

# Relationship between the hand discomfort with the dimensions of hand and touch screen mobiles

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## ABSTRACT

**Introduction:** With the development of communication technology, mobile phone seems to become an important personal device that everyone have. Texting is the most widely used mobile data service, with 74% of all mobile phone users worldwide being active users of it. **Aim of the Study:** This study aims to find the relationship between hand discomfort and dimensions of mobile phone and hand. **Methods:** A total of 150 college-going girls in the age group of 18–24 years were taken for this study by simple convenient sampling. A subjective questionnaire was used to collect details about mobile model name, years of usage, total hours of usage per day, and type of activity predominantly done using the touch screen mobile. After selecting the participants with the criteria's, Cornell hand discomfort questionnaire was given to them who were having hand discomfort. **Results:** The result was analyzed using Pearson correlation between Cornell score and ratio of hand length and diagonal length and ratio of diagonal length and thumb length. There is a significant negative correlation between Cornell score and the ratio of hand length and mobile length ( $r = -0.225$ ), and moderate positive correlation between Cornell score and the ratio of diagonal length and thumb length ( $r = 0.534$ ). **Conclusion:** We concluded that the dimensions of touch screen mobile and hand are not major contributing factor in causing hand discomfort.

**KEY WORDS:** Dimensions, Hand discomfort, Touch screen

## INTRODUCTION

Touch screen mobiles are portable devices with a touch screen interface that can be used with stylus or finger touch.<sup>[1]</sup> With the development of communication technology, mobile phones seem to become an important personal device that everyone have. Mobile internet usage is growing at the rate of nearly 85% per annum.<sup>[2]</sup> Accompanying the considerable use of mobile phones, there have been concerns raised about possible musculoskeletal problems. Indeed, excessive texting with mobile phones has been associated with musculoskeletal disorders in the thumb and upper limb, suggesting that these concerns may be justified.<sup>[3,4]</sup> Considering the immense and widespread use of smartphones for texting in almost all age groups, understanding the underlying causes of musculoskeletal disorders related to smartphone use are important. Cell phone users are at risk of developing

various repetitive strain injury-type conditions. The combination of repetitive movements, poor posture, and overuse of mobile phone for texting or playing games, without taking rest breaks, can cause injury 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.<sup>[4]</sup> In most cases, the digits used for texting are the thumbs of each hand, but these digits are not as well for fine manipulative or dexterous work as the other fingers. Apart from soft tissues, joints can also be damaged in the form of arthritis/subluxation with excessive use of mobile phone for texting.<sup>[5]</sup> These problems have been recognized by several physiotherapy associations and by mobile phone operators worldwide.<sup>[6,7]</sup> With a rise in smartphone ownership globally, China will have the highest number of smartphone users, 13 billion in 2018 followed by India with 530 million users.<sup>[8]</sup> Internet and Mobile Association of India reported that the number of internet users stood at 481 million by June 2018. Urban India with an estimated population of 455 million already has 295 million using the internet. Rural India, with an estimated population of

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918 million as per 2011 census, has only 186 million internet users leaving out potential 732 million users in rural India.<sup>[9]</sup> Anxiety and fear of missing out on information make university students check their mobile devices as many as 150 times in a day on an average.<sup>[10]</sup> A research conducted on the effect of cell phone on handheld device users was a significant association between the total times spent using a six mobile device each day and pain in the base of thumb. The smartphones are not ergonomically supported, and intensive usage of smartphones increases tension on muscles such as upper trapezius, extensor pollicis longus, and abductor pollicis.<sup>[11]</sup> In another study, they have conducted research on the extensive usage of handheld devices and their impact on musculoskeletal disorder. In their work, the scientists acknowledged that prolonged use of cell phone is known to cause symptoms of musculoskeletal disorder keeping this into consideration, this study is based on finding some relationship between hand discomfort and dimensions of hand and touch screen mobile phones.<sup>[12]</sup>

## METHODS

An observational study was conducted among 150 female students between the age group of 18 and 22 years from School of Physiotherapy, Vels Institute of Science, Technology, and Advanced Studies (VISTAS), Chennai. Students were selected by simple convenient sampling. Keypad mobile users, students with hand injury and deformity, and any neurological and musculoskeletal conditions affecting upper limb were excluded from the study. This study has been divided into two parts, in the first part where the participants suitable for the study were selected using the subjective questionnaire. The selected participants were evaluated and the Cornell questionnaire was given to them to find out the areas of hand discomfort and their mobile usage and dimension in the second part. In the first step, a preplanned subjective questionnaire was given to the students. The questionnaire consists of the name and age of student, mobile model name they are using, and for how many years. Total duration of mobile phone usage in a day, any history of using keypad mobile and if yes than for how many years, mode of operation single handed or both handed, what type of activity they do most of the time such as chatting, scrolling, and watching videos, do they have any discomfort and pain in hand, and last their hand dimensions, i.e., hand length, hand width, thumb length, index finger length, middle, and ring little finger length of dominant side. The second step is of Cornell questionnaire, of 150 students, only 130 students filled the form correctly, and of 130, 42 were having hand related discomfort and pain. Cornell questionnaire and visual analog scale were given to these 42 students. Of 42, only 30 students returned

the completely filled Cornell questionnaire and visual analog scale.

## Statistical Analysis

As the aim of the study is to find the relationship between hand discomfort and dimensions of hand and touch screen mobiles, for this, the ratio of hand length and diagonal length was taken as these are the maximum dimension of hand and touch screen mobile, respectively, and Pearson correlation was done between Cornell score and these values. After that, the ratio between thumb length and diagonal length was taken and Pearson correlation was done between Cornell score and this ratio of thumb length and diagonal length. Based on the Cornell score and visual analog scale, participant was divided into two categories, mild and moderate discomfort and pain.

## RESULTS

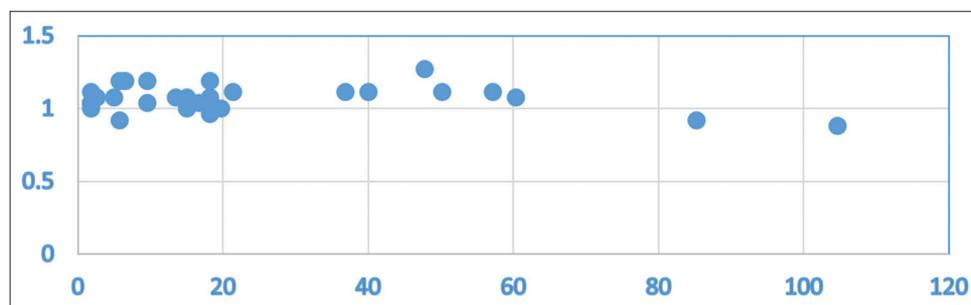
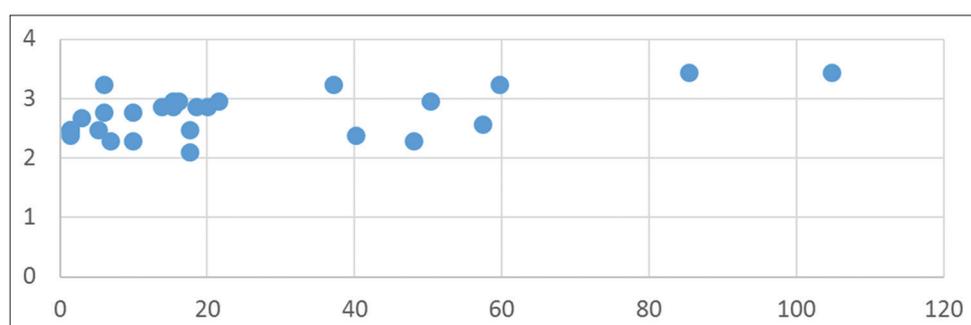
The baseline measurements of participants hand dimension were taken with the complaints of hand discomfort [Table 1]. The relationship among Cornell score with hand length/diagonal length of hand shows the correlation ( $r$ ) value of  $-0.2253$  [Figure 1]. Thus, the relationship between hand discomfort with hand length and diagonal length is weaker and thereby not producing the hand discomfort of participants. In case of the relationship of Cornell score with diagonal length/thumb length shows the value of Pearson correlation ( $r$ ) is  $0.5344$ , which is technically showing the moderate positive correlation [Figure 2]. It means that there is a tendency of hand discomfort with changes in the diagonal length and thumb length of participants.

## DISCUSSION

This study is focused on finding some association between the hand discomfort and the dimensions of hand and mobile phone. The hand discomfort was assessed by Cornell hand discomfort questionnaire. Before the study, we hypothesized that these touch screen and hand dimensions are one of the major factor in causing hand discomfort, but in the end, it was clear that there are other factors which are more responsible for causing hand discomfort in touch screen users. In the first stage of this study, a subjective preplanned questionnaire was given to 150 female students of School of Physiotherapy, VISTAS, Chennai, to identify students having hand-related discomfort and pain. Only 32.3% of students were having mild-to-moderate discomfort. Most of the user's mode of operation was bilateral and majority of students who were complaining of pain and discomfort were using mobile by one hand, and the pain was predominantly around thumb (Area C and Area E of Cornell questionnaire). The average duration of mobile phone usage per day is 4.5 h. Maximum duration is of 7 h/

**Table 1: Hand and mobile dimensions in participants (cm)**

Values	Hand length	Hand width	Thumb length	Mobile length	Diagonal length	Mobile width
Minimum	15.4	6.8	5	12.38	13.6	5.8
Maximum	19.8	9	7.5	15.9	17.62	7.8

**Figure 1:** Pearson correlation between Cornell score and hand length/diagonal length**Figure 2:** Pearson correlation between Cornell score and diagonal length/thumb length

day. The students were commonly engaged in chatting and playing video games. Eapen *et al.* also states that the symptoms severity lies from mild to moderate in their study participants and especially, the symptoms in the thumb were also found to be 53%.<sup>[4]</sup> As per the study was done by Balakrishnan *et al.* that there is some relationship between design and anthropometry of the handheld devices which will lead to discomfort and fatigue in hand due to excessive usage of mobile phones.<sup>[12]</sup> The study was done by Gustafsson *et al.* also concluded that the range of movement of the thumb varies according to the size of mobile.<sup>[3]</sup> Hence, we compared the diagonal length of mobile screen and thumb length, which were showing moderate positive correlation. This signifies that more the diagonal length, more the thumb movement, and more the chance of thumb discomfort. In single-handed operation, we usually rest the mobile on thenar crease, which decreases the thumb range as compared to holding by both hands. Rui and Zhongzhe state that the area size of touch screen has a significant influence on operation performance, the complexity of one-hand operation increases along with the increase of area size.<sup>[13]</sup> Thus, we recommend that before buying mobile phone check that your thumb length should be at least half of the diagonal length of touch screen mobile. The longest dimension of a mobile is its diagonal length, so

we have compared hand length with diagonal length. Sustained gripping, abnormal holding, and typing posture are also responsible for hand discomfort. To minimize these risk factors, always buy a mobile phone whose diagonal length is at least 1.5 cm less than your hand length. The above findings are based on observation only, more mathematical calculation are required for actual values. Limitation of the study was as follows: The sample size is smaller and male subjects are not included, subjective fatigue analysis was not done which can be done in future studies.

## CONCLUSION

The hand dimensions and mobile dimension are related to the development of hand discomfort, but the total duration of touch screen mobile usage, hours per day, history of keypad mobile usage, and type of activity such as chatting and playing video games was also more responsible for developing hand discomfort in the individuals.

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