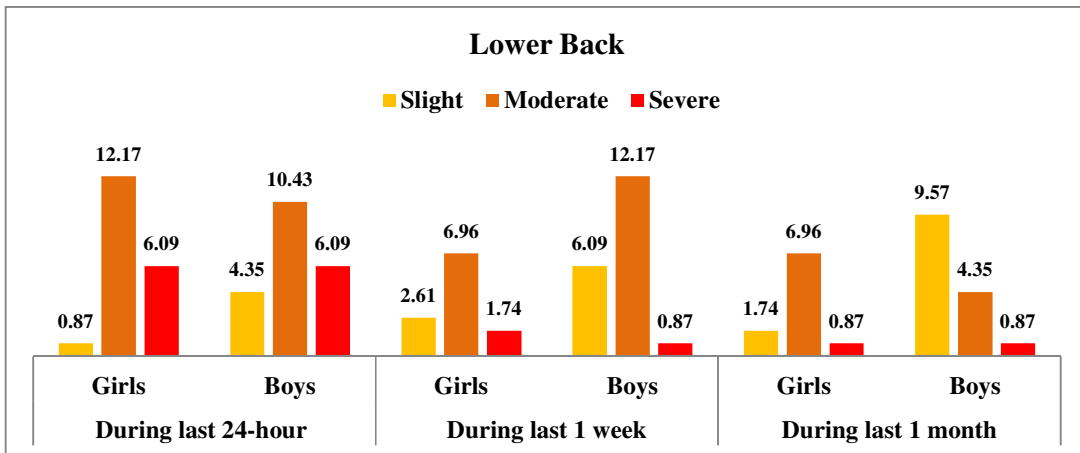


Fig: 4.46. Distribution of respondents on the basis of ranking for musculoskeletal symptoms experienced in Lower Back

Table 4.31: Distribution of respondents ranking on the basis of musculoskeletal symptoms experienced in different regions of right Hand

N=230

S.no	Right hand	Duration	Rank for pain							
			None (0)		Slight(1-3)		Moderate (4-6)		Severe (7-10)	
			Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
i.	Tip of thumb	During last 24-hour	6 (5.22)	1 (0.87)	4 (3.48)	11 (9.57)	14 (12.17)	7 (6.09)	-	-
		During last 1 week	6 (5.22)	10 (8.70)	6 (5.22)	5 (4.35)	7 (6.09)	3(2.61)	-	-
		During last 1 month	9 (7.83)	11 (9.57)	8 (6.96)	3(2.61)	2 (1.74)	2 (1.74)	-	-
ii.	Middle of thumb	During last 24-hour	12 (10.43)	6 (5.22)	5 (4.35)	9 (7.83)	8 (6.96)	5 (4.35)	-	-
		During last 1 week	7 (6.09)	9 (7.83)	6 (5.22)	7 (6.09)	5 (4.35)	2 (1.74)	-	-
		During last 1 month	12 (10.43)	11 (9.57)	5 (4.35)	4 (3.48)	3 (2.61)	2 (1.74)	-	-
iii.	Base of thumb	During last 24-hour	7 (6.09)	4 (3.48)	5 (4.35)	8 (6.96)	8 (6.96)	7 (6.09)	-	1 (0.87)
		During last 1 week	4 (3.48)	9 (7.83)	8 (6.96)	4 (3.48)	4 (3.48)	5 (4.35)	1 (0.87)	-
		During last 1 month	12 (10.43)	10 (8.70)	9 (7.83)	2(1.74)	-	3(2.61)	1 (0.87)	-
iv.	Fingers	During last 24-hour	10 (8.70)	8 (6.96)	7 (6.09)	6 (5.22)	5 (4.35)	3 (2.61)	-	-
		During last 1 week	10 (8.70)	10 (8.70)	5 (4.35)	4 (3.48)	1 (0.87)	2 (1.74)	-	-
		During last 1 month	21 (18.26)	12 (10.43)	-	2(1.74)	-	2 (1.74)	-	-
v.	Front	During last 24-hour	14 (12.17)	13 (11.30)	3 (2.61)	4 (3.48)	5 (4.35)	3(2.61)	-	-
		During last 1 week	17 (14.78)	13 (11.30)	5 (4.35)	4 (3.48)	1 (0.87)	1 (0.87)	-	-
		During last 1 month	17 (14.78)	13 (11.30)	-	4 (3.48)	-	-	-	-
vi.	Back	During last 24-hour	12 (10.43)	13 (11.30)	5 (4.35)	6 (5.22)	5 (4.35)	-	-	-
		During last 1 week	17 (14.78)	13 (11.30)	7 (6.09)	5 (4.35)	1 (0.87)	-	-	-
		During last 1 month	16 (13.91)	13 (11.30)	-	4 (3.48)	-	-	-	-

*multiple responses were given by the respondents

*values given in parentheses indicate Percentage

The complaint frequency of the musculoskeletal symptoms is presented in table 4.31 respondents in which ranking was given by the respondents on the basis of pain/discomfort experienced in different regions of right hand.

Most of the respondents reported slight pain in at least one part of right hand. Pain was found most common at the tip of the thumb (10% boys reported slight pain and 12.1% girls reported moderate pain) in last 24 hours. During last one week, 6 percent boys reported slight pain and 4.3 percent girls reporting moderate pain whereas 7 percent girls and 2.6 percent reported slight pain in the last 1 month.

In middle of thumb, slight pain was reported by the 4.3 percent girl and 3.48 boy respondents in last 1 month whereas 5.2 percent girls and 6 percent boys experienced slight pain in last 1 week. In last 24 hours, 7.8 percent boys felt slight pain whereas most of the girls (6.9%) reported for moderate pain.

When inquired about the symptoms experienced in base of the thumb, about 8 percent girls experienced slight pain while 2.6 percent boys experienced moderate pain, though in last 1 week about 7 percent girls had slight pain and 4.3 percent boys had moderate pain. In last 24 hours 7 percent from both of the respondents reported moderate and slight pain respectively.

In fingers of right hand, most of the respondents (6% girls and 5.2% boys) felt slight pain in last 24 hours whereas only few respondents sensed slight pain since last 1 week.

In front of right hand, 4 percent boys experienced slight pain since 1 month to last 1 day. In case of girls 4.3 percent girls reported slight pain in last 1 week yet again experienced moderate pain in last 24 hours.

In last 24 hours 3.48 percent boys experienced slight and 2.61 percent severe pain. During last 1 week 3.48 percent boys experienced slight pain and 0.87 percent experienced moderate pain. In last 1 month 3.48 percent felt slight pain.

At the Back of the right hand, majority of boys experienced slight pain since 1 month to last 1 day whereas 6 percent girls started sensing slight pain since last 1 week and 4.3 percent experienced slight pain till last 24 hours.

The results of the study was found to be similar with the study conducted by **Berolo et al. (2011)** in which they found that at the base of the thumb (17% reported slight, 9% moderate and 2% reported severe pain) was most common affected area in the right hand. In the present study majority of respondents experienced slight pain in different parts of right hand. Tip and base of thumb was much affected area having moderate pain in girls than boys. It can be stated that due to increased penetration of smartphone in young generation has increased discomforts in upper limbs day by day. According to **Taufiq et al. (2015)** females are more prone to experiencing these problems than the males.

Findings of the present study was supported by the results of the recent study conducted by **Balakrishnan et al. (2016)** they evaluated symptoms of pain by using VAS (visual analogue scale) among 200 students from which 27.5 percent subjects were unaffected by hand pain symptom, 44.5 percent of them were affected by mild hand pain, for moderate hand pain there were 24 percent of the respondents. Apart from that, there were 3.5 percent of students were known to be affected by severe hand pain and worst possible pain. **Ali et al. (2014)** checked the association of De Quervain's tendinitis with SMS texting in different physical therapy schools of Karachi. The results of this study concluded that the thumb pain and frequent text messaging have a positive association.

In another study, **Eapen et al. (2014)** reported in a study that use of mobile phones for text messaging repetitively can damage the extensor pollicis longus of the thumb and the tendons of the first compartment of the wrist joint. Additionally, **Ashurst (2010)** concluded that the overuse of the thumb musculature is the common cause of De Quervain's tenosynovitis. The excessive use of mobile phones for texting can aggravate the disease and also suggested that limitation of texting resulted in recovery of patient suffering from this disease. Studies also revealed that while texting in mobile keypad the thumb covers motions in planes of extension, flexion, abduction-adduction and opposition. These motions occur simultaneously in three dimensions and as a result it becomes difficult to measure the kinematics of thumb (**Ong, 2009**). **Sharan and Ajeesh (2012)** indicated that the thumb worked near the extreme range of motion, may contribute to the development of musculoskeletal disorders and this phenomena is common in mobile phone usage while texting as well as diagnosed associated problems with texting on smartphone were thoracic outlet syndrome (51.8%), fibromyalgia syndrome (25.9%), hypothyroidism (7.4%), wrist tendinitis (14.8%) and De Quervain's syndrome (7.4%).

Table 4.32: Distribution of respondents ranking on the basis of musculoskeletal symptoms experienced in different regions of left hand (N=230)

S.no	Left hand	Duration	Rank for pain							
			None (0)		Slight(1-3)		Moderate (4-6)		Severe (7-10)	
			Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
i.	Tip of thumb	During last 24-hour	11 (9.57)	6 (5.22)	5 (4.35)	7 (6.09)	4 (3.48)	6 (5.22)	2 (1.74)	-
		During last 1 week	12 (10.43)	11 (9.57)	7 (6.09)	5 (4.35)	-	1 (0.87)	-	-
		During last 1 month	18 (15.65)	12 (10.43)	3 (2.61)	4 (3.48)	1 (0.87)	1 (0.87)	-	-
ii.	Middle of thumb	During last 24-hour	13 (11.30)	10 (8.70)	4 (3.48)	7 (6.09)	4 (3.48)	1 (0.87)	1 (0.87)	-
		During last 1 week	15 (13.04)	11 (9.57)	4 (3.48)	7 (6.09)	2 (1.74)	-	-	-
		During last 1 month	18 (15.65)	12 (10.43)	2 (1.74)	5 (4.35)	-	-	-	-
iii.	Base of thumb	During last 24-hour	11 (9.57)	10 (8.70)	4 (3.48)	6 (5.22)	6 (5.22)	2 (1.74)	-	-
		During last 1 week	10 (8.70)	13 (11.30)	4 (3.48)	3 (2.61)	4 (3.48)	2 (1.74)	-	-
		During last 1 month	18 (15.65)	14 (12.17)	4 (3.48)	4 (3.48)	2 (1.74)	-	-	-
iv.	Fingers	During last 24-hour	17 (14.78)	13 (11.30)	7 (6.09)	5 (4.35)	-	1 (0.87)	-	-
		During last 1 week	17 (14.78)	14 (12.17)	3 (2.61)	4 (3.48)	-	-	-	-
		During last 1 month	18 (15.65)	16 (13.91)	1 (0.87)	3 (2.61)	-	-	-	-
v.	Front	During last 24-hour	16 (13.91)	15 (13.04)	6 (5.22)	4 (3.48)	1 (0.87)	-	-	-
		During last 1 week	17 (14.78)	15 (13.04)	-	3 (2.61)	-	-	-	-
		During last 1 month	28 (24.35)	18 (15.65)	-	2 (1.74)	-	-	-	-
vi.	Back	During last 24-hour	18 (15.65)	16 (13.91)	5 (4.35)	4 (3.48)	-	-	-	-
		During last 1 week	17 (14.78)	15 (13.04)	-	3 (2.61)	-	-	-	-
		During last 1 month	23 (20)	17 (14.78)	-	2 (1.74)	-	-	-	-

*multiple responses were given by the respondents

*values given in parentheses indicate Percentage

Data exhibiting the distribution of respondents ranking on the basis of musculoskeletal symptoms experienced in different regions of left hand is presented in Table 4.32 and it can be seen that slight pain is more prevalent among the respondents.

In tip of the left thumb, the percentage of slight pain experiencing boys goes double since last 1 month (3.4%) to one day (6.0%). Similarly it happened in case of girls, pain incidences in respondents prolonged from last 1 month (2.6%) to last 24 hours (4.3%).

When asked about middle of the thumb, 1.74 percent girls encountered slight pain that was prolonged in 3.4 percent girls in last 24 hours. In case of boys, 4.3 percent girls faced slight pain that was continued in 6 percent girls in last 24 hours in the left hand.

In base of the thumb, 5.22 percent girls were experiencing moderate pain while 5.22 percent boys experienced slight pain however in last 1 month, 3.4 percent of each girls and boys experienced slight pain in base of the left thumb. Similarly **Berolo et al. (2011)** found that in left hand most common pain spot was base of the thumb for which majority of respondents (15%) reported slight pain followed by 4 percent moderate pain and 1 percent respondents reported severe pain.

In fingers, 6.09 percent girls and 4.35 percent girls were experiencing slight pain during last 24 hours. When inquired about pain in front part of left hand, most respondents (5.2% girls and 3.4% boys) experienced slight pain in last 24 hours. Consequently, in back portion of the left hand some respondents including girls (4.3%) and boys (3.4%) were experienced slight pain in last 24 hours.

The table 4.32 shows that majority of the girls and boys feel slight pain in last 24 hours. It can be said that as the majority of respondents were right handed so the left hand was less affected than the right hand.

4.9 Muscular fatigue in hands

Muscular fatigue is a temporary reduction in muscle strength it may be the power or endurance. It is the condition of the muscle in which its capacity to produce maximum voluntary action, or to perform a series of repetitive actions, is reduced. For determination of muscular fatigue while smartphone use, the grip strength and pinch strength of the respondents was measured.

4.9.1 Grip strength

For determination of the muscular fatigue the grip strength of the selected respondents was measured with the help of grip dynamometer, before and after usage of Smartphone. The grip strength for both, left and right hands was measured at before and after the usage separately. Decreased grip strength was interpreted as grip fatigue of the muscle.

Table 4.33: Mean and Standard Deviation of Grip Strength (kg) of the respondents

Hand	Mean± SD (Girls)	Mean± SD (Boys)
Right	18.44±4.15	34.83±7.37
Left	16.41±4.02	34.46±6.65

In the present study the grip strength was measured at 0° elbow flexion and the data revealed that among girls, the average grip strength of right hand was 18.44±4.15 and left hand was 16.41±4.02. Whereas in boys the average grip strength of right hand was 34.83±7.37 and left hand was 34.46±6.65. Data showed that boys had higher mean value of the grip strength than girls and similar results were reported by **Mullerpatan (2013)** in which he reported that men presented significantly higher values for grip strength ($p \leq 0.001$) at 0° of elbow flexion (37.8 kg) than women (22.12 kg).

The values of hand grip strength of the participants of the present study were less than the normative values of a similar age group as reported by **Mathiowetz et al. (1985)** in their study, the average values of hand grip strength were 54.81 kg for males and 31.71 kg for females. However, the normal values of key pinch strength are 11.78 kg for males and 7.97 kg for females, which was also higher than the results of present study. It was observed from the previous study that grip and key pinch strength is decreased with increasing time.

Table 4.34: Grip strength of Girls before use and after use (n*=8)

	Mean± SD (before use)	Mean± SD (after use)	% change in grip strength
Right hand	18.74±2.25	18.30±3.17	2.41
Left hand	17.0±3.98	16.99±2.65	0.06

Analysis of the data revealed that in girls before smartphone use, the average grip strength of right hand was 18.74 ± 2.25 whereas after using the smartphone it was 17.0 ± 3.98 . While the data of the left hand before using smartphone shows that the average grip strength was 18.30 ± 3.17 whereas after using the smartphone it was 16.99 ± 2.65 . Data clearly shows that there was 2.41 percent decrease in girls grip strength of right hand after using smartphone for 30 minutes. As the right hand was the dominant hand so the left hand was not showing grip change.

Table 4.35: Grip strength of Boys before use and after use (n*=8)

	Mean± SD (before use)	Mean± SD (after use)	% change in grip strength
Right hand	33.13±4.95	32.45±5.81	2.05
Left hand	31.53±4.78	31.80±4.53	0.85

Analysis of the data revealed that in boys before smartphone use, the average grip strength of right hand was 33.13 ± 4.95 whereas after using the smartphone it was 32.45 ± 5.81 . While the data of the left hand before using smartphone shows that the average grip strength was 31.53 ± 4.78 whereas after using the smartphone it was 31.80 ± 4.53 . Data clearly shows that there was 2.05 percent decrease in boys grip strength of right hand after using smartphone for 30 minutes. As the right hand was the dominant hand so the left hand was not showing grip change.

In a recent study conducted by **Oulakh and Vinay (2017)** on female workers engaged in watch assembly unit concluded that the decrease in grip strength of the left hand was higher (48.6) than right hand (45.1). The findings were similar to the present study but the percentage of change in grip strength was higher.

4.9.2 Pinch Strength

While holding or using smartphone the users mainly adopt three pinches for holding that are namely: tip, palmer and chuck pinch. Lateral pinch was found mainly used for operating smartphone. Pinch strength was measured with the help of pinch force meter before and after use of smartphone.

Table 4.36: Mean and Standard Deviation of the respondents Pinch force including Palmer pinch, Tip pinch, and Lateral pinch (n=160)

Pinch force (in kg)						
	Tip pinch		Palmer pinch		Lateral pinch	
	Right hand	Left hand	Right hand	Left hand	Right hand	Left hand
Girls	3.41±1.42	2.35±0.53	5.09±1.77	5.37±1.16	4.80±1.59	3.4±1.30
Reference value*	3.25±1	-	4.68±3.1	-	4.85±1	-
Boys	4.56±1.81	5.72±1.99	7.23±2.40	4.71±1.87	6.69±2.41	6.80±1.99
Reference value*	3.95 ±1.5	-	6.52 + 1.6	-	6.97±1.2	-

*Acc. to Mullerpatan (2013)

In the present study the grip strength was measured at 0° elbow flexion and the data revealed that in girls, the average tip pinch force of right hand was 3.41±1.42, palmer pinch force was 5.09±1.77 and lateral pinch force was 4.80±1.59 while the data of the left hand shows that the average tip pinch was 2.35±0.53, palmer pinch force was 5.37±1.16 and lateral pinch force was 4.80±1.59 while pulp pinch force was 3.4±1.30.

Whereas in boys, the average tip pinch force of right hand was 4.56±1.81, palmer pinch force was 7.23±2.40 and lateral pinch force was 6.69±2.41 while the data of the left hand shows that the average tip pinch was 5.72±1.99, palmer pinch force was 4.71±1.87 and lateral pinch force was 6.80±1.99. Data revealed that boys represent the higher mean values than girls and the similar results were found in a study by **Mullerpatan (2013)** men presented significantly higher values of tip, palmar and key pinch (3.9, 6.7 and 7.2 kg) than women (3.2, 4.71 and 4.81 kg).

Table 4.37: Pinch force of girls before and after using smartphone (n*=8)

	Tip pinch		Palmer pinch		Lateral pinch	
	Before	After	Before	After	Before	After
Right hand	3.0±0.78	2.35±0.53	5.77±1.28	5.37±1.16	4.43±1.27	3.4±1.30
Left hand	4.1±1.51	3.93±0.92	3.01±0.81	2.6±0.69	5.62±1.45	5.57±1.45

Analysis of the data revealed that in girls before smartphone use, the average tip pinch force of right hand was 3.0 ± 0.78 , palmer pinch force was 5.77 ± 1.28 and lateral pinch force was 4.43 ± 1.27 whereas after using the smartphone the average tip pinch force of left hand was 2.35 ± 0.53 , palmer pinch force was 5.37 ± 1.16 and lateral pinch force was 3.4 ± 1.30 .

While the data of the left hand after using smartphone shows that the average tip pinch was 4.1 ± 1.51 , palmer pinch force was 3.01 ± 0.81 and lateral pinch force was 5.62 ± 1.45 whereas after using the smartphone the average tip pinch force of left hand was 3.93 ± 0.92 , palmer pinch force was 2.6 ± 0.69 and lateral pinch force was 5.57 ± 1.45 . Data clearly shows that there was slight decrease in girls pinch strength of mainly right hands after using smartphone. As the lateral pinch was mainly used for gripping smartphone while usage, it was found that the lateral pinch strength of right hand was decreased 1.03 kg after using smartphone for 30 minutes.

Table 4.38: Pinch force of boys before and after using smartphone (n*=8)

	Tip pinch		Palmer pinch		Lateral pinch	
	Before	After	Before	After	Before	After
Right hand	4.22±2.11	4.07±1.76	8.77±1.47	7.92±2.74	6.2±0.97	5.15±1.43
Left hand	6.37±2.20	6.0±2.06	4.16±1.40	3.38±1.16	7.6±1.37	6.9±1.38

Whereas in boys before smartphone use, the average tip pinch force of right hand was 4.22 ± 2.11 , palmer pinch force was 8.77 ± 1.47 and lateral pinch force was 6.2 ± 0.97 whereas after using the smartphone the average tip pinch force of left hand was 4.07 ± 1.76 , palmer pinch force was 7.92 ± 2.74 and lateral pinch force was 5.15 ± 1.43 .

While the data of the left hand before using smartphone shows that the average tip pinch was 6.37 ± 2.20 , palmer pinch force was 4.16 ± 1.40 and lateral pinch force was 7.6 ± 1.37 whereas after using the smartphone the average tip pinch force of left hand was 6.0 ± 2.06 , palmer pinch force was 3.38 ± 1.16 and lateral pinch force was 6.9 ± 1.38 . Data clearly shows that there was also slight decrease in boys pinch strength of right hands after using smartphone. As the lateral pinch was mainly used for gripping smartphone while usage, it was found that the lateral pinch strength of right hand was

decreased 1.06 kg after using smartphone for 30 minutes. Similarity was found from a study in context of key pinch **Abdelhameed and Abdel-aziem (2016)** included the key pinch strength to assess the strength of the thumb because it is the most affected part of the hand due to touchscreen phone use. The results proved its strength reduction due to touchscreen phone use and improvement due to proper handling and exercise training.

4.10 Postural analysis of respondents in different positions (Sitting and standing)

Postural analysis helps to determine which areas of the body are under more strain than others, and which muscle groups are causing the strain. Postural analysis of the respondents was done through inclinometer which consists of primary and secondary inclinometer which was joined with the help of connecting cable. In spite of this three straps of Velcro were used for tying both the inclinometer to measure the neck flexion and extension in respondents while smartphone usage.

Table 4.39: Cervical (Neck flexion) of boys while using smartphone in standing position

n₁=40

S. No.	Standing Position	Cervical Neck flexion (in degree)		
		Flexion	Extension	TROM
1.	Normal	6.4°	15.8°	11.5°
	Normal range (Acc. to AMA)	50°	60°	-
2.	While using Smartphone	29.6°	35.1°	22.9°
	Deviation from normal	21°	25°	-
	Force To Cervical Spine (in lbs.)	40 lbs.	-	-

Table 4.39 depicts the Cervical (Neck flexion) of boys while using smartphone in standing position in normal standing the table shows that the average flexion in normal standing position was 6.4° degree and while using smartphone it was found 29.6° that was 21° deviated from normal range. The extension of neck while using smartphone was 35.1° that was 25° deviated from the normal range.

Table 4.40: Cervical (Neck flexion) of girls while using smartphone in standing position

(n₂=40)

S. No.	Standing Position	Cervical (Neck flexion)		
		Flexion	Extension	TROM
1.	Normal	5.9°	14.4°	9.6°
	Normal range (Acc. to AMA)	50°	60°	-
2.	While using Smartphone	27.6°	31.3°	25.0°
	Deviation from normal	23°	29°	-
	Force To Cervical Spine (in lbs.)	40 lbs.	-	-

Table 4.40 depicts the Cervical (Neck flexion) of girls while using smartphone in standing position in normal standing the table shows that the average flexion in normal standing position was 5.9° degree and while using smartphone it was found 27.6° that was 23° deviated from normal range. The extension of neck while using smartphone was 31.3° that was 29° deviated from the normal range.

Table 4.41: Cervical (Neck flexion) of boys while using smartphone in sitting position

(n₁=40)

S. No.	Sitting Position	Cervical (Neck flexion)		
		Flexion	Extension	TROM
1.	Normal	6.28°	14.76°	10.01°
	Normal range (Acc. to AMA)	50°	60°	-
2.	While using Smartphone	30°	35°	16.71°
	Deviation from normal	20°	25°	-
	Force To Cervical Spine (in lbs.)	40 lbs.	-	-

Table 4.41 depicts the Cervical (Neck flexion) of boys while using smartphone in sitting position in normal sitting the data shows that the average flexion in normal sitting position was 6.28° degree and while using smartphone it was found 30° that was 20° deviated from normal range. The extension of neck while using smartphone was 35° that was 25° deviated from the normal range.

Table 4.42: Cervical (Neck flexion) of girls while using smartphone in sitting position

n₂=40

S. No.	Sitting Position	Cervical (Neck flexion)		
		Flexion	Extension	TROM
1.	Normal	5.08°	11.5°	7.89°
	Normal range (Acc. to AMA)	50°	60°	-
2.	While using Smartphone	35°	34°	19.1°
	Deviation from normal	15°	26°	-
	Force To Cervical Spine (in lbs.)	40-49 lbs.	-	-

Table 4.42 depicts the Cervical (Neck flexion) of girls while using smartphone in sitting position in normal sitting the data shows that the average flexion in normal sitting position was 5.08° degree and while using smartphone it was found 35° that was 15° deviated from normal range. The extension of neck while using smartphone was 34° that was 26° deviated from the normal range.

According to a recent study, the weight supported by the spine dramatically increases when flexing the head forward at varying degrees. An adult head weighs 10–12 pounds in the neutral position. As the head tilts forward, the forces felt by the neck surge to 27 pounds at 15 degrees, 40 pounds at 30 degrees, 49 pounds at 45 degrees, and 60 pounds at 60 degrees. At 90 degrees, the model prediction was not reliable. (Hansraj, 2014)

Table 4.43: Mean Value of Cervical (Neck flexion) of the respondents in different duration

n*=16

S. No.	Duration	Mean Value of Cervical (Neck flexion)					
		Flexion		Extension		TROM	
		Girls	Boys	Girls	Boys	Girls	Boys
a)	0 min	29.92°	26.04°	37.46°	38.58°	14.67°	12.29°
b)	10 min	32.02°	29.63°	43.29°	37.83°	36.96°	9.63°
c)	20 min	38.38°	40.21°	46.17°	43.17°	10.67°	13.46°
d)	30 min	45.71°	46.63°	50.79°	55.42°	13.50°	14.46°

On the basis of previous study it can be conclude that as the respondents haunch their head on their smartphone up to 45 degrees that gives load on neck up to 49 lbs. which means when smartphone is used for longer period it gives the feeling of neck pain in respondents including shoulders and upper back that will lead to musculoskeletal disorders.

The neck flexion of the respondents were measured by using inclinometer in sitting position at 3 different time duration i.e. 0 min., 10 min., 20 min. and 30 min.

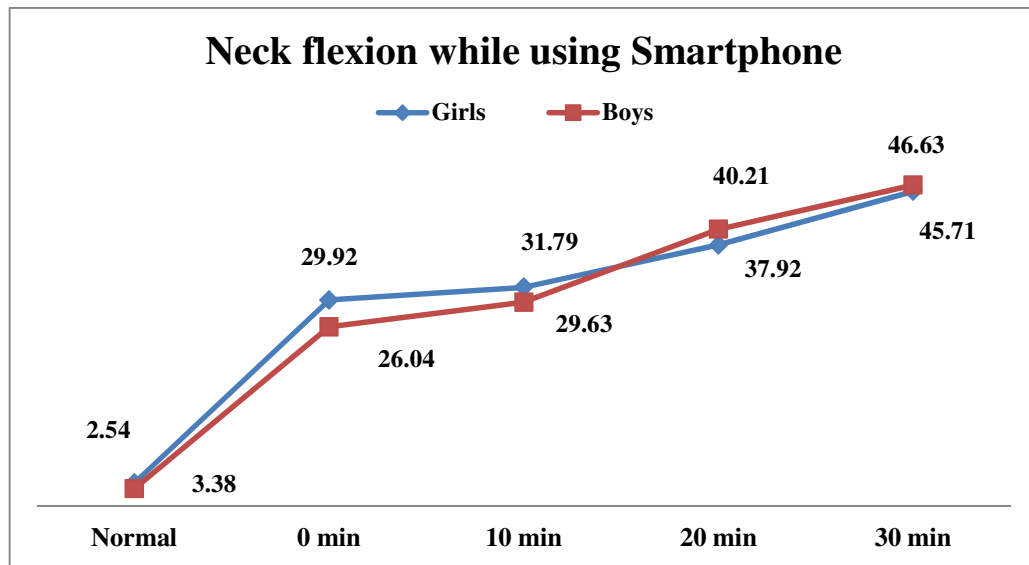


Fig: 4.47. Neck flexion while using a smartphone in sitting position (unit: degree)

In girls 29.92° followed by 32.02°, 38.38° and 45.71° neck flexion was measured in 0 min, 10 min., 20 min. and 30 min. respectively. In the case of boys 26.04° followed by 29.63°, 40.21° and 46.63° neck flexion was measured in 0 min, 10 min., 20 min. and 30 min. respectively. From the above table and figure it is clearly represented that with increasing usage time affects the neck flexion to the respondents in sitting posture. In line with the present study result, **Lee et al. (2016)** also stated that a longer duration of smartphone usage led to a higher neck flexion angle for each of the three postures i.e. standing, sitting on chair and sitting on floor. Similar with the present study, **Lee et al. (2015)** envisages that head flexion angle ranged from 30.28 to 46.88 in three different activity text messaging, web browsing and video watching. He also found that in general, participants flexed the head more while using the smartphone in sitting compared to standing. **So and Woo (2014)** reported that smart phone use

decreased the experimental pressure threshold and the cervical range of motion, which, in turn, increased neck and shoulder fatigue and pain. In a study, **Yoo (2008)** reported that the mean flexion angle of the neck bone while subjects viewed a digital multimedia broadcasting (DMB) phone in a flexed neck posture was $38.5 \pm 6.02^\circ$, and flexed neck posture may increase the muscle activity of the upper trapezius and splenius capitis more than neutral neck posture that can become the cause of pain in the musculoskeletal system of the neck and shoulder. In addition, according to a previous study by **Hansraj (2014)** when flexing the head forward at varying degrees, the forces experienced by the cervical spine considerably increase and lead to cervical curve loss, which may cause neck pain.

4.11 Assessment of psychological Problems in respondents due to Smartphone use

4.11.1 Smartphone Addiction in respondents

Data produced in the table 4.35 gives sufficient support to the association that on the basis of weighted mean individual statements were ranked and it was concluded that girls gave first rank to the statement “Spending a lot of time on my smartphone has become a habit.” whereas the statement “My mind keeps busy with my smartphone even when I don’t use it.” was ranked second whereas third rank to “There is nothing more fun to do than using smartphone”. Hence, it clearly shows that girls use their smartphone like the part of daily life; they engage themselves in thinking about their smartphone and they think that fun is limited all around their smartphone it is evident the dependency and addiction in the girl respondents with their smartphone.

While in the case of boys first rank was given to the statement that “their mind keeps busy with the smartphone even when they don’t use it”; second rank to “I Won’t be able to stand if I am not having a smartphone” likewise **Cheever et al. (2014)** also revealed that most participants would feel disconnected from others rather than feeling distressed when the mobile phone is absent. The statement “their friends and family complain about their use of smart phone” was ranked third. Hence, it clearly shows that boys engage themselves in thinking about their smartphone; they won’t be able to stand without smartphone and they were complained by their friends and family complain about smart phone use these reasons shows the dependency and addiction in the boy respondents to their smartphone.

Table 4.44: Distribution of respondents on the basis of responses for the Addiction due to smartphone use (n=116)

S.No.	Statements		Agree	Neutral	Disagree	Weighted Mean	Rank
1.	My friends and family complain about my use of the smart phone.	Girls	12 (20.69)	17 (29.31)	29 (50.00)	1.71	
		Boys	26 (44.83)	15 (25.86)	17 (29.31)	2.16	3 (B)
2.	Spending a lot of time on my smartphone has become a habit.	Girls	11 (18.97)	8 (13.79)	39 (67.24)	2.48	1 (G)
		Boys	21 (36.21)	17 (29.31)	20 (34.48)	2.02	
3.	My fully charged battery does not last for more than one day.	Girls	10 (17.24)	8 (13.79)	40 (68.97)	1.48	
		Boys	5 (8.62)	13 (22.41)	40 (68.97)	1.40	
4.	I would love to spend more time on smartphone rather than outdoor activities.	Girls	8 (13.79)	15 (25.86)	35 (60.34)	1.53	
		Boys	13 (22.41)	23 (39.66)	22 (37.93)	1.84	
5.	I feel most liberal while using a smartphone.	Girls	11 (18.97)	9 (15.52)	38 (65.52)	1.53	
		Boys	15 (25.86)	12 (20.69)	31 (53.45)	1.72	
6.	I feel that I lack something when I am not able to use my smartphone.	Girls	18 (31.03)	10 (17.24)	30 (51.72)	1.79	
		Boys	26 (44.83)	13 (22.41)	19 (16.52)	2.12	
7.	I Won't be able to stand if I am not having a smartphone.	Girls	16 (13.91)	13 (22.41)	29 (50.00)	1.78	
		Boys	27 (46.55)	14 (24.14)	17 (29.31)	2.17	2 (B)
8.	I feel obsessed to use my smartphone.	Girls	9 (15.52)	7 (12.07)	42 (72.41)	1.43	

		Boys	13 (22.41)	12 (20.69)	33 (56.90)	1.66	
9.	There is nothing more fun to do than using my smartphone.	Girls	14 (24.14)	19 (32.76)	25 (43.10)	1.81	3 (G)
		Boys	13 (22.41)	30 (51.72)	15 (25.86)	1.97	
10.	I feel anxious if I have not checked for messages on my smart phone for the 10 minutes.	Girls	17 (29.31)	12 (20.69)	29 (50.00)	1.79	
		Boys	21 (36.21)	20 (34.48)	17 (29.31)	2.07	
11.	My mind keeps busy with my smartphone even when I don't use it.	Girls	22 (37.93)	8 (13.79)	28 (48.28)	1.90	2 (G)
		Boys	32 (55.17)	9 (15.52)	17 (29.31)	2.26	1 (B)
12.	I become irritable if I have to switch off my smart phone for class, exams etc.	Girls	2 (3.45)	6 (10.34)	50 (86.21)	1.17	
		Boys	5 (8.62)	15 (25.86)	38 (65.52)	1.43	
13.	I lose sleep due to the time I spend on my smart phone.	Girls	5 (8.62)	9 (15.52)	44 (75.86)	1.33	
		Boys	13 (22.41)	7 (12.07)	38 (33.04)	1.57	
14.	I feel tired due to excessive usage of smartphone.	Girls	12 (20.69)	5 (8.62)	41 (70.69)	1.50	
		Boys	16 (27.59)	10 (17.24)	32 (55.17)	1.72	
15.	I feel pain in wrists and back of neck while using smartphone.	Girls	10 (17.24)	13 (22.41)	35 (60.34)	1.57	
		Boys	12 (20.69)	10 (17.24)	36 (62.07)	1.59	
16.	I experience light headedness or blurred vision due to smartphone use.	Girls	11 (18.97)	8 (13.79)	39 (67.24)	1.52	
		Boys	17 (29.31)	13 (22.41)	28 (48.28)	1.81	

*percentage is given in parentheses, B=Boys, G=Girls

The Smartphone Addiction scores of respondents were collected using Smartphone Addiction scale composed of 16 statements. The result of the score is presented in Table 4.44. The respondents were divided into 3 addiction level category – Low, Medium and High addiction level. The 49.14 percent of the respondents, whose scores ranged from 16-26, is classified into the lower addiction group, the 40.52 percent of respondents, whose scores ranged from 27-37, placed in medium addicted group whereas 10.35 percent of the respondents, whose scores ranged from 38 to 48, were assigned to the highly addicted group.

In a study conducted by **Shin and Lee (2017)** used a self-diagnosis scale for smartphone addiction composed of 15 questions and divided scale scores of 3 Groups – Normal, Risky and Addicted. More than half of the respondents i.e. 67.7 percent were in normal group whose scores ranged from 6 to 29, the 18.5% of participants, whose scores ranged from 29 to 33 classified into the risky groups and 13.8% of the participants, whose scores ranged from 34 to 44, is assigned to the addicted group. The results of this study were similar to the present study.

Table 4.45: Distribution of respondents on the basis of Smartphone Addiction level

n=116					
S.no.	Addiction level	Scores	Girls (n₁=58)	Boys (n₂=58)	Total
1.	Low	16-26	33 (56.89)	24 (41.38)	57 (49.14)
2.	Medium	27-37	23 (39.65)	24 (41.38)	47 (40.52)
3.	High	38-48	2 (3.44)	10 (17.25)	12 (10.35)

The table 4.45 shows the addiction level in respondents in which maximum girls (56.89%) comes under the low addiction level category followed by 39.65 and 3.44 percent in medium and high addiction level respectively.

In case of boys, 41.38 percent boys were having the low level of addiction and same percentage was in medium level addiction whereas 17.2 percent were in high addiction level category. Overall majority of respondents were having low addiction towards smartphone but 10 percent were highly addicted to their smartphone. The results are in accordance with the study conducted by **Ahmed and Qazi (2011)** in

which results revealed that very few students (4.8 - 18.5%) exhibited extreme addictive behaviour in Pakistan. Thus, they concluded that university students used their mobile phones within reasonable limits and did not move towards extreme behaviours that lead to addictive mobile phone use.

This relationship is interesting in light of recent work by **Cha and Seo (2018)** they reported that 30.9% were classified as a risk group for smartphone addiction and 69.1% were identified as a normal user group by using Smartphone Addiction Proneness Scale. They also mentioned that the adolescents used mobile messengers for the longest, followed by Internet surfing, gaming, and social networking service use.

This can be concluded from the present study that addiction is increasing in the young people gradually, as the some of the respondents laying under high addiction level means they are exhibiting the over addictive behaviour and if with time it will not take care it may leads to serious problems among youngsters.

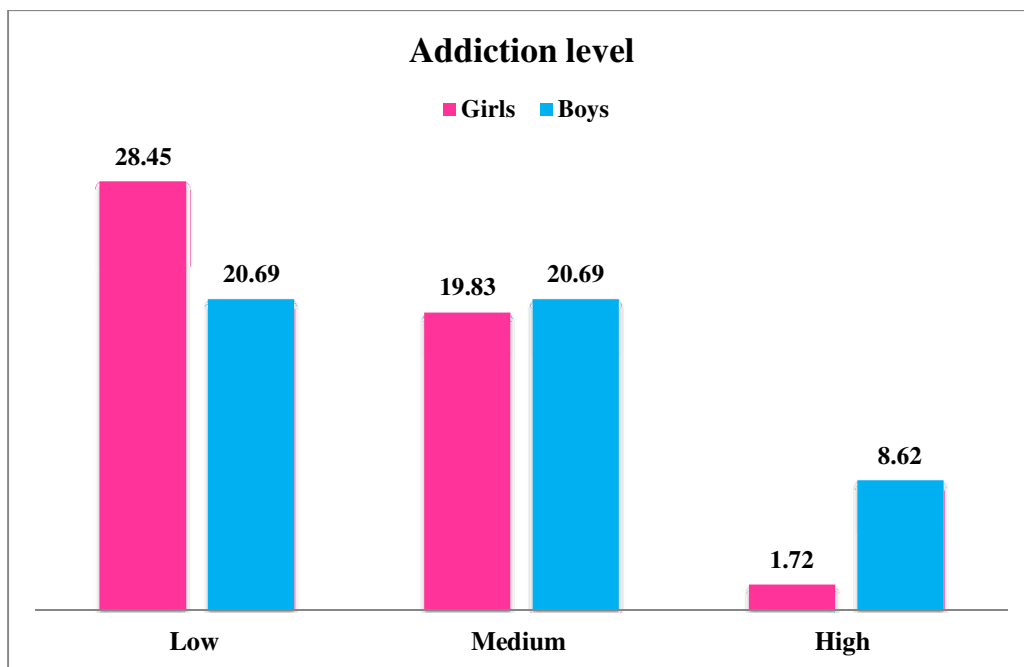


Fig: 4.48. Distribution of respondents on the basis of level of Addiction

4.11.2 Depression in Respondents due to smartphone

Data produce the ample support to the association that on the basis of weighted mean individual statements were ranked by respondents and it was concluded that both girls and boys gave highest weight to the statement that they get very irritated when internet connection get slow in their smartphone whereas the statement “felt scared only from the thought of losing my smartphone” was ranked second by both gender whereas girls give third rank to “they feel more tensed about their future because of excessive involvement with smartphone” and “I feel disappointed when I cannot pick a call or message immediately” got fourth rank and “I feel the sense of my heart rate increase or heart palpitates when I get message from very close friend” got the fifth rank.

While in case of boys third rank was given to the statement “increased heart rate or heart palpitates when I get message from very close friend”; forth rank to “I found myself impatient when someone tries to distract me when I am busy with my smartphone” and the statement “I feel good while having my smartphone in front of my friends” was ranked fifth.

Hence, it clearly shows that respondents were having the symptoms of depression due some reasons like loss of data connectivity, loss from the contact of smartphone and feel disappointed when not receiving the notifications. A study was done by **Walsh et al. (2008)**, in which they found that not receiving messages and voice calls regularly is often perceived as not being loved by people, leading to feelings of depression. Whereas **Ikeda and Nakamura (2014)** reported in a study that prolonged use of mobile phones resulted in depression in a sample of Japanese high school students.

Researchers have found that regular cellular phone users often suffer from feelings of anxiety, stress and insecurity in the absence of the device. This has been reported too often happening in situations such as poor network zones, or when unexpectedly, the battery or the phone credit runs out. This view encompasses the term “Nomo phobia”, literally meaning no mobile phobia. Briefly, it is the fear of being out of mobile phone contact, due to any reason The other related term is “textiety”, the feeling of anxiety on not receiving or sending text messages." This can possibly stem from an underlying fear of social isolation (**Billieux et al. 2015; Aggarwal, 2013; Dixit et al., 2010**).

Table 4.46: Distribution of respondents on the basis of responses for the Depression due to smartphone use (n=116)

S.no	Statements		Never	Occasionally	Frequently	Mostly	Weighted Mean	Rank
1.	I feel disappointed when I cannot pick a call or message immediately.	Girls	14 (24.14)	31 (53.45)	11 (18.97)	2 (3.45)	2.02	4 (G)
		Boys	21 (36.21)	22 (37.93)	11 (18.97)	4 (6.90)	1.97	
2.	I feel more tensed about my future because of excessive involvement with smartphone.	Girls	18 (31.03)	25 (43.10)	10 (17.24)	5 (8.62)	2.03	3 (G)
		Boys	19 (32.76)	26 (44.83)	9 (15.52)	4 (6.90)	1.97	
3.	I tend to overreact if someone touches my smartphone.	Girls	31 (53.45)	20 (34.48)	4 (6.90)	3 (5.17)	1.64	
		Boys	26 (44.83)	24 (41.38)	4 (6.90)	4 (6.90)	1.76	
4.	I found that I was very irritated when internet connection get slow in my smartphone.	Girls	2 (3.45)	27 (46.55)	16 (27.59)	13 (22.41)	2.69	1 (G)
		Boys	5 (8.62)	22 (37.93)	14 (24.14)	17 (29.31)	2.74	1 (B)
5.	I found myself impatient when someone tries to distract me when I am busy with my smartphone.	Girls	29 (50.00)	22 (37.93)	4 (6.90)	3 (5.17)	1.67	
		Boys	15 (25.86)	27 (46.55)	12 (20.69)	4 (6.90)	2.09	4 (B)
6.	I feel good while having my smartphone in front of my friends.	Girls	29 (50.00)	15 (25.86)	9 (15.52)	5 (8.62)	1.83	
		Boys	23 (39.66)	15 (25.86)	13 (22.41)	7 (12.07)	2.07	5 (B)

7.	I felt I was about to panic many times when my phone's battery gets discharge.	Girls	21 (36.21)	24 (41.38)	12 (20.69)	1 (1.72)	1.88	
		Boys	19 (32.76)	24 (41.38)	10 (17.24)	5 (8.62)	2.02	
8.	I feel trouble in sleeping at night if I do not use my smartphone before.	Girls	36 (62.07)	13 (22.41)	5 (8.62)	4 (6.90)	1.60	
		Boys	31 (53.45)	15 (25.86)	7 (12.07)	5 (8.62)	1.76	
9.	I found it hard to calm down if there is no notification in my phone throughout whole day.	Girls	42 (72.41)	13 (22.41)	2 (3.45)	1 (1.72)	1.34	
		Boys	33 (56.90)	16 (27.59)	6 (10.34)	3 (5.17)	1.64	
10.	I feel the sense of my heart rate increase or heart palpitates when I get message from very close friend.	Girls	22 (37.93)	21 (36.21)	10 (17.24)	5 (8.62)	1.97	5 (G)
		Boys	17 (29.31)	23 (39.66)	7 (12.07)	11 (18.97)	2.21	3 (B)
11.	I felt scared only from the thought of losing my smartphone.	Girls	12 (20.69)	20 (34.48)	17 (29.31)	9 (15.52)	2.40	2 (G)
		Boys	15 (25.86)	14 (24.14)	15 (25.86)	14 (24.14)	2.48	2 (B)
12.	I lost interest in other ways of entertainment and communication sources except my smartphone.	Girls	31 (53.45)	20 (34.48)	5 (8.62)	2 (3.45)	1.62	
		Boys	31 (53.45)	17 (29.31)	8 (13.79)	2 (3.45)	1.71	

*Percentage is given in parentheses, B=Boys, G=Girls

Table 4.47: Distribution of respondents on the basis of level of Depression due to Smartphone use n=116

S.no.	Level of Depression	Scores	Girls (n ₁ =58)	Boys (n ₂ =58)	Total
1.	Mild	12-23	38 (65.52)	33 (56.90)	71 (61.2)
2.	Moderate	24-35	17 (29.32)	21 (36.20)	38 (32.7)
3.	High	36-48	3 (5.18)	4 (6.90)	7(6.0)

Table 4.47 shows the depression level in respondents in which majority of respondents including girls (65.52%) and boys (56.9%) comes under the mild depression level category followed by 29.32 percent girls and 36.2 percent boys had moderate depression and few respondents (5.18% girls and 6.9% boys) had high depression. respectively. From the findings it may conclude that depression is increasing in the young people gradually.

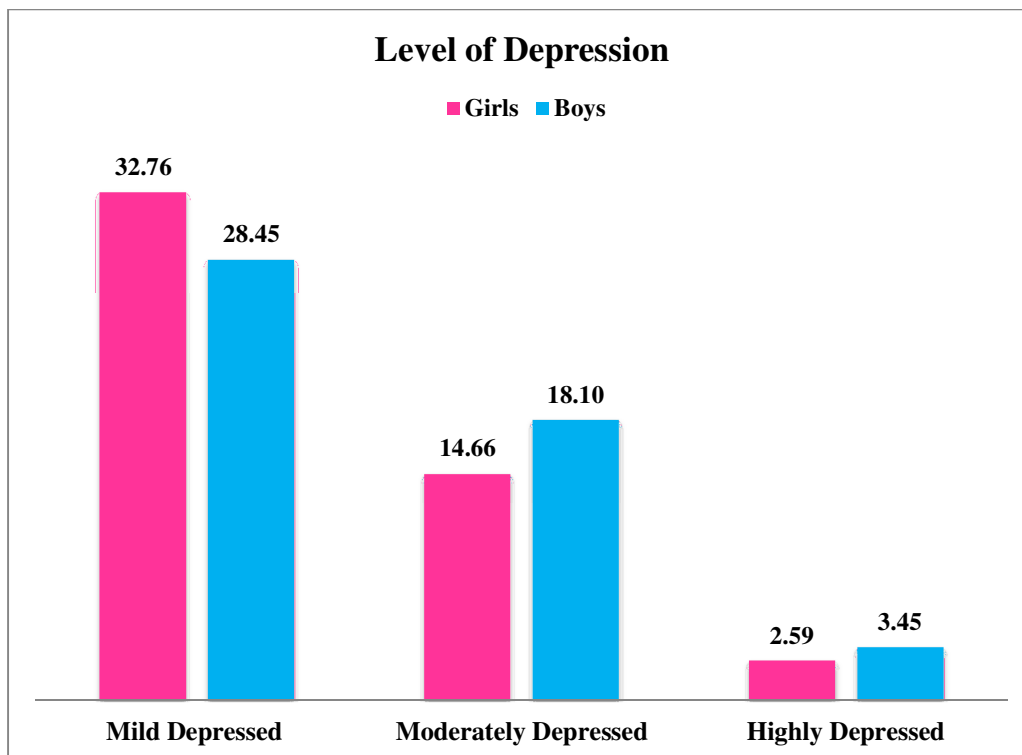


Fig: 4.49. Distribution of respondents on the basis of level of depression

4.11.3 Awareness of the respondents regarding postural disorders due to smartphone

On the basis of ranking by respondents weighted mean was calculated and ranking was given to statements having higher weighted mean to lower (Table 4.39). It was concluded that both girls and boys gave first rank to the statement “they experience problem in gripping of any object due to pain in fingers” whereas the statement “they experience pain and irritation in the base of the thumb after long usage of smartphone” was ranked second by both the respondents whereas girls and boys both give third rank to “they fully exhausted at night time and unable to have a sound sleep just because of smartphone use” and “they experience joint pain in fingers and wrist due to excessive smartphone use” got fourth rank and “I experience pain and discomfort but still I cannot reduce my usage time of smartphone” got the fifth rank.

While in case of boys second rank was given to the statement “experiencing pain and irritation in the base of the thumb after long usage of smartphone”; forth rank to “experiencing joint pain in fingers and wrist due to excessive smartphone use.” and the statement “experiencing pain and discomfort but unable to reduce usage time of smartphone” was ranked fifth. Hence, it clearly shows that there is some difference in reason among girls and boys they both are aware about the symptoms but not exactly the postural disorders that affecting their body.

The respondents were experiencing the symptoms of De Quervain's tenosynovitis. It is a chronic overuse syndrome of the wrist and hand and a common cumulative movement disorder (**Moore, 1997**). Gripping and grasping, moving the wrist in radial and ulnar direction, repetitive or unaccustomed use of the thumb thickened the fibrous tendon sheath due to which inflammation and stenosis of the tendon sheath occur. The causes of De Quervain's tenosynovitis in students are overuse of the thumb as in: in writing, short messaging service (SMS, typing, computer users, unnecessary grasping and pinching of objects over a prolonged time. (**Taufiq *et al.*, 2015**)

Table 4.48: Distribution of respondents on the basis of awareness regarding postural and psychological disorders due to smartphone use

(n=116)

S.no.	Statements		Never	Occasionally	Sometimes	Often	Always	Weighted Mean	Rank
1.	I limit my smartphone use accordingly if I have planned something for the day.	Girls	1 (1.72)	5 (8.62)	8 (13.79)	17 (29.31)	27 (46.55)	4.10	4 (G)
		Boys	5 (8.62)	13 (22.41)	11(18.97)	14 (24.14)	15 (25.86)	3.36	
2.	I experience strain on my backbone while looking in forward position in smartphone.	Girls	0 (0.00)	10 (17.24)	9 (15.52)	23 (39.66)	16 (27.59)	3.78	
		Boys	0 (0.00)	7 (12.07)	21(36.21)	16 (27.59)	14 (24.14)	3.64	
3.	I do not bend my backbone for smartphone use.	Girls	16 (27.59)	10 (17.24)	14 (24.14)	15 (25.86)	3 (5.17)	2.64	
		Boys	10 (17.24)	19(32.76)	18 (31.03)	10 (17.24)	1 (1.72)	2.53	
4.	I adjust my body posture according to my smartphone.	Girls	16 (27.59)	10 (17.24)	14 (24.14)	15 (25.86)	3 (5.17)	2.64	
		Boys	15 (25.86)	12 (20.69)	16 (27.59)	7 (12.07)	8 (13.79)	2.67	
5.	I keep my smartphone at proper eye level.	Girls	8 (13.79)	14 (24.14)	22 (37.93)	9 (15.52)	5 (8.62)	2.81	
		Boys	5 (8.62)	6(10.34)	13 (22.41)	13 (22.41)	21(36.21)	3.67	
6.	I experience stiffness or pain in neck area after continuous use of smartphone for more than one hour.	Girls	3 (5.17)	12 (20.69)	18 (31.03)	13 (22.41)	12 (20.69)	3.33	
		Boys	3 (5.17)	7 (12.07)	15 (25.86)	18 (31.03)	15 (25.86)	3.60	
7.	I try to engage myself in sports and creative work instead of smartphone.	Girls	2 (3.45)	6 (10.34)	15 (25.86)	20 (34.48)	15 (25.86)	3.69	
		Boys	6 (10.34)	11(18.97)	16 (27.59)	15 (25.86)	10 (17.24)	3.21	
8.	I feel cramping or tingling of muscles and nerves of the shoulder.	Girls	2 (3.45)	11 (18.97)	13 (22.41)	18 (31.03)	14 (24.14)	3.53	
		Boys	1 (1.72)	6 (10.34)	19 (32.76)	11 (18.97)	21(36.21)	3.78	
9.	I experience pain and irritation in the base of the thumb after long usage of smartphone.	Girls	1 (1.72)	4 (6.90)	14 (24.14)	12 (20.69)	27 (46.55)	4.03	5 (G)
		Boys	2 (3.45)	3 (5.17)	11 (18.97)	15 (25.86)	27 (46.55)	4.07	2 (B)
10.	I experience problem in gripping of any object due to pain in my fingers.	Girls	0 (0.00)	1 (1.72)	3 (5.17)	9 (15.52)	45 (77.59)	4.69	1 (G)
		Boys	2(3.45)	5 (8.62)	4 (6.90)	7 (12.07)	40(68.97)	4.34	1 (B)
11.	I spend my holiday with my friends instead of being busy on smartphone.	Girls	3 (5.17)	4 (6.90)	11 (18.97)	24 (41.38)	16 (27.59)	3.79	
		Boys	6(10.34)	11 (18.97)	11 (18.97)	9 (15.52)	21(36.21)	3.48	

12.	I feel headache after using smartphone for prolonged time.	Girls	4 (6.90)	7 (12.07)	18 (31.03)	14 (24.14)	15 (25.86)	3.50	
		Boys	2 (3.45)	6 (10.34)	18 (31.03)	13 (22.41)	19 (32.76)	3.71	
13.	I feel pain in neck and shoulders which increases in night hours.	Girls	3 (5.17)	3 (5.17)	15 (25.86)	20 (34.48)	17 (29.31)	3.78	
		Boys	4(6.90)	4 (6.90)	12 (20.69)	15 (25.86)	23 (39.66)	3.84	
14.	I get fully exhausted at night time and unable to have a sound sleep just because of smartphone use.	Girls	2 (3.45)	1 (1.72)	16 (27.59)	8 (13.79)	31(53.45)	4.12	3 (G)
		Boys	2 (3.45)	1 (1.72)	15 (25.86)	15 (25.86)	25 (43.10)	4.03	3 (B)
15.	I prefer to use smartphone in daytime.	Girls	6 (10.34)	12 (20.69)	24 (41.38)	15 (25.86)	1 (1.72)	2.88	
		Boys	7 (12.07)	16(27.59)	22(37.93)	9 (15.52)	4 (6.90)	2.78	
16.	I use one hand for chatting/gaming in my smartphone.	Girls	20 (34.48)	4 (6.90)	12 (20.69)	7 (12.07)	15 (25.86)	2.88	
		Boys	3(5.17)	6 (10.34)	12 (20.69)	20(34.48)	17 (29.31)	3.72	
17.	I experience joint pain in my fingers and wrist due to excessive smartphone use.	Girls	2 (3.45)	4 (6.90)	9 (15.52)	11 (18.97)	32 (55.17)	4.16	2 (G)
		Boys	3 (5.17)	1 (1.72)	14 (24.14)	18 (31.03)	22 (37.93)	3.95	4 (B)
18.	I do not realize any kind of pain and discomfort in hand and arms due to smartphone use.	Girls	14 (24.14)	14 (24.14)	10 (17.24)	5 (8.62)	15 (25.86)	2.88	
		Boys	16 (27.59)	17(29.31)	6 (10.34)	11 (18.97)	8 (13.79)	2.62	
19.	I experience pain and discomfort but still I cannot reduce my usage time of smartphone.	Girls	5 (8.62)	5 (8.62)	11 (18.97)	15 (25.86)	22 (37.93)	3.76	
		Boys	2(3.45)	4 (6.90)	18 (31.03)	8(13.79)	26 (44.83)	3.90	5 (B)
20.	I use smartphone only 1-2 hours/day so that I can stay away from any type of problems and discomforts related to this.	Girls	11 (18.97)	11 (18.97)	12 (20.69)	8 (13.79)	16 (27.59)	3.12	
		Boys	11 (18.97)	10 (17.24)	20 (34.48)	10 (17.24)	7(12.07)	2.86	
21.	I feel mild pain in my upper back due to hunching on smartphone.	Girls	4 (6.90)	6 (10.34)	15 (25.86)	12 (20.69)	21 (36.21)	3.69	
		Boys	4(6.90)	3 (5.17)	13 (22.41)	21 (36.21)	17(29.31)	3.76	
22.	I use both hand for chatting/gaming in my smartphone.	Girls	6 (10.34)	8 (13.79)	8 (13.79)	7 (12.07)	29 (50.00)	3.78	
		Boys	7 (12.07)	9(15.52)	11 (18.97)	11 (18.97)	20 (34.48)	3.48	

*percentage is given in parenthesis, B=Boys, G=Girls

Table 4.49: Distribution of respondents on the basis of Awareness regarding postural and psychological disorders due to smartphone (n=116)

S.no.	Level of Awareness	Scores	Girls (n ₁ =58)	Boys (n ₂ =58)	Total
1.	Aware	80-110	28 (48.27)	24 (41.37)	52 (44.82)
2.	Partially Aware	51-79	30 (51.72)	34 (58.26)	64 (55.17)
3.	Not Aware	22-50	-	-	-

According to the data presented in the table 4.48 indicates majority of girls (51.72%) and boys (58.26%) were partially aware and rest 48.27 percent girls and 41.37 percent boys were aware about the discomforts due to smartphone but not about the postural and psychological disorders so it was found necessary to aware them for the various problems raising due to excessive smartphone use. Although many social media working towards spreading awareness regarding this issue but usually it was found that they do not leave any impact therefore need was felt to organise a intervention program for respondents to impart knowledge about the health hazards of excessive use of smartphones. In a study conducted by **Niaz (2008)** also reported that it is need of the hour to spread awareness about the hazards caused by excessive mobile usage as it has become a public health issue. At present, we could realize that an awareness program organized on smartphone related health problems on behalf of health authority of governmental or statutory body or private organization is rare, across the globe. Hence, it is the time for all health organizations of nations across a globe to initiate and implement preventive and curative interventions to control the rising global threat.

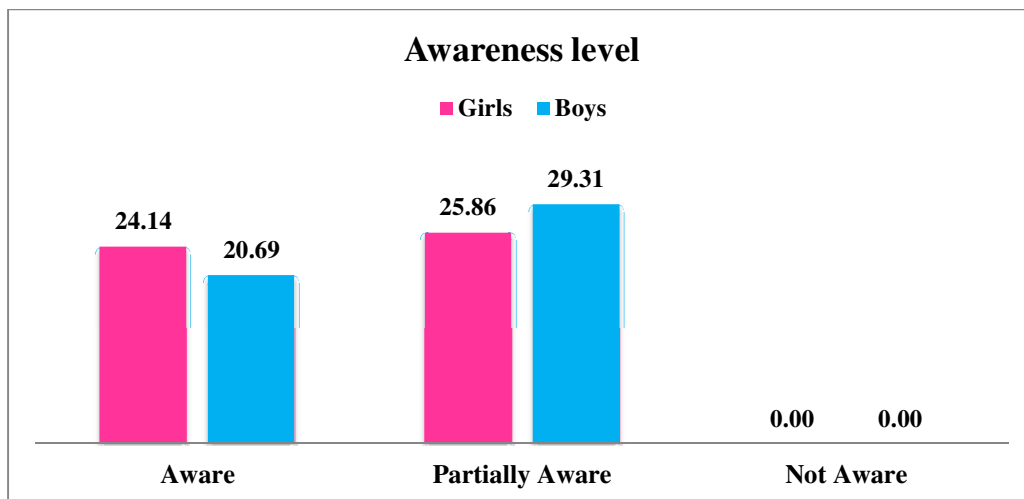


Fig: 4.50. Distribution of respondents on the basis of level of Awareness

4.17 Testing of Hypotheses:

H₀1: There is no significant effect of:

- i. Age on Addiction and Depression level
- ii. Settlement type on the Smartphone Addiction and Depression level

Table 4.50: Effect of Age, Settlement Types on Addiction level and Depression level

S.No.	Variables	Chi-square values	Result
i.	Age on Addiction level	$\chi^2 = 8.446575$	Significant
ii.	Age on Depression level	$\chi^2 = 2.582309$	Non-Significant
iii.	Settlement Types on Smartphone Addiction level	$\chi^2 = 1.421089$	Non-Significant
iv.	Settlement type on Depression level	$\chi^2 = 1.029684$	Non-Significant

Table 4.50 shows the effect of Age, Settlement Types on Addiction level and Depression level and the Chi-square values ($\chi^2 = 8.446575$) indicate that there was a significant effect of respondents age on smartphone Addiction level at $p < 0.05$ level of significance. It can be interpreted that age was affecting factor for addiction the younger respondents had more addictive symptoms than other respondents.

The Chi-square values ($\chi^2 = 2.582309$) indicated that there was a no significant effect of respondent's age on Depression level. It can be interpreted that respondents of each age group experienced depression symptoms at some point due to smartphone usage.

The Chi-square values 1.421089 and 1.029684 shows no significant effect of settlement type on addiction level and depression level. It can be determined that addiction and depression was not affected by settlement type of the respondents. It can be concluded that only age influenced the addiction level of the respondents.

H₀2: There is no significant relationship between Smartphone Addiction and Depression level of girls and boys

Table 4.51 represents the significant relationship between Smartphone Addiction level between Girls and Boys having chi square value $\chi^2 = 6.775662$ at 5% level of significance. In Depression level between Girls and Boys there was not

significant relationship having chi square value 0.9160225 but there was significant relationship between Smartphone Addiction and Depression in the respondents. The chi square was $\chi^2 = 3.799981$ significant at 5% level of significance. The significant value showed that as the addiction increases the depression also increases in the respondents.

Table 4.51: Relationship between Smartphone Addiction and depression level between Girls and Boys

S.No.	Variable	Chi-square values	Result
i.	Smartphone Addiction level between Girls and Boys	$\chi^2 = 6.775662$	Significant
ii.	Depression level between Girls and Boys	$\chi^2 = 0.9160225$	Non-Significant
iii.	Smartphone Addiction and Depression	$\chi^2 = 3.799981$	Significant

*Significant at 5% level of significance

H₀3: There is no significant effect of

- i. Age on visual fatigue
- ii. Addition level on visual fatigue
- iii. Smartphone usage hours on visual fatigue

Table 4.52: Effect of Age, Addition level, Smartphone usage hours on Visual Fatigue

S.No.	Variables	Chi-square values	Result
i.	Age on visual fatigue	$\chi^2 = 4.229270$	Significant
ii.	Addition level on visual fatigue	$\chi^2 = 7.028204$	Significant
iii.	Smartphone usage hours on visual fatigue	$\chi^2 = 6.588203$	Significant

*Significant at 5% level of significance

The result indicated that the Visual Fatigue was significantly affected by age ($\chi^2 = 4.229270$), Addition level ($\chi^2 = 7.028204$) and Smartphone usage hours ($\chi^2 = 6.588203$) at 5% level of significance. Therefore, the study proved that age of the

respondents, smartphone addiction, and longer usage of smartphone leads to visual fatigue.

H₀4: There is no significant difference in before and after use grip strength of girls and boys.

H₀5: There is no significant difference in before and after use pinch strength of girls and boys.

Table 4.53: Paired t-test for the pinch and grip strength before and after use smartphone

		Before	After	t value	p value
		Mean±SD	Mean±SD		
Grip strength	Girls	18.88± 4.01	18.82 ±4.79	0.25189	0.5958 ^{NS}
	Boys	31.4± 4.86	30.2±5.17	0.15917	0.561 ^{NS}
Pinch strength	Girls	4.27 ±0.74	3.94±0.85	0.99883	0.8244 ^{NS}
	Boys	6.20 ±1.03	5.61±1.27	0.97337	0.8186 ^{NS}

^{NS} denotes Non-Significant at 5% level of significance

It was found from the results of paired t-test that in girls the average grip strength of before and after were 18.88 and 18.82 kg with standard deviation of 4.01 and 4.79 respectively. The t value was 0.25189 and the p value was 0.5958. The calculated p value of girls (0.5958) and boys (0.561) was greater than 0.05; this indicates to accept the null hypothesis. Therefore it can be said that there was no significant difference in before and after grip strength of the girls. When we come to the boys, the average grip strength of before and after were 31.4± 4.86 and 30.2±5.17 respectively. The t value was 0.15917 and the p value was 0.561. The calculated p value was greater than the 0.05; this indicates the acceptance of null hypothesis. Therefore it can be said that there was no significant difference in before and after grip strength of the boys. **Dakoria and Khuman (2017)** also compared and found no statistical significant difference in the grip strength of Smartphone used and non-used hand having p value 0.941 and 0.604 (p>0.05).

The results of paired t-test (Table 4.53) showed the average pinch force of girls before and after was 4.27 ± 0.74 and 3.94 ± 0.85 respectively. The calculated t value was 0.99883 and the p value was 0.8244 and the average pinch force of boys before and after was and 6.20 ± 1.03 respectively. The calculated t value was 0.97337 and the p value was 0.8186. Since, the calculated p value was more than 0.05; this revealed that the null hypothesis was true. Therefore it can be conclude that there was no significant difference between before and after pinch strength of boys.

H₀₆: There is no significant effect of green light before and after use of smartphone in girls and boys.

Table 4.54: Effect of CFF value before and after use of smartphone in girls in green light source n=8

S.No.		Green light		
		CFF threshold (Hz)	t-value	p value
1.	Before	38.77 ± 2.61	2.2213	0.9691 ^{NS}
2.	After	35.97 ± 1.92		

^{NS} denotes Non significant at 5% level

Table 4.54 reported the result of comparison of CFFFR value of boys before and after 30 minutes in green light source. Mean value of both eyes before and after was 36.85 ± 2.68 and 35.67 ± 2.08 respectively. It showed that the CFF threshold value of before was slightly higher than the after case. The t value (0.99751) showed the significant difference between the CFFFR value of before and after case in boys. As the calculated p value was greater than 0.05; this provides evidence to accept the null hypothesis of equal means. Therefore it can be said that there was no significant effect of green light source before and after in girls using smartphone for 30 minute continuously.

Table 4.55: Effect of CFF value before and after use of smartphone in boys in green light source n=8

S.No.		Green light		
		CFF threshold (Hz)	t-value	p value
1.	Before	36.85 ± 2.68	0.99751	0.8241 ^{NS}
2.	After	35.67 ± 2.08		

^{NS} denotes Non significant at 5% level

Data showed in Table 4.55 reported the result of comparison of CFFFR value of boys before and after 30 minutes in green light source. Mean value of both eyes before and after was 36.85 ± 2.68 and 35.67 ± 2.08 respectively. It showed that the CFF threshold value of before was slightly higher than the after case. The t value (0.99751) showed the significant difference between the CFF value of before and after case in boys. Since, the calculated p value was greater than 0.05; this provides evidence to accept the null hypothesis of equal means. Therefore it can be said that there was no significant effect of green light source before and after in boys using smartphone for 30 minute continuously.

H₀7: There is no significant effect of red light before and after use of smartphone in girls and boys.

Table 4.56: Effect of CFF value before and after use of smartphone in girls in red light source n=8

S.No.		Red light		
		CFF threshold (Hz)	t-value	p value
1.	Before	38.42 ± 2.41	-1.0366, P<.05	0.1672 ^{NS}
2.	After	37.03 ± 2.28		

^{NS} denotes Non significant at 5% level

Data showed in the table 4.56 reported the result of comparison of CFF value of before and after of the respondents in red light source. Mean value of the before and after was 38.42 ± 2.41 and 37.03 ± 2.28 respectively. It showed that the CFF threshold value was slightly decreased after smartphone use. The decrease in critical flicker fusion frequency means that the brain is less active. The critical flicker fusion threshold (CFFT) is often used as a measure of the current state of the central nervous system of an individual. Therefore, decrease in frequency threshold shows marked fatigue in the individual (**Gangopadhyay et al., 2013**). The t value (-1.0366) showed the non-significant difference between the CFF value of boys in before and after case while using smartphone for 30 minute continuously.

Table 4.57: Effect of CFF value before and after use of smartphone in boys in red light source n*=8

S.No.		Red light		
		CFF threshold (Hz)	t-value	p value
1.	Before	37.44±3.17	0.13037	0.55 ^{NS}
2.	After	37.65±2.54		

^{NS} denotes Non significant at 5% level

Data showed in the Table 4.57 reported the result of comparison of CFFFR value of before and after of the respondents in red light source. Mean value of the before and after was 37.44±3.17 and 37.65±2.54 respectively. It showed that the CFF threshold value of before was slightly higher than after. The t value (0.13037) showed the non-significant difference between the CFFFR value of before and after of the respondents in red light source. Since, the calculated p value was greater than 0.05; this provides evidence to accept the null hypothesis of equal means. Therefore it can be said that there was no significant effect of red light source before and after in boys using smartphone for 30 minute continuously.

It can be concluded that smartphone use for 30 minutes cannot affect the CFF threshold value; the reason may be the short duration of experiment. The result of the present study is opposite with the study conducted by **Endukuru et al. (2015)** to examined the video games effect on Critical flickering fusion frequency rate. The findings of the study showed that CFFFR threshold increases significantly in media players when compared to non-media players (p<0.001).

H₀8: There is no significant difference in neck flexion angle of girls and boys in different duration

Table 4.58: One way ANOVA for neck flexion angle of girl in different duration

Source	df	SS	MS	F value	P value
Treat	3	1214.211	404.7370	25.50847	5.503565**
Error	28	444.2695	15.86677		
Total	31	1658.480			

**Significant at 1% level of significance

It is clear from the above table 4.58 that the flexion when using smartphone for 0, 10, 20 and 30 minutes. The p value 5.503565 at 1% level of significance shows that there is difference in girl's neck flexion while using smartphone in continuous time duration. The increasing neck flexion with time increases the load on neck muscle and leads to muscle fatigue. In addition, **Viljanen et al. (2003)** revealed that smartphone overuse places the head in an unvarying posture and that continuous muscle contraction then brings about muscle weakness and fatigue that could easily develop into chronic cervical pain. **Kim and Koo (2016)** studied the effect of duration of smartphone use on neck and shoulder muscle fatigue and pain in adults with forward head posture in which respondents showed significant differences in VAS scores after the experiment, and there was also a significant difference between the 10-minute and 30-minute groups ($p < 0.05$).

Table 4.59: One way ANOVA for neck flexion angle of boy in different duration

Source	df	SS	MS	F value	P value
Treat	3	2159.109	719.7031	17.88411	8.764818**
Error	28	1126.793	40.2426		
Total	31	3285.902			

**Significant at 1% level of significance

Table 4.59 depicted that the neck flexion of boys when using smartphone for continuous 30 minutes. The p value 8.764818 at 1% level of significance shows that there is difference in their neck flexion while using smartphone in continuous long duration. The increasing neck flexion with time increases the load on neck muscle and leads to muscle fatigue and chronic neck pain. In a study by **Park et al. (2013)** found that participants who used a smartphone for 20 minutes showed median fatigue frequency decrements both the upper trapezius and cervical erector spinae muscles, and also reported more load on the right shoulder than the left because the right shoulder was used more often.

4.15 Intervention

The two days sensitization program was conducted for the respondents who were assessed for not having the awareness regarding postural and psychological

disorders affecting the human body due to excessive smartphone usage with the help of developed sensitization presentation. According to the need of the smartphone users sensitization program was prepared. Relevant information with the adequate pictures was inserted for making easy to understand to the students. Information was developed in the form of booklet. Content validity was tested by judges from different fields. The content validity was done mainly on the visual quality, vocabulary, clarity, authenticity, continuity and organization. A through discussion with respondents helped to gain an insight into the problems faced by them. The preventive measures were presented according to their needs to create awareness among them. This was helpful for reducing postural and psychological disorders affecting the human body due to excessive smartphone usage. Besides, the recommendations some stretching routines were also introduced for daily basis to reduce the MSDs taking place day to day. With the help of this program the awareness level was increased and the respondents were also involved with a positive attitude and get the information to follow in their daily to get rid of different problems that leads to permanent disorders if left untreated.

Table 4.60: Feedback of sensitization program on the basis of ranking given by the respondents

S.No.	Criteria	Score	f (%)	Weighted mean	Rank
1.	Content	1-3	-	2.87	IV
		4-6	8(13.33)		
		7-10	52 (86.66)		
2.	Gain in knowledge	1-3	-	2.88	III
		4-6	7 (11.66)		
		7-10	53 (88.33)		
3.	Interaction with facilitators	1-3	-	2.97	II
		4-6	2 (3.33)		
		7-10	58 (96.66)		
4.	Stretching session	1-3	-	2.75	V
		4-6	15 (25.0)		
		7-10	45 (75.0)		
5.	Overall Session	1-3	-	3.00	I
		4-6	-		
		7-10	60 (100)		

The feedback of sensitization program was also taken from the respondents on the basis of five criteria. Further rank was given after calculating weighted mean and it was found that overall session got first rank as every respondents found it very useful that enhanced there awareness level and give knowledge for vigilant usage of smartphone.



Plate 4: Day 1 Sensitization Program

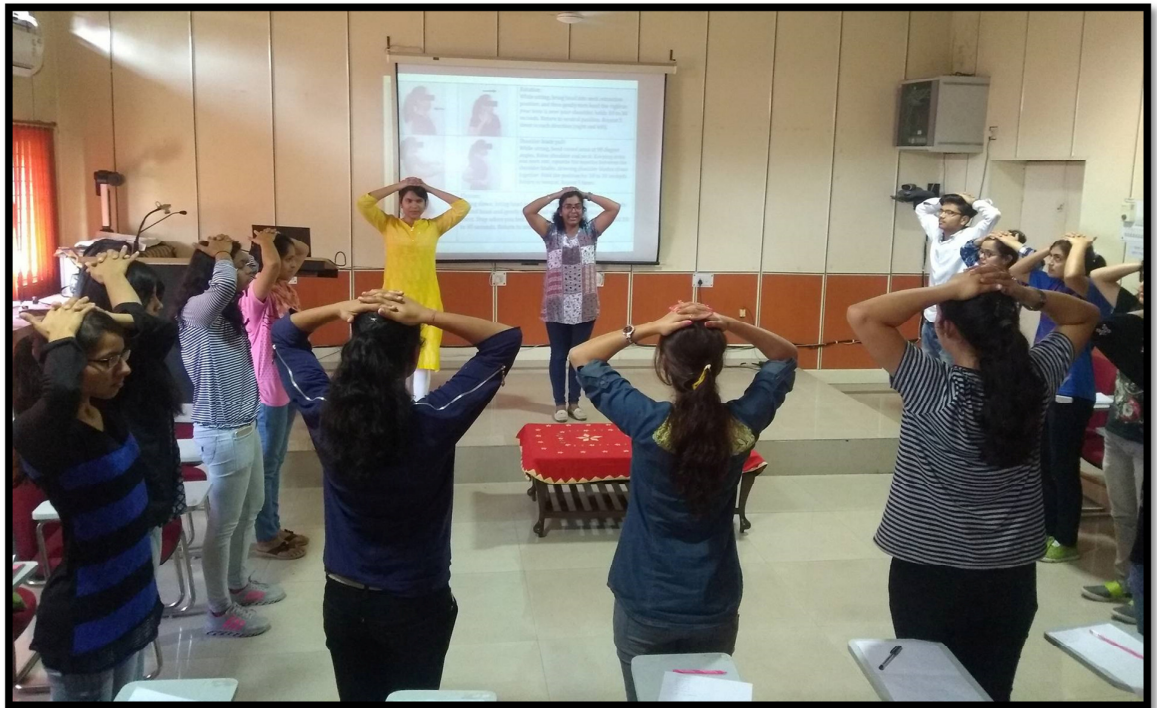


Plate 5: Day 2 Sensitization Program



*Summary
and
Conclusions*



Nowadays, Smartphones are increasingly becoming an integral part of our lives because of many features such as phone calls, text messaging, camera, internet and many more. As India is the second most populous country in the world having 340 million smartphone users in 2017 that is more than the smartphone users of U.S. (**Acc. to Statista.com, 2017**). With the greater availability and many exclusive features of smartphone, its use is excessively increased among adolescents and young adults leading to many psychological problems and postural problem. As per India’s Census 2011, Youth (15-24 years) in India constitutes one-fifth (19.1%) of India’s total population. According to **Bianchi and Phillips (2005)**, younger people are more likely to spend an excessive amount of time on their mobile phones than older people which makes them more vulnerable to mobile phone-related problems. Nielsen informed mobile insights also reported that half of the smartphone users i.e. 48 percent are younger than 25 years in India means a majority of smartphone users comes under the 18-24 years of age group.

Smartphone is one the most popular communication devices in this modern world. Nowadays, it is kind of a device which has almost every advanced features and connectivity options similar to the traditional computer. These features enable new kinds of mobile services that in turn shape the usage habits of smartphone users (**Alfawareh and Jusoh, 2014**). University students are among the highest contributors to the increasing number of smartphone sales. The factor that most influences the increase in smartphone usage is the functionality that helps users in their daily life especially business people and university students (**Jacob and Isaac, 2008**).

Smart phones are used frequently in daily life, and affect users both physically and psychologically. Longer duration of smart phone usage causes continuous mechanical stress on the muscles and tendons, which can produce musculoskeletal symptoms as pain in the neck and shoulders due to increased stress caused by a continuously forward neck posture. Most of the time this kind of problems is not taken as a serious problem. It is simply becoming a habit of the user and is ignored. The

dependence of smartphone is increasing day by day and creating alarming situation especially for the college going students. As smartphone seeks excessive attention by the college students for their desire of finding new information or different current agendas, the excessive use of it can not only damage interpersonal skills but also it can lead to negative health risks and harmful psychological effects.

However, with all the advantages we gain from mobile technology comes the risk of serious and permanent health problems. There are various health problems that are arising due to excess use of smartphone some problems are psychological and some are postural however all these problems are related to risk of our human body.

As it is nearly impossible to avoid the technologies and current practice of students exposes them to prolonged poor postures with smartphone use which leads to various musculoskeletal problems. Proper ergonomic interventions can reduce the incidence of smartphone related health problems. Therefore, it is very important to identify the smartphone usage and the postures of the students so that the Musculoskeletal Disorder and its consequences can be controlled before it becomes an obsession. Thus, the present study was designed to evaluate the current practice of smartphone usage and the postural and psychological problems arising from it. Hence, considering the above facts in the mind, the investigation entitled **“PSYCHOLOGICAL ASSESSMENT AND POSTURAL ANALYSIS OF SMARTPHONE USERS”** was an attempt to find out the prevalence of health problems and also analyze the posture of the smartphone users. Therefore, the present study was conducted with the following objectives:

OBJECTIVES

1. To find out the practices, usage pattern and standard of living of Smartphone users.
2. To analyse the posture and Musculoskeletal discomforts while using Smartphone.
3. To assess the psychological problems among youth due to excessive use of Smartphone.
4. To study the visual fatigue of selected Smartphone users.
5. Ergonomic intervention for creating the awareness among youth for the vigilant use of Smartphone.

Hypotheses

H₀1: There is no significant effect of

- i. Age on Addiction and Depression level
- ii. Settlement type on the Smartphone Addiction and Depression level

H₀2: There is no significant relationship between Smartphone Addiction and Depression level of girls and boys

H₀3: There is no significant effect of

- i. Age on Visual Fatigue
- ii. Addiction level on Visual fatigue
- iii. Smartphone usage hours on visual fatigue

H₀4: There is no significant difference in before and after use grip strength of girls and boys.

H₀5: There is no significant difference in before and after use pinch strength of girls and boys.

H₀6: There is no significant effect of green light before and after use of smartphone in the girls and boys.

H₀7: There is no significant effect of red light before and after use of smartphone in the girls and boys.

H₀8: There is no significant difference of posture on neck flexion angle of girls and boys in different durations.

ASSUMPTION

The present study was undertaken with following assumptions:

- The students are suffering from musculoskeletal problems because of excessive use of smartphone.
- The users were adopting unnatural posture while using smartphone which was affecting their health.

Focus of the study

1. The study focused on the students of G.B. Pant University of Agriculture and Technology, Pantnagar.
2. Only 5% sample from the total population was focused for the present study.
3. The study focused on the students in the age group of 18 to 24 years only.

METHODS AND MATERIAL

The research methodology of the present study was planned keeping in view to scope of the study and time constraints. This section provides the detailed description of the procedure adopted for conducting the study. In order to achieve the objectives of the study descriptive cum experimental design was used.

Selection of locale and sample size

The present study was carried out in G.B. Pant University, Pantnagar Uttarakhand. Random sampling technique was used to select the study area and sample. Total 230 (115 boys and 115 girls) samples were selected from the population and descriptive data was collected. Half of the respondents were taken for psychological assessment (58 girls and 58 boys). For anthropometry measurement 70 percent respondents were randomly selected including 80 girls and 80 boys and from this 50 percent were selected for postural analysis and 10 percent were selected for the experimental study.

Construction of tools

A pre-coded questionnaire was used as a tool to collect the data with respect to general and specific information of Smartphone users. A questionnaire was developed which consisted of five sections.

Preparation and formulation of Standard of Living Index, Smartphone addiction, Depression scale and Awareness scale with the validity and reliability. Both quantitative and qualitative data were collected from the selected respondents in different phases.

Phase I: Descriptive data

For descriptive data, questionnaire method was adopted to collect the data. The data collected from the smartphone users belonged to personal characteristics and the

standard of living and the acquisition and usage patterns. Assessment of musculoskeletal discomforts and visual fatigue was done by using self-reporting scale and respondents were asked to rank different body region and hand areas having discomfort.

Phase II: Experimental data

For the collection of experimental data, the parameters chosen were height, weight, eye height, shoulder height, critical flicker fusion frequency, neck flexion, grip strength, pinch force and hand measurements of the students

A small sample (8 girls and 8 boys) was selected for assessing the differences pre and post the experiment which included grip strength, pinch strength, CFF frequency, and neck flexion. The grip, pinch, and CFF were measured before and 30 minutes after the smartphone use but the difference in neck flexion was measured in different duration i.e. 0 min, 10 min, 20 min and 30 minutes.

Statistical analysis and interpretation of the data

Subjective statistics i.e. frequency, percentage, mean, standard deviation and descriptive statistics i.e. paired t test, ANOVA and chi-square test were used for analysis of data.

MAJOR FINDINGS OF THE STUDY

Demographic profile of the respondents

- The demographic profiles of the respondents indicated that majority of girls (40.86%) were in the age group of 21-22 years whereas maximum boys 80.86 percent were in the age group of 18-20 years. The majority of boys were younger than the girl respondents.
- As per the finding, Less than three quarters of girls were from college of Home science whereas nearly 60 percent boys were from College of Technology. Majority of the girls i.e. 65 percent girls and 97 percent of the boys were pursuing their graduation degree.
- The relationship status of the respondents was inquired which showed that majority of girls (97.39%) and boys (89.56%) were unmarried.

- When asked about family type, majority of respondents including girls (80%) and boys (62.6%) belonged to nuclear family and almost 20 percent girls and about 38 percent boys were belonged to joint family.
- In terms of religion, majority of girls (95.5%) and boys (91.3%) belonged to Hindu religion, very few percent of the respondents were from other religions.
- When inquired about settlement type majority of respondent including both girls (51.3%) and boys (42.6%) were from urban area.

Standard of living of the respondents

- The developed standard of living index with having high reliability ($r=0.93$) was used to assess the standard of living of the respondents. It was categorized into three categories, i.e. High, Medium and Low standard of living respectively.
- On the basis of classified categories, majority of the girls (59.13%) and boys (58.26%) belonged to the middle standard of living.

Acquisition, ownership and attitude of the smartphone users

- As per the findings, majority of girls (97.39%) and boys (88.69%) owned one smartphone and some of the respondents owned 2 smartphones. It was inferred from the data that majority of girls i.e. 78.26 percent and about 68 percent boys had 2 SIM cards.
- From the overall respondents including both girls and boys almost 90 percent were right handed. Majority of girls i.e. 64.34 percent and boys (60%) had been using smartphone for last 1-3 years.
- When it was asked about the payment of their first smartphone, about 89 percent girls and 94 percent boys reported that their parents paid for their first smartphone. With respect to purchase options, Maximum girls (80.8%) and boys (69.5%) preferred to buy smartphone from store.
- When inquired about the reasons of buying a Smartphone the respondents about 60 percent girls and 55.6 percent boys said that necessity was the very important reason for purchasing a smartphone.

- When asked about the Peer group Pressure most of the girls (46%) and boys (44.3%) said that peer group pressure is not an important reason for buying smartphone.
- As mobile phones provide a sense of Safety/Security for the users, it was found from the data that about half of the girls (52%) and about 35 percent boys felt that Safety/Security was very important reason for purchase of new smartphone. Girls were keener to use smartphone for security purpose than boys.
- The data revealed that majority girls (60.8%) and boys (60%) said emergency was very important reason for buying smartphone. Majority of girls i.e. 80 percent said it is a very important reason for buying smartphone. Whilst, half of the boys (50.43%) said it is an important way to connect with their family members.
- Likewise when inquired about Communication with friends, nearly half of the girls (49.5%) and 38.26 percent boys responded that it was very important reason while purchasing a smartphone. In case of convenience, findings revealed that 48.70 percent girls and 46.09 percent boys said very important for having smartphone.
- When it was enquired about the important factors of smartphone like availability, features, cost, battery backup, model and brand maximum respondents considered it very important factor while purchase of a smartphone.
- As per the outcomes, that memory/processing, camera, software features, screen resolution, design and build quality music player and ease of texting except screen size was the very important features that make smartphone very popular among people and they considered it while purchasing a smartphone.
- Attitude towards Smart phones as a personal media device was also enquired most of the respondents including girls (85.22%) and boys (89.57%) both considered smart phone as a personal property where very few were disagree with this.

- When respondents were asked about possessiveness about their Smartphone, more than half of the girls and boys showed their agreement for this sentiment. For privacy more than half of the girls i.e. 53.91 percent 56.52 percent boys whereas more than one quarter respondents showed their disagreement for this context, In addition, six out of ten girls and about third forth of boys also agreed that they lock smart phone with a security code so that no one can go through the contents of their smart phone.
- When enquired regarding Smart phone as a social technology, all the respondents were inclined towards the statements that presenting smartphone as a social technology and they agreed that they use their smartphone as everyone is having and it makes more easier way to communicate with friends and gives feeling of connectedness whereas majority of girls (43.48%) and 27.83 percent boys were disagreeing for maintaining relationship with a girlfriend/ boyfriend or other persons.

Usage pattern of the smartphone among respondents

When investigated about Smartphone usage pattern following results were found:

- About 34 percent girls and nearly half of the boys used their phone 2-4 hours whereas 23.48 percent girls used their device for more than 6 hours and 20 percent boys said they used their phone for 4- 6 hours.
- When enquired about the first instance of smartphone in a day, half of the respondents were including 54.78 percent girls and 47.82 percent boys answered that they check first their smartphone as soon as wake up.
- Most of the girls answered that they use their smartphone for couple of times a day whereas maximum boys i.e. 34.78 percent checked their smartphone every hour.
- When enquired about the location of smartphone while sleeping, majority of girls (68.69%) and boys (58.26%) keep their smartphone beside the bed followed by 26.08 percent girls and 23.48 percent boys keep their phone under the pillow.

- Majority of respondents said that they never took their smartphone to the bathroom whereas more than one quarter of girls (28.70%) and boys (30.43%) had taken it sometimes to the bathroom, few of them also considered for taking their smartphone in bathroom.
- The gender difference was found regarding the use of smartphone, about 40 percent girls use their Smartphone mostly for Social Networking, followed by 37.39 percent for texts and calls whereas maximum boys i.e. 38.26 percent use their Smartphone mostly for music and games.
- There was general agreement between respondents among both girls and boys 70.43 and 75.65 percent prefer communication through calling.
- When asked about the time spent on voice call per day, majority of respondents including girls (65.2%) and boys (73.9%) spent less than 1 hour on voice call.
- Likewise time spent on social networking sites, maximum girls i.e. 43.48 percent spent less than 1 hour whereas more than half of the boys (53.9%) spent 1 to 3 hours on Social Networking Sites.
- Almost half of the girl respondents preferred to use smartphone in leisure time whereas 6 out of 10 boys preferred to use smartphone at night. None of the respondents used smartphone during college time.
- When asked, more than half of the girls (52.1%) and boys (56.52) used their smartphone less than 1 hour during exams.
- When they were asked that Smartphone usage time has increased compared to the normal multimedia phone, most of the girls (85.21%) and boys (93.04%) were agreed for this. Majority of respondents also said that smartphone had made work very easy.
- Out of total respondents, three quarters stated that smartphone saved energy and time and for productivity enhancement most of girls (81.7%) and boys (80.8%) also agreed.
- The data also taken from the respondents regarding with whom they mostly communicated through smart phones, in this the maximum girls (70.43%) and boys (59.13%) preferred call for communicating to the parents.

- For siblings and cousins, more than half of the respondents including girls (54.7%) and boys (50.4%) preferred to text and call both whereas for relatives most of them preferred call for communication.
- When asked about friends, responses were varied between both most of the girls (66.9%) preferred text and call both while texting was more prevalent among the boys (53.9%).
- When asked about the mode of communication with special one, majority of girls (45.2%) and boys (37.3%) boys preferred text and call both. About 32.1 percent of boys said they preferred calling for communicating to the special person. It was observed that few respondents were not comfortable to disclose their personal matters.
- Finding revealed that majority of girls (39.1%) preferred text and call both whereas majority of boys (48.7%) preferred call to communicate with the person for other work.
- The data regarding frequency of communication through calling revealed that 64 percent girls and more than half of the boys communicated with parents once a day. Most of the respondents communicated with siblings and cousins, relatives and friends occasionally.
- When enquired about communication with special one, maximum boy 21.74 percent boys communicated more than twice a day whereas one quarter of girls talked to the special person once a day.
- Almost half of the respondents including girls (44.3%) and boys (50.4%) communicated to others occasionally through calling.
- Findings revealed that maximum girls (34.7%) and boys (46%) communicated to parents and Siblings/cousins through chatting less than one hour per day. Most of girls (36.5%) communicated to the relatives rarely whereas maximum boys (27.8%) communicated to the relatives occasionally through chatting.

- For communicating to friends, 32.1 percent girls communicated through calling 1 to 2 hours per day while most of the boys (41.7%) communicated friends through calling less than 1 hour per day.
- When enquired about communication to special person, girls (37.3%) said rarely while boys (35.6%) said they occasionally communicated to them through chatting. About 40 percent girls and 30.4 percent boys communicated to others through chatting.
- Major factors that affected the decision of making voice call were topic of conversation, nature of friendship and convenience to both of the respondents.
- When enquired about trend of downloading, it was found that girls mostly downloaded Music/Songs, Educational content, and featured apps than while boys mostly downloaded music/songs, videos and featured Apps via their Smartphone.
- The data depicts uploading trend of respondents, it was found that boys and girls both mostly uploaded pictures, videos and educational content than news and others via their smartphone.
- It was also found that both respondents including boys and girls used mostly WhatsApp, followed by Facebook and Hike messaging app mostly.
- Data pertaining to the information related to the usage of smartphone showed that majority of respondents used their Smartphone very frequently for making voice calls, chatting listening music, clicking pictures and web surfing.
- Gender variation was found in responses about playing games in which 44.3 percent boys said they used their phone very frequently while 33.04 percent girls used smartphone rarely for playing games.
- Respondents noticed pain/discomfort in different body parts while sitting in one posture for longer period, furthermore stress and fatigue were common psychological symptoms expressed by the respondents. Hearing problems were also faced by the some of the respondents due to loud volume and long conversations.

- Staying in touch through messaging app was the first preference by all the respondents.
- The frequency of discomfort experienced by respondents was also assessed in which 27.8 percent girls and 26 percent boys experienced Pain/discomfort sometimes at night. Nearly 32.1 percent girls and one quarter boys experienced Pain/discomfort sometimes during day time.
- Weakness and tingling sensations were rarely experienced by most of the respondents, however 2 out of 10 boys experienced numbness sometimes while about 15 percent girls experienced numbness rarely.
- Boys experienced numbness or tingling at night rarely whereas girls experienced it sometimes and girls (13.0%) also faced difficulty sometimes in grasping objects than boys (7.8%).

Assessment of Visual Problems in respondents due to Smartphone use

- A higher percentage of boys (52.1%) and girls (53.0%) faced visual problems due to Smartphone use out of which most of the respondents complained for strain on eyes, followed by watery eyes.
- It was also enquired that more than half of girls (61.74%) and boys (53.04%) did not used spectacles and other 38.26 percent girls and 46.96 percent boys used spectacles.
- The majority of respondents reported that they experienced visual discomfort sometimes when they continuously watched videos (39.1% girls and 40% boys) followed by constant chatting (40% girls and 31.3% boys).
- In context of continuous gaming on smartphone responses varied from girls to boys. Maximum girls (53.9%) experienced rarely any discomforts due to continuous gaming, however most of boys (35.6%) felt it sometimes to very frequently (20%).
- Most of the respondents including girls (46.0%) and boys (45.2%) reported the moderate level of visual fatigue, further 33 percent girls and 37.3 percent boys accounted for mild visual fatigue whereas accordingly 2 out of ten respondents reported for experiencing severe visual fatigue.

Identification of musculoskeletal symptoms experienced in different body parts by the respondents

- Majority is highlighted here regarding pain experienced by respondents, during last 1 month, 9.57 percent girls experienced in hand/wrists, 6.96 percent in elbows, 16.52 percent in shoulders/ neck, 19.13 percent in lower back and 20.87 percent experiencing pain in upper back.
- In boys, 10.43 percent experienced pain in hand/wrists, 5.22 percent in elbows, 22.61 percent in shoulders 13.04 percent in lower back and 20 percent in upper back experienced pain during last 24 hours.
- Findings revealed that frequency of pain experienced by the respondents increased in almost every body part, since the last one month to 24 hours of usage.
- Further, amongst the total surveyed respondents, 45.2 percent girls and 37.4 percent boys stated that they were not experiencing any kind of pain in any part of body.
- The incidence of pain has risen considerably since last 1 month to last 1 day for both girls and boys. The data also provides evidences that maximum boys experienced severe pain in neck and maximum girls experiencing severe pain in shoulders in last 24 hours that was the major point for concern.
- Majority of respondents experienced moderate pain in every body part in different durations and only elbow is the less affective area in respondents.
- Most participants reported slight pain in at least one part of right hand. Pain in the right hand was most common at the tip of the thumb (10% boys reporting slight pain and 12.1% girls reporting moderate pain) in last 24 hours.
- Majority of the girls and boys felt slight pain in their left hands during last 24 hours. It can be said that as the majority of respondents were right handed so the left hand was less affected than the right hand.
- More than half of the girls and boys said staying in touch was preferred reason for using messaging apps.

- Respondents noticed pain/discomfort in different body parts while sitting in one posture for longer period, furthermore stress and fatigue were common psychological symptoms expressed by the respondents. Hearing problems were also faced by the some of the respondents due to loud volume and long conversations.
- A higher percentage of boys (52.1%) and girls (53.0%) faced visual problems due to Smartphone use out of which most of the respondents (45.2% girls and 32.1% boys) complained for strain on eyes followed by (26% girls and 21.7% boys) watery eyes.
- Maximum girls (53.9%) experienced rarely any discomforts due to continuous gaming however most of boys (35.6%) felt it sometimes to very frequently (20%).
- The numerical rating of the respondents indicated that majority of the respondents including girls (46.0%) and boys (45.2%) reported the moderate level of visual fatigue whereas 2 out of ten respondents reported for experiencing severe visual fatigue.

4.10 Postural analysis of respondents

- The neck flexion of the respondents was measured by using inclinometer in sitting position at 3 different time duration i.e. 0 min., 10 min., 20 min. and 30 min. The findings clearly represented that increased usage time affected the neck flexion to the respondents in sitting posture.
- The respondents haunched their head on their smartphone up to 45 degrees that gives load on neck up to 49 lbs. which means when smartphone is used for longer period it gives the feeling of neck pain in respondents including shoulders and upper back that will lead to musculoskeletal disorders.

Pinch strength

- Analysis of the data revealed that in girls before smartphone use, the average lateral pinch force was 4.43 ± 1.27 whereas after using the smartphone the average lateral pinch force was 3.4 ± 1.30 . There was 1.03 kg decrease of pinch strength after using smartphone for half an hour.

- In boys, the average lateral pinch force was 6.2 ± 0.97 whereas after using the smartphone, the average lateral pinch force of left hand was 5.15 ± 1.43 before smartphone use.
- There was slight decrease in pinch strength of both the respondents after using smartphone for 30 minutes.

Grip Strength

- Analysis of the data revealed that there was 2.41 percent decrease in girls and 2.05 percent decrease in boys grip strength of right hand after using smartphone for 30 minutes.
- As the right hand was the dominant hand so the left hand was not showing grip change.

Critical flicker fusion

- The findings showed that there was slight decrease in fusion and flicker frequency in both eyes of the respondents that indicated the visual fatigue in the respondents due to smartphone use for longer period.

Assessment of psychological Problems in respondents due to Smartphone use

- A Smartphone Addiction scale was developed with high reliability ($r=0.97$) and used for assessing Smartphone addiction among respondents. Majority of respondents had low addiction towards smartphone. As per findings, it can be concluded that addiction is increasing in the young people gradually, as the majority of respondents under the low addiction level means they are not exhibiting the over addictive behaviour.
- A Depression scale was developed with high reliability ($r=0.95$) and used for assessing depression among respondents. Majority of respondents (61.2%) including girls and boys were under the mild depression level whereas 32.7 percent respondents had moderate depression and few respondents (6.0%) had high depression.

- As per the findings it may conclude that depression is increasing in the young people gradually, as the majority of respondents having the mild depression means they were having little depression due to smartphone use.
- A highly reliable Awareness scale with having r value 0.97 was used for assessment of awareness regarding health problems among the respondents and it was found that majority of respondents were partially aware, hence the need was felt to plan a sensitization program for spreading awareness regarding postural and psychological problems as well as some preventive measures.

Intervention

- Two days sensitization program was conducted according to the need of the smartphone users. The preventive measures were presented according to their needs to create awareness among them.
- It was helpful for reducing postural and psychological disorders affecting the human body due to excessive smartphone usage. Besides, the recommendations some stretching routines were also introduced on daily basis to reduce the MSDs taking place day to day.
- The feedback of sensitization program was also taken by participant and almost every participant find it useful and gain in their knowledge regarding smartphone overuse disorders.

Implications of the study

The finding of the investigation brought out a number of implications:

For smartphone users

- The study will help the users in maintaining the correct postures while using Smartphone.
- The users can understand the chronic health effects due to prolonged usage of smartphone.
- The preventive tips and measures given in the present study will be helpful to avoid the health problems among users.

For health professionals and consultants

- The finding of the study will be useful for them and they can integrate the sensitization sessions including the information related to postural and psychological problems which are arising due to Smartphone usage.
- The study will help to assess the prevalence of MSDs, Addiction and depression among students in this particular area.

For Manufacturers

- The study provides insight to the relationship between hand anthropometry and smartphone dimensions. Thus providing a better understanding of smartphone design related factors.
- The screen size of the Smartphone can be designed in this way so that it can be easily fit in the grip of the users.
- It would be interesting to see if these hand size variations have effect on the recently launched smartphone with bigger screens.
- The present study can be helpful for the manufacturers for designing the user friendly smartphone by keeping in mind the hand dimensions of the users.
- The manufactures can elaborate the detail and safety measures of smartphone in local language.

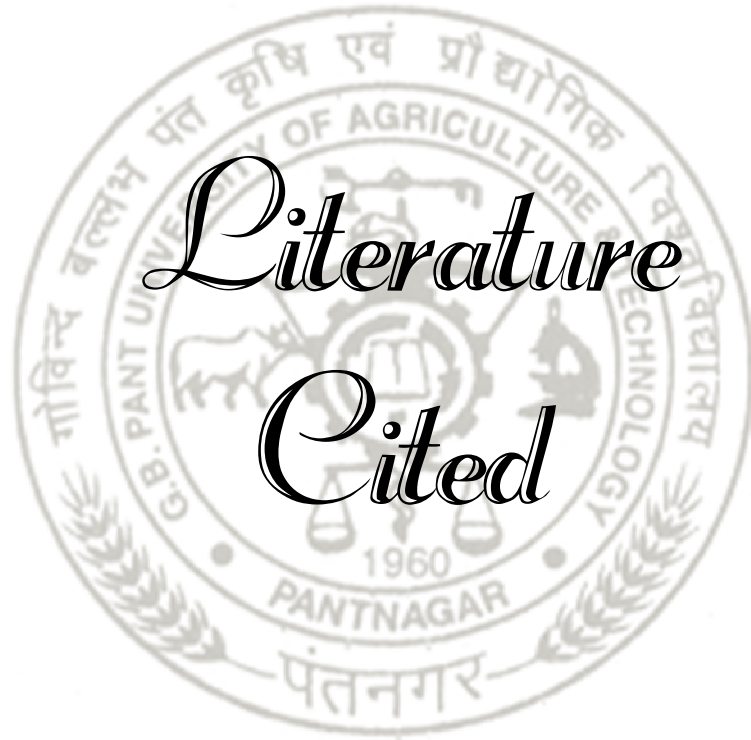
For government and policy makers

The government can make the possible standards for designing a suitable smartphone.

Recommendations of the study

1. Further study is necessary to determine the impact of postural problems and psychological problem to the other age groups like children, pregnant women and elderly.
2. The study focused on only two psychological problems the other aspects can also be measured with available tools.

3. Further study can be designed for detailed visual problem assessment due to smartphone usage.
4. Further study can be planned with large sample.
5. Additional laboratory experiments are recommended to get the detailed impact of smartphone on its users.
6. There is need to organize more sensitization program in different institutions for the awareness regarding these problems.
7. Further study is necessary to determine the reliability and efficacy of developed Smartphone scale, depression scale, Awareness scale and Standard of living index.



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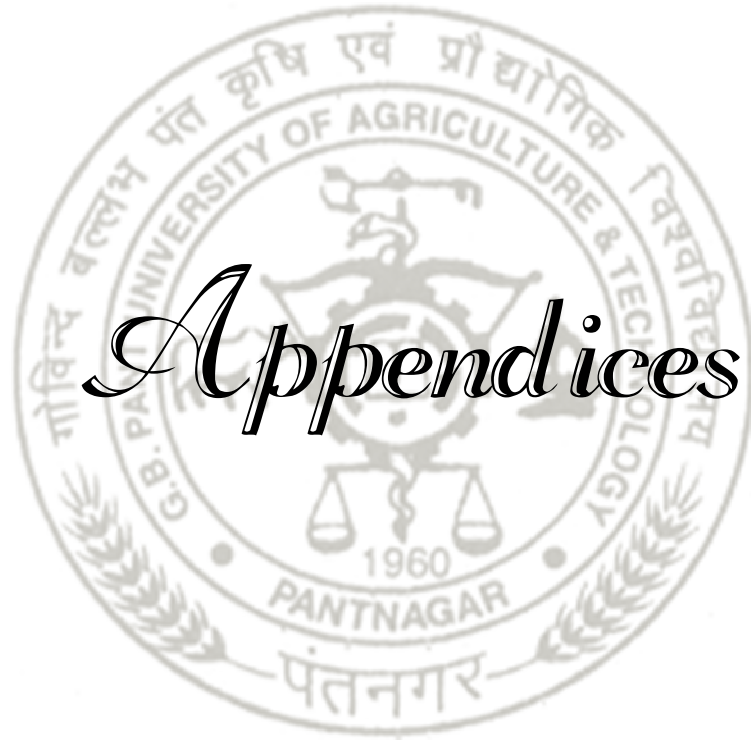
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Appendices



[PART – II]

Practices and Usage Pattern of Smartphones

A. Acquisition, Ownership & Attitude:

1. How many smart phones do you own at present? i. 1 ii. 2 iii. 3
2. How many SIM cards do you have now? i. 1 ii. 2 iii. 3 iv. 4
3. Brand & model no. of your Smartphone:
4. Width, length and thickness of smartphone:
5. Dominant hand:
6. How long you are using your smartphone (in months)?

7. Who paid for your first smart phone?

- a. Parents – father, mother c. Friend
- b. Self d. Sibling – brother, sister

8. You prefer to buy your smartphone from?

- i. Online ii. By store

9. What are the important reasons for buying a smart phone? (Tick just one answer for each)

S.No.	Items	very important	fairly important	important	not at all important
a.	Necessity				
b.	Peer group Pressure				
c.	Safety/Security				
d.	Emergency				
e.	Connect with family				
f.	Communicate with friends				
g.	Convenient				

10. How important were the following factors in buying a smart phone? (Tick just one answer for each)

S.No.	Items	very important	fairly important	Important	not at all important
a.	Availability				
b.	Brand				
c.	Model				
d.	Design and Build Quality				
e.	Features				
f.	Cost				
g.	Battery Backup				

11. How important are the following features in a smart phone? (Tick just one answer for each)

S.No.	Items	very important	fairly important	Important	not at all important
a.	Screen size				
b.	Software Features				
c.	Music player				
d.	Ease of texting				
e.	Camera				
f.	Availability				
g.	Design and Build Quality				
h.	Screen Resolution and Quality				
i.	Memory (RAM) And Processing Power				

B. Smart phones as a personal media device

S.No.	Items	Agree	Undecided	Disagree
a.	Do you think of smart phone as your personal property?			
b.	I am very possessive about my smart phone.			
c.	I am emotionally attached to my smart phone.			
d.	I do not like other people to go through the contents of my smart phone.			
e.	I lock my smart phone with a security code so that no one can go through the contents of my smart phone			

C. Smart phones as a social technology

S.No.	Items	Agree	Undecided	Disagree
a.	All of my friends have a smart phone.			
b.	Having a smart phone allows me to attract new friends.			
c.	Smart phones help me to create a positive impression on people from opposite sex.			
d.	I use my smart phone to co-ordinate plans with my friends.			
e.	I use my smart phone to socialize with my friends.			
f.	Smart phones help me to create friendships with people.			
h.	I use smart phone to maintain my relationship with a girlfriend/ boyfriend or other persons.			

Smartphone Usage Pattern

1. How many hours you use your smartphone per day

- a. Less than 2 hours
- b. 2-4 hours
- c. 4-6 hours
- d. More than 6 hours

2. You first check your phone-

- a. As soon as wake up
- b. During breakfast
- c. On the way to work
- d. When you get a message

3. How often do you check it?

- a. Every 5 minutes
- b. Every 30 minutes
- c. Every hour
- d. Couple of times a day

4. Where do you keep your Smartphone while you sleep?

- a. Under the pillow
- b. Beside the bed
- c. Other side of the room
- d. In another room

5. Do you take your phone with you to the bathroom?

- a. Usually
- b. Sometimes
- c. You've considered it.
- d. Never

6. What do you use it mostly for?

- a. Social Media Networking
- b. Emails
- c. Music and games
- d. Texts and calls

- e. Educational purpose

7. Which way you prefer for communication

- a. Message
- b. Call

8. How much time you spend on voice call

- a. Less than 1 hours
- b. 1- 2 hours
- c. 2-4 hours
- d. More than 4 hours

9. How much time you spend on Social Networking Site

- a. Less than 1 hours
- b. 1-3 hours
- c. 3-6 hours
- d. More than 6 hours

10. On which time you prefer to use your smartphone mostly

- a. Day time
 - i. early morning
 - i. Morning
 - ii. Afternoon
- b. Night time
 - i. Evening
 - ii. Late night
- c. Leisure time
- d. During college time

11. How much time you use your smartphone in exam days

- 1. Less than 1 hours
- 2. 1-2 hours
- 3. More than 2 hours

12. Did you think that your time of smartphone use is increased comparison to the normal multimedia phone

- i. Yes
- ii. No

13. Do you really think that smartphone make every work very easy

- i. Yes
- ii. No

14. Is smartphone saving your energy and time?

- i. Yes
- ii. No

15. Do you agree that smartphones increase productivity?

i. Yes

ii. No

16. How do you mostly communicate with your friends, family and other through smart phones? (Tick just one answer)

S.no.	Person	Text	Call	Text and call Both	None
1.	Parents				
2.	Siblings & cousins				
3.	Relatives				
4.	Friends				
5.	Special one				
6.	Others (work related)				

17. How frequently you communicate through calling with the following persons (Tick all that apply)

S.no	Persons	Daily			Occasionally	Rarely	Never
		Once a day	Twice a day	More than twice a day			
1.	Parents						
2.	Siblings & cousins						
3.	Relatives						
4.	Friends						
5.	Special one						
6.	Others (work related)						

18. How much time you spend on chatting with the following persons (Tick all that apply)

S.no	Persons	Daily				Occasionally	Rarely	Never
		less than 1 hour	1- 2 hours	2 -4 hours	More than 4 hours			
1.	Parents							
2.	Siblings & cousins							
3.	Relatives							
4.	Friends							
5.	Special one							
6.	Others (work related)							

19. Which of the following factors affect your decision to make a voice call? (Tick all that apply)

- a. Cost
- b. Nature of friendship (e.g. smart phone friend and real life friend)
- c. Convenience
- d. Topic of conversation
- e. None of the above

20. Rank the following reason for using messaging app?

- 1. Photo Sharing
- 2. Staying in touch
- 3. Group messaging
- 4. Cost
- 5. Emoticon

21. What do you download on your smart phone? (Tick all that apply)

- a. Featured Apps
- b. Educational content
- c. Wall papers
- d. Games
- e. Music / Songs
- f. Pictures
- g. Videos
- h. I don't download
- i. If others, please specify _____

22. Which of the following have you uploaded from your smart phone on internet? (Tick all that apply)

- a. Educational content
- b. Pictures
- c. Videos
- d. News
- e. If others, please specify _____
- f. I don't upload

23. Which of the following mobile applications have you use for group messaging using your smart phone? (Tick all that apply).

- a. WhatsApp
- b. Facebook
- c. Hike
- d. Hangout
- e. Skype
- f. Other, please specify

24. How often do you use your smart phone for (Tick just one answer for each)

S.No.	Items	very frequently	Sometimes	Rarely	Never
a.	Making voice calls				
b.	Chatting				
c.	For sending MMS				
d.	Listening to music				
e.	Clicking pictures through camera				
f.	Playing Mobile games				
g.	Using Internet				
h.	Watching TV				
i.	Listening to radio				
j.	For micro blogging for e.g. on Twitter				

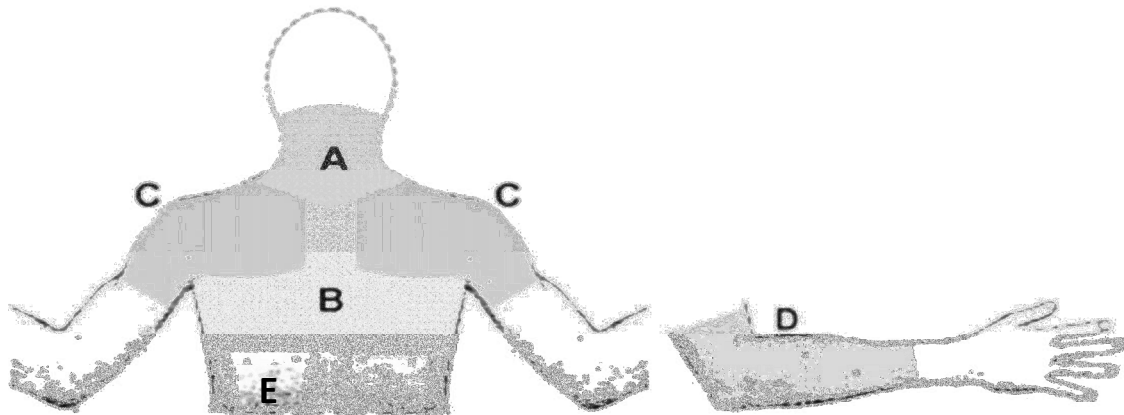
[PART – IV] Identification of the symptoms of Musculoskeletal Disorder

1. Have you experienced any pain / discomfort due to Smartphone? If yes, then in which body parts? Please Choose No, yes or both for each body area you experience pain/discomfort. (Tick all that apply)

S.n	Body Parts	No	During last 24-hour period			During last 1 week			During last 1 month		
			Left	Right	Both	Left	Right	Both	Left	Right	Both
1.	Hands/Wrists										
2.	Elbows										
3.	Shoulders/Neck area										
4.	Low back										
5.	Upper Back										

2. How severe have you experienced any pain or discomfort due to Smart phone in following body parts? Please give rank (1 - 10) according to your experience of pain/discomfort by using the body map and hand map.

Body parts	During last 24-hour period		During last 1 week		During last 1 month	
	No pain	Rank	No pain	Rank	No pain	Rank
A. Neck						
B. Upper back						
C. Shoulders						
D. Elbows						
E. Lower Back						



Body map showing neck, shoulders, elbow and back

3. When did you often notice pain/discomfort in your body part while using a Smartphone?

- i. Chatting for longer periods
- ii. Sitting in one posture for longer period while using smartphone
- iii. Excessive gaming

4. How severe have the following symptoms in your hands, wrists, arms, shoulders or neck been during in the past TWO WEEKS?

S.no.	Symptoms	Very frequently	Sometimes	Rarely	Never
1.	Pain/discomfort at night				
2.	Pain/discomfort during day				
3.	Numbness (no feeling)				
4.	Weakness				
5.	Tingling sensations				
6.	Numbness or tingling at night				
7.	Difficulty grasping and using small objects				

5. Any psychological discomfort do you feel like

- a. Stress
- b. Fatigue
- c. Dizziness
- d. Lack of sleep

6. Any daily activity or work affected by smartphone usage

- a. Yes
- b. No

7. Do you feel any disturbance in sleep due to excessive use of smartphone

- a. Yes
- b. No

8. Do you take any medical prescription for these problems?

- a. Yes
- b. No

ANNEXURE – II

STANDARD OF LIVING INDEX

Important parameters of family

- | | | | |
|----|---|------|---------|
| 1. | Family type | i. | Nuclear |
| | | ii. | Joint |
| 2. | Total eligible member in family
(above 18 years) | i. | 1-2 |
| | | ii. | 3-4 |
| | | iii. | >4 |
| 3. | Working members in family | i. | 0-1 |
| | | ii. | 2-3 |
| | | iii. | 3-4 |
| | | | >4 |
| 4. | Number of children in family | i. | 0-1 |
| | | ii. | 2-3 |
| | | iii. | 4->4 |

1. Family Annual income

- a. High Income group (5-10 & above 10 lakhs/year)
- b. Middle income group (2.5 to 5 lakhs/year)
- c. Lower income group (up to 2.5 lakhs/year)

2. Education

a) High

- i) Highest education in the family is Ph.D./ P.G.
- ii) All the members of family are educated

b) Medium

- i) Highest education in the family is graduate/vocational courses.
- ii) Only 2-3 members are graduated.

c) Low

- i) Highest education in the family is intermediate/middle,
High school, Diploma (Vocational training)
- ii) Only children are educated.

3. Housing

a) High

- i) Owned detached multi-storey house/ bungalow or owned flat with front garden or landscape.
- ii) Different room for different activities like gym, study room, mandir, kid's room, guestroom etc.
- iii) Theme based paint in all room
- iv) All rooms are well furnished and proper interior decoration.
- v) Efficient lighting and ventilation in all rooms.
- vi) Modular kitchen

b) Medium

- i) 2 or 3 BHK flat, rented house or owned house with kitchen garden in city area.
- ii) Somewhat sufficient space according to family (1-2 people sharing a room).
- iii) All room are well painted/distempered.
- iv) Proper lighting and ventilation in all rooms.
- v) Separate Kitchen

c) Low

- i) Rented or owned house in town.
- ii) 2-4 members sharing one room.
- iii) White wash in all rooms.
- iv) Number of rooms is somewhat less according to the family.
- v) Proper lighting but not in all rooms.
- vi) Proper ventilation but not in all rooms.
- vii) Small kitchen/ No separate kitchen

4. Material possession

a) High

- i. Car/ four wheeler
 - Sedan
 - 4x4
 - Luxury car

- ii. Air conditioner
- iii. Laptop / computer with Wi-Fi connection
- iv. Dish washer
- v. Home theatre
- vi. LED TV
- vii. Double door refrigerator
- viii. Camera (DSLR)
- ix. Food processor
- x. Expensive Smartphone

b) Medium

- i. Oven
- ii. Juicer
- iii. Mixer/grinder/blender
- iv. Water purifier
- v. Geyser
- vi. Washing machine
- vii. Cooler
- viii. Refrigerator single door
- ix. Furniture
- x. Smartphone
- xi. LCD TV

c) Low

- i. Cooler
- ii. Motor cycle/ scooter/ two wheeler
- iii. Television
- iv. Double bed
- v. Telephone/ Mobile

5. Health/ Medical care

a) High

i) In general health of all family members is very good.

(Very rarely fall sick and have healthy look.)

ii. Immunization on regular interval master check-up per 6 month/ twice in 6 months.

iii. If anyone falls ill proper treatment is being taken from specialized doctor or best hospital.

iv) All family members have Mediclaim policy.

b) Medium

- i) In general health of all the family members is good.
(Children or adults falls sick sometimes and susceptible to infection and change of weather.)
- ii) Immunization and health check-up on irregular intervals.
(Master check-up only when needed)
- iii) If anyone falls ill, the treatment is being taken from private doctor/ local doctor.
- iv) Few members have mediclaim policy.

c) Low

- i) In general health of some of the family members is poor.
(falls sick quite often or has chronic ailment)
- ii) Not immunized/ vaccinated children properly.
- iii) If anyone falls ill treatment is being taken by government hospital.
- iv) No member has mediclaim policy.

6. Food

a) High

- i) Includes nutritive diets like 2- 3 types vegetables at least 2 types pulses, curd, cereals, salad, desserts, starter, soup in every meal and Non veg once in a week.
- ii) All family members take milk, juice, shake and coffee daily.
- iii) Consume fruits and dry fruits daily.

b) Medium

- i) Include cereals, curd, pulses, vegetables, simple salad daily in the meal and non-veg once in a month.
- ii) All family members take milk 3-4 times in a week.
- iii) Fruits thrice in a week.

c) Low

- i) Include very simple diet like only one vegetable or pulse and chapatti/ rice with pickle etc.
- ii) Milk once or twice in a week given to children.

7. Sanitation

a) High

i) Daily cleaning of whole house (sweeping, dusting and moping by modified mope).

ii) Have water closets with double flush system attached with all rooms and fully utilize.

iii. Separate disposal of organic/ inorganic waste and proper drainage of water.

b) Medium

i) Daily cleaning but not in all the rooms.

ii) Kitchen is cleaned properly

iii) At least 2 water closets with proper water facilities.

iv. Proper disposal of waste water and garbage.

c) Low

i. Cleaning of house on alternate days.

ii. Clean kitchen but not clean surrounding area daily.

iii. Only one sanitary toilet with or without flush system.

iv. Improper disposal of waste and drainage system.

8. Clothing

a) High

i) Every family member wear only branded clothes i.e. properly washed and ironed.

ii) Purchase from brand showrooms and renowned dress material store.

iii) Every family member has all categories of clothes like formal, informal, casual, ethnic, sports and party wear.

iv) Every family member has already their own separate dresses for any ceremony or function.

v) Separate wardrobe for every family member.

b) Medium

i) Every family member wear washed and ironed clothes daily.

ii) Only few member purchases branded clothes and other members purchase non-branded clothes.

iii) Every member has at least 8 to 10 number of clothing.

- iv) Every family member makes new dresses for any ceremony or function.
- v) Combined wardrobe for every family member.

c) Low

- i) Every family member wear washed clothes daily but iron occasionally.
- ii) Purchase dress materials and readymade clothes from local market.
- iii) Every family member has at least 1-2 dress for any occasion.
- iv) Few members (children) in the family make new dress for any occasion or function.
- v) No wardrobe in house.

9. Finance Management

a) High

- i) Every eligible member of family has 2 to 3 bank accounts.
- ii) Debit/Credit card use for maximum transaction.
- iii) Prefer to do online transaction including tickets of flight, movies, food, gifts, hotels, shopping etc.
- iv) Children get pocket money every month.
- v) Every member of family has insurance policy.

b) Medium

- i) Every eligible member of family has at least 1 bank account.
- ii) Prefer to do cash method in maximum transaction.
- iii) Few members do online shopping but only COD mode.
- iv) Children get money only if needed.
- v) Only children have insurance policy.

c) Low

- i) Only parents have 1 bank account.
- ii) Spend money only in cash method avoid card payment.
- iii) Never do online transactions.
- iv) Children don't get money for any purpose.

10. Leisure Activity

a) High

- i) Daily News Paper and monthly subscription of magazine.
- ii) Every member goes for holiday in every 6 months (India/Abroad).
- iii) Eligible members of family are members of 2-3 clubs/kitty/other societies.
- iv) Children go for extracurricular classes like swimming, dancing, music, judo etc.
- v) Children play games online in smartphones and have playing kit for outdoor games.

b) Medium

- i) Daily newspaper but magazine subscription annual or biannual.
- ii) Every member goes for holiday once in two year.
- iii) Only few family members are member of any club/society.
- iv) Children play with video games and online games on computer and laptop.
- v) Few members go for yoga class and gym.

c) Low

- i) Daily local newspaper but no subscription of magazine.
- ii) Few members go for holiday once in 5 year.
- iii) Children play outdoor games.
- iv) None of the family member is member of any club/ societ

SCORING FOR PARAMETERS OF STANDARD OF LIVING INDEX

S.no.	Parameters	High	Score	Medium	Score	Low	Score
1.	Family Annual income (As per income tax slab 2017-18)	5 to 10 lakhs & above 10 lakhs/year	3	2.5 to 5 lakhs/year	2	Up to 2.5 lakhs/year	1
2.	Education	i) Highest education in the family is Ph.D./ P.G./M.D. ii) All the members of family are educated	3 3	i) Highest education in the family is graduate/vocational courses. ii) Very few members are graduated.	2 2	i) Highest education in the family is intermediate/middle, high school, Diploma (Vocational training) ii) Only children are educated.	1 1
3.	Housing	i) Owned detached multi-storey house/ bungalow or owned flat with front garden or landscape. ii) Different room for different activities like gym, study room, mandir, kid's room, guestroom etc. iii) Theme based paint in all room iv) All rooms are well furnished and proper interior decoration. v) Efficient lighting and ventilation in all rooms. vi) Modular kitchen	3 3 3 3 3 3	i) 2 or 3 BHK flat, rented house or owned house with kitchen garden in city area. ii) Somewhat sufficient space according to family (1-2 people sharing a room). iii) All room are well painted/distempered. iv) Proper lighting and ventilation in all rooms. v) Separate Kitchen	2 2 2 2 2	i) Rented or owned house in town. ii) 2-4 members sharing one room. iii) White wash in all rooms. iv) Number of rooms is somewhat less according to the family. iv) Proper lighting but not in all rooms. v) Proper ventilation but not in all rooms. vi) Small kitchen/ No separate kitchen	1 1 1 1 1 1

4.	Material Possession	<p>(i) Car/ four wheeler</p> <ul style="list-style-type: none"> • Sedan • 4x4 • Luxury car <p>(ii) Air conditioner</p> <p>(iii) Laptop / computer with Wi-Fi connection</p> <p>(iv) Dish washer</p> <p>(v) Home theatre</p> <p>(vi) LED TV</p> <p>(vii) Double door refrigerator</p> <p>(viii) Camera (DSLR)</p> <p>(ix) Food processor</p> <p>(x) Smartphone (>20,000 Rs.)</p>	3 3 3 3 3 3 3 3 3 3 3	<p>(i) Oven</p> <p>(ii) Juicer</p> <p>(iii) Mixer/grinder/blender</p> <p>(iv) Water purifier</p> <p>(v) Geyser</p> <p>(vi) Washing machine</p> <p>(vii) Cooler</p> <p>(viii) Refrigerator single door</p> <p>(ix) Furniture</p> <p>(x) Smartphone(<20,000)</p> <p>(xi) LCD TV</p>	2 2 2 2 2 2 2 2 2 2	<p>(i) Cooler</p> <p>(ii) Motor cycle/ scooter/ two wheeler</p> <p>(iii) Television</p> <p>(iv) Double bed</p> <p>(v) Telephone</p> <p>(vi) Mobile</p>	1 1 1 1 1 1
4.	Health/Medical care	<p>i) In general health of all family members is very good. (Very rarely fall sick and have healthy look.)</p> <p>ii) Immunization on regular interval master check-up per 6 month/ twice in 6 months.</p> <p>iii) If anyone falls ill proper treatment is being taken from specialized doctor or best hospital.</p> <p>iv) All family members have Mediclaim policy.</p>	3 3 3 3	<p>i) In general health of all the family members is good. (Children or adults falls sick sometimes and susceptible to infection and change of weather.)</p> <p>ii) Immunization and health check-up on irregular intervals. (Master check-up only when needed)</p> <p>iii) If anyone falls ill, the treatment is being taken from private doctor/ local doctor.</p> <p>iv) Few members have Mediclaim policy.</p>	2 2 2 2	<p>i) In general health of some of the family members are poor (falls sick quite often or has chronic ailment)</p> <p>ii) Not immunized/ vaccinated children properly.</p> <p>iii) If anyone falls ill treatment is being taken by government hospital.</p> <p>iv) No member has Mediclaim policy</p>	1 1 1 1
5.	Food	<p>i) Includes nutritive diets like 2- 3 types vegetables at least 2 types pulses, curd, cereals, salad,</p>	3	<p>i) Include cereals, curd, pulses, vegetables, simple salad daily in the meal and non-veg</p>	2	<p>i) Include very simple diet like only one vegetable or pulse and chapatti/ rice</p>	1

		<p>desserts, starter, soup in every meal and Non veg once in a week.</p> <p>ii) All family members take milk, juice, shake and coffee daily.</p> <p>iii) Consume fruits and dry fruits daily.</p>	3	<p>once in a month.</p> <p>ii) All family members take milk 3-4 times in a week.</p> <p>iii) Fruits thrice in a week.</p>	2	<p>with pickle etc.</p> <p>ii) Milk once or twice in a week only children.</p>	1
6.	Sanitation	<p>i) Daily cleaning of whole house (sweeping, dusting and moping by modified mope).</p> <p>ii) Have water closets with double flush system attached with all rooms and fully utilize.</p> <p>iii. Separate disposal of organic/ inorganic waste and proper drainage of water.</p>	3	<p>i) Daily cleaning but not in all the rooms.</p> <p>ii) kitchen is cleaned properly</p> <p>iii) At least 2 water closets with proper water facilities.</p> <p>iv) Proper disposal of waste water and garbage.</p>	2	<p>i) Cleaning of house on alternate days.</p> <p>ii) Clean kitchen but not clean surrounding area daily.</p> <p>iii) Only one sanitary toilet with or without flush system.</p> <p>iv) Improper disposal of waste and drainage system.</p>	1
7.	Clothing	<p>i) Every family member wear only branded clothes i.e. properly washed and ironed.</p> <p>ii) Purchase from brand showrooms and renowned dress material store.</p> <p>iii) Every family member has all categories of clothes like formal, informal, casual, ethnic, sports and party wear.</p> <p>iv) Every family member has already their own separate dresses for any ceremony or function.</p> <p>v) Separate wardrobe for every family member.</p>	3	<p>i) Every family member wear washed and ironed clothes daily.</p> <p>ii) Only few member purchases branded clothes and other members purchase non-branded clothes.</p> <p>iii) Every member has at least 8 to 10 number of clothing.</p> <p>iv) Every family member makes new dresses for any ceremony or function.</p> <p>v) Combined wardrobe for every family member.</p>	2	<p>i) Every family member wear washed clothes daily but iron occasionally.</p> <p>ii) Purchase dress materials and readymade clothes from local market.</p> <p>iii) Every family member has at least 1-2 dress for any occasion.</p> <p>iv) Few members (children) in the family make new dress for any occasion or function.</p> <p>v) No wardrobe for cloths.</p>	1

8.	Financial Management	<p>i) Every eligible member of family has 2 to 3 bank accounts.</p> <p>ii) Debit/Credit card use for maximum transaction.</p> <p>iii) Prefer to do online transaction including tickets of flight, movies, food, gifts, hotels, shopping etc.</p> <p>iv) Children get pocket money every month.</p> <p>v) Every member of family has insurance policy.</p>	3 3 3 3 3	<p>i) Every eligible member of family has at least 1 bank account.</p> <p>ii) Prefer to do cash method in maximum transaction.</p> <p>iii) Few members do online shopping but only COD mode.</p> <p>iv) Children get money only if needed.</p> <p>v) Only children have insurance policy.</p>	2 2 2 2 2	<p>i) Only parents have 1 bank account.</p> <p>ii) Spend money only in cash method avoid card payment.</p> <p>iii) Never do online transactions.</p> <p>iv) Children don't get money for any purpose.</p>	1 1 1 1
9.	Leisure Activity	<p>i) Daily News Paper and monthly subscription of magazine.</p> <p>ii) Every member goes for holiday in every 6 months (India/Abroad).</p> <p>iii) Eligible members of family are members of 2-3 clubs/kitty/other societies.</p> <p>iv) Children go for extracurricular classes like swimming, dancing, music, judo etc.</p> <p>v) Children play games online in smartphones and have playing kit for outdoor games.</p>	3 3 3 3 3	<p>i) Daily newspaper but magazine subscription annual or biannual.</p> <p>ii) Every member goes for holiday once in two year.</p> <p>iii) Only few family members are member of any club/society.</p> <p>iv) Children play with video games and online games on computer and laptop.</p> <p>v) Few members go for yoga class and gym.</p>	2 2 2 2 2	<p>i) Daily local newspaper but no subscription of magazine.</p> <p>ii) Few members go for holiday once in 5 year.</p> <p>iii) Children play outdoor games.</p> <p>iv) None of the family member is member of any club/ society.</p>	1 1 1 1

APPENDIX III
SMARTPHONE ADDICTION SCALE

S.No.	Statements	Agree	Neutral	Disagree
1.	My friends and family complain about my use of the smart phone.			
2.	Spending a lot of time on my smartphone has become a habit.			
3.	My fully charged battery does not last for more than one day.			
4.	I would love to spend more time on smartphone rather than outdoor activities.			
5.	I feel most liberal while using a smartphone.			
6.	I feel that I lack something when I am not able to use my smartphone.			
7.	I Won't be able to stand if I am not having a smartphone.			
8.	I feel obsessed to use my smartphone.			
9.	There is nothing more fun to do than using my smartphone.			
10.	I feel anxious if I have not checked for messages on my smart phone for the 10 minutes.			
11.	My mind keeps busy with my smartphone even when I don't use it.			
12.	I become irritable if I have to switch off my smart phone for class, exams etc.			
13.	I lose sleep due to the time I spend on my smart phone.			
14.	I feel tired due to excessive usage of smartphone.			
15.	I feel pain in wrists and back of neck while using smartphone.			
16.	I experience light headedness or blurred vision due to smartphone use.			

APPENDIX IV

DEPRESSION SCALE

S.no	Statements	Mostly	frequently	Occasionally	Never
1.	I feel disappointed when I cannot pick a call or message immediately.				
2.	I feel more tensed about my future because of excessive involvement with smartphone.				
3.	I tend to overreact if someone touches my smartphone.				
4.	I found that I was very irritated when internet connection get slow in my smartphone.				
5.	I found myself impatient when someone tries to distract me when I am busy with my smartphone.				
6.	I feel good while having my smartphone in front of my friends.				
7.	I felt I was about to panic many times when my phone's battery gets discharge.				
8.	I feel trouble in sleeping at night if I do not use my smartphone before.				
9.	I found it hard to calm down if there is no notification in my phone throughout whole day.				
10.	I feel the sense of my heart rate increase or heart palpitates when I get message from very close friend.				
11.	I felt scared only from the thought of losing my smartphone.				
12.	I lost interest in other ways of entertainment and communication sources except my smartphone.				

APPENDIX V

Awareness Scale

S.No	Statements	Never	Occasionally	Sometimes	Often	Always
1.	I limit my smartphone use accordingly if I have planned something for the day.					
2.	I experience strain on my backbone while looking in forward position in smartphone.					
3.	I do not bend my backbone for smartphone use.					
4.	I adjust my body posture according to my smartphone.					
5.	I keep my smartphone at proper eye level.					
6.	I experience stiffness or pain in neck area after continuous use of smartphone for more than one hour.					
7.	I try to engage myself in sports and creative work instead of smartphone.					
8.	I feel cramping or tingling of muscles and nerves of the shoulder.					
9.	I experience pain and irritation in the base of the thumb after long usage of smartphone.					
10.	I experience problem in gripping of any object due to pain in my fingers.					
11.	I spend my holiday with my friends instead of being busy on smartphone.					
12.	I feel headache after using smartphone for prolonged time.					
13.	I feel pain in neck and shoulders which increases in night hours.					
14.	I get fully exhausted at night time and unable to have a sound sleep just because of smartphone use.					
15.	I prefer to use smartphone in daytime.					
16.	I use one hand for chatting/gaming in my smartphone.					
17.	I experience joint pain in my fingers and wrist due to excessive smartphone use.					
18.	I do not realize any kind of pain and discomfort in hand and arms due to smartphone use.					
19.	I experience pain and discomfort but still I cannot reduce my usage time of smartphone.					
20.	I use smartphone only 1-2 hours/day so that I can stay away from any type of problems and discomforts related to this.					
21.	I feel mild pain in my upper back due to hunching on smartphone.					
22.	I use both hand for chatting/gaming in my smartphone.					

APPENDIX VI

HAND MEASUREMENTS

S.no.	Name	Hand Measurement (in cm)					
		Hand length	Palm breath across thumb	Palm length	Palm width	Thumb length	Thumb circumference
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

APPENDIX VII
GRIP STRENGTH (GRIP DYNAMOMETER)

		Before use		After use	
	Name of the respondents	Reading (in kilogram)		Reading (in kilogram)	
		Right hand	Left hand	Right hand	Left hand
S.no.					
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

APPENDIX VIII

PINCH STRENGTH (PINCH FORCE METER)

		Pinch strength (Reading in k.g.)					
	Name	Left hand			Right hand		
		Tip	Palmer	Lateral	Tip	Palmer	Lateral
S.no.							
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

APPENDIX IX

NECK FLEXION (INCLINOMETER)

S.no.	Name of the respondents	In normal position			While using position		
		*Reading (in Degree)			*Reading (in Degree)		
		Flexion	Extension	Difference	Flexion	Extension	Difference
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

*3 readings for each

APPENDIX X

VISUAL TEST (FLICKER FUSION)

	Name of the respondents	Green Light (Reading in Hz)				Red light (Reading in Hz)			
		Left eye		Right eye		Left eye		Right eye	
		IF	DF	IF	DF	IF	DF	IF	DF
S.no.									
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									

IF = Increasing frequency DC = Decreasing frequency

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ABSTRACT

Nowadays, Smartphones are increasingly becoming an integral part of our lives. The dependence of smartphone is increasing day by day and creating alarming situation especially for the young adults. Nowadays, it is a kind of device which has almost every advanced feature as it can be used for education, gaming, music, photos and chatting etc., the list is endless so with these features smartphone became a new companion for the user. It is simply becoming a habit of the user to spend more time with their smartphone without taking care of their physical and psychological wellness. Adopting poor postures while prolonged smartphone usage can leads to various health problems that will not be curable if left untreated. Thus, the need was felt to plan the study to assess the usage pattern, postural problems, psychological effect of smartphone on the users so that negative effects can be minimize. The study was carried out in different phase i.e. collection of descriptive data, collection of anthropometric data and collection of experimental data. Due to convenience and accessibility 230 college going students under 18-24 years of Pantnagar University was selected as respondents through random sampling. Descriptive data was collected with the help of developed questionnaire, standard of living index, Smartphone addiction scale, depression scale and awareness scale. Under anthropometric data height weight and hand measurements was recorded and for experimental data grip strength, pinch strength, CFF (critical flicker fusion), neck flexion. However, findings of the present investigation revealed that majority of the girls (59.13%) and boys (58.26%) belong to the middle standard of living. About 34 percent girls and nearly half of the boys used their phone 2-4 hours. A higher percentage of boys (52.1%) and girls (53.0%) faced visual problems due to Smartphone use out of which most of the respondents complained for strain on eyes followed by watery eyes. The findings show that there was decrease in fusion and flicker frequency in both eyes of the respondents that indicates the visual fatigue in the respondents due to smartphone use for longer period. The incidence of pain has risen considerably since last 1 month to last 1 day for both girls and boys. The data also provides evidences that maximum boys are experiencing severe pain in neck and maximum girls experiencing severe pain in shoulders in last 24 hours that is the major point for concern. Majority of respondents experiencing moderate pain in every body part in different durations and only elbow is the less affective area in respondents. Slight pain was most prominent at the tip of the thumb in both hands. Findings revealed that frequency of pain experienced by the respondents increased in almost every body part, since the last one month to 24 hours of usage.

The neck flexion of the respondents were measured by using inclinometer in sitting position at 3 different time duration i.e. 0 min., 10 min., 20 min. and 30 min. The findings clearly represented that increasing usage time affected the neck flexion of the respondents in sitting posture. The respondents haunch their head on their smartphone up to 45 degrees that gives load on neck up to 49 lbs. which showed that when smartphone used for longer period it gives the feeling of pain in neck, shoulders and upper back that will lead to musculoskeletal disorders. Analysis of the data revealed that there was slight decrease in pinch and grip strength of both the respondents after using smartphone for 30 minutes. Analysis of the data revealed that there was 2.41 percent decrease in girls and 2.05 percent decrease in boys grip strength of right hand after using smartphone for 30 minutes. As the right hand was the dominant hand so the left hand was not showing grip change. As per findings, majority of respondents were having the low addiction level this leads to conclude that addiction is increasing in the young people gradually whereas majority of respondents comes under the mild depression level. As per the findings it may conclude that depression is increasing in the young people gradually, as the majority of respondents having the mild depression due to smartphone use. Awareness level of respondents were also assessed and it was found that maximum respondents (55.17%) were partially aware about the postural and psychological disorders so two days sensitization program was conducted and the preventive measures as well as some stretching routines were also introduced to create awareness among students. It was helpful for reducing postural and psychological disorders affecting the human body due to excessive smartphone usage.


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सेमेस्टर व प्रवेश का वर्ष: प्रथम, 2014-15

प्रमुख विषय: पारिवारिक संसाधन प्रबंधन

गौण विषय: पर्यावरण विज्ञान

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शोध शीर्षक: " स्मार्टफोन उपयोगकर्ताओं का मनोवैज्ञानिक कलन और सनीय विश्लेषण"

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विभाग: पारिवारिक संसाधन प्रबंधन

सारांश

कलन, स्मार्टफोन तेजी से हमारे जीवन का एक अभिन्न हिस्सा बन रहे हैं। स्मार्टफोन की निर्भरता दिन-प्रतिदिन बढ़ रही है और खासकर युवा वयस्कों के लिए खतरनाक स्थिति पैदा कर रही है। कलन, यह एक तरह का उपकरण है जिसमें लगभग हर उन्नत सुविधा है जो कि इसका उपयोग शिक्षा, गेमिंग, संगीत, फोटो और चर्चा के लिए किया जा सकता है। सूची अंतहीन है इसलिए इन सुविधाओं के साथ स्मार्टफोन उपयोगकर्ता के लिए एक नया साथी बन गया है। अपने शारीरिक और मानसिक स्वास्थ्य की देखभाल किए बिना अपने स्मार्टफोन के साथ अधिक समय बिताना उपयोगकर्ता की कलन बन रही है। लंबे समय तक स्मार्टफोन के खराब मुद्राओं में उपयोग से कई स्वास्थ्य समस्याएं हो सकती हैं जो भविष्य में इलाज योग्य नहीं होंगी। अतः, उपयोग पैटर्न तथा सनीय समस्याओं का कलन करने के लिए अध्ययन की योजना बनाने की आवश्यकता महसूस की गई ताकि उपयोगकर्ताओं पर स्मार्टफोन के शारीरिक और मानसिक नकारात्मक प्रभाव को कम किया जा सके। अध्ययन विभिन्न चरणों में किया गया जहाँ वर्णनात्मक डेटा संग्रह, मानव विज्ञान डेटा का संग्रह और प्रयोगात्मक डेटा संग्रह। सुविधा और पहुंच के कारण पंतनगर विश्वविद्यालय के 18-24 साल के 230 कॉलेज जाने वाले छात्रों को यादृच्छिक नमूनाकरण के माध्यम से उत्तरदाताओं के रूप में चुना गया। वर्णनात्मक अध्ययन के लिए, विकसित प्रश्नावली, जीवन स्तर सूचकांक, स्मार्टफोन स्केल, अवसाद स्केल और जागरूकता स्केल की सहायता से डेटा एकत्र किया गया था। अन्त्रोपामेर्टिक माप के तहत लम्बाई, वजन और हाथ का माप रिकॉर्ड किया गया और प्रयोगात्मक डेटा के लिए पकड़ ताकत, चुटकी ताकत, सीएफएफ (क्रिटिकल फ्लिकर फ्यूजन) और गर्दन फ्लेक्सन लिया गया। हालांकि, वर्तमान जांच के निष्कर्ष बताते हैं कि अधिकांश लड़कियों (59.13%) और लड़कों (58.26%) का जीवन स्तर मध्यम था। लगभग 34 प्रतिशत लड़कियां और लगभग 10% लड़कों ने एक दिन में 2-4 घंटे अपने फोन का इस्तेमाल किया। स्मार्टफोन के उपयोग के कारण लड़कों (52.1%) और लड़कियों (53.0%) के एक उच्च प्रतिशत ने दृश्य समस्याओं का सामना किया, जिनमें से अधिकांश उत्तरदाताओं ने कंधों पर तनाव और कंधों से पानी पीने की शिकायत की। निष्कर्ष बताते हैं कि उत्तरदाताओं की दोनों कंधों में फ्लिकर और फ्यूजन की कमी है। लंबे समय तक स्मार्टफोन उपयोग के कारण उत्तरदाताओं में कंधों की थकान को इंगित करता है। कंधे दर्शाते हैं कि अधिकतम लड़कों को गर्दन में गंभीर दर्द का सामना करना पड़ रहा है और पिछले 24 घंटों में कंधे में गंभीर दर्द का सामना करने वाली अधिकतम लड़कियां चिंता का प्रमुख बिंदु है। अधिकांश उत्तरदाताओं ने अलग-अलग अवधि में प्रत्येक शरीर के हिस्से में मध्यम दर्द का अनुभव किया तथा उसमें से कोहनी सबसे कम प्रभावशाली क्षेत्र है। कुछ उत्तरदाताओं ने दोनों हाथों के अंगूठे की नोक पर हल्का दर्द महसूस किया गया। निष्कर्षों से पता चला कि एक महीने से 24 घंटों में स्मार्टफोन उपयोग के कारण उत्तरदाताओं द्वारा अनुभव किए गए दर्द की कमी लगभग हर शरीर के हिस्से में बढ़ी है। उत्तरदाताओं की गर्दन फ्लेक्सन को 3 अलग-अलग समय अवधि में बड़े मुद्रा में इनक्लिनोमीटर का उपयोग करके मापा गया यानी 0 मिनट, 10 मिनट, 20 मिनट और 30 मिनट। निष्कर्ष स्पष्ट रूप से दर्शाते हैं कि बड़े मुद्रा में बढ़ते स्मार्टफोन उपयोग से उत्तरदाताओं की गर्दन फ्लेक्सन प्रभावित हुई। उत्तरदाताओं ने अपने स्मार्टफोन उपयोग के दौरान 45 डिग्री तक अपने सिर को नीचे झुकाया जो 49 पाउंड तक भार गर्दन पर देता है। जो दिखाता है कि जब स्मार्टफोन लंबे समय तक उपयोग किया जाता है तो यह गर्दन, कंधे और ऊपरी हिस्से में दर्द की अनुभूति देता है जो मस्कुलोस्केलेटल विकारों का कारण बनता है। कंधों के विश्लेषण से पता चला कि 30 मिनट के लिए स्मार्टफोन का उपयोग करने के बाद दोनों उत्तरदाताओं की चुटकी और पकड़ शक्ति में मामूली कमी है। कंधों के विश्लेषण से पता चला कि 30 मिनट के लिए स्मार्टफोन का उपयोग करने के बाद लड़कियों की पकड़ शक्ति में 2.41 प्रतिशत और लड़कों की पकड़ शक्ति में 2.05 प्रतिशत गिरावट है। हफ्ते का दिन हाथ प्रभावशाली हाथ था इसलिए बाएं हाथ की पकड़ में परिवर्तन नहीं दिख रहा था। निष्कर्षों के मुताबिक, अधिकांश उत्तरदाताओं में स्मार्टफोन की लत का स्तर कम था। जबकि अधिकांश उत्तरदाताओं में स्मार्टफोन के उपयोग के कारण हल्का अवसाद था। उत्तरदाताओं के जागरूकता स्तर का कलन भी किया गया और यह पाया गया कि अधिकतम उत्तरदाता (55.17%) शारीरिक और मानसिक स्वास्थ्य विकारों के बारे में शिक्षा के रूप से अवगत थे इसलिए छात्रों के बीच पूर्ण रूप से जागरूकता पैदा करने के लिए दो दिन का संवेदीकरण कार्यक्रम आयोजित किया गया और निवारक उपायों के साथ-साथ कुछ स्ट्रेचिंग भी सिखाई गयी। अत्यधिक स्मार्टफोन उपयोग के कारण मानव शरीर को प्रभावित करने वाले शारीरिक और मानसिक विकारों को कम करने के लिए यह कार्यक्रम सहायक था। यह शोध स्पष्ट करता है कि युवाओं में स्मार्टफोन सम्बंधित स्वास्थ्य समस्याएं दिन प्रतिदिन बढ़ रही हैं अतः उन्हें इस सम्बन्ध में जागरूक करने की आवश्यकता है ताकि वह अपने स्मार्टफोन का उचित इस्तेमाल करके स्वास्थ्य सम्बंधित विकारों से बच सकें।


(दीपा विनय)
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