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Morphological and Functional Changes in Thumb and Little Finger of the Dominant Hand Among College Going Students Due to Smartphone Addiction - A Review of Literature

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ABSTRACT

Objective: To systematically review the randomized controlled trials to describe morphological and functional changes of thumb and little finger of the dominant hand due to smartphone usage in college going students.
Methodology: The review was performed according to PRISMA guidelines and it was defined by searching journal article databases (PubMed, Google Scholar, ScienceDirect, Cochrane) using the keywords mentioned below.
Result: According to the investigations, there were not much morphological and functional changes in thumb and little finger of dominant hand in college going students.
Conclusion: This literature review describes the exploration of morphological and functional changes in the thumb and little finger of the dominant hand among college going students due to smartphone usage reveals a complex interplay between technology and human anatomy. The implications extend beyond mere convenience and into potential alterations in musculoskeletal health and motor skills development.

Keywords: Nomophobia, Smartphone Addiction, Thumb, Little Finger, Morphology of Fingers, Function of Fingers.

INTRODUCTION

Nomophobia is a term used for anxiety, discomfort and nervousness caused by being without any contact with a smartphone .[1] The utility of smartphone has drastically changed in the past decades. Everyone can afford a mobile phone today due to decrease in its cost and research suggests that its usage will further increase in future .[2] In India the smartphone market has grown rapidly so much so that it has the 2nd position in the world for mobile phone handsets. Due to the easy access to smartphone its utility has increased specially among youth.[3] Studies have shown that Indian youth spend at least 3.5 h/day or more using smartphone for texting, emailing or surfing the internet .[4]

With the growing popularity of smartphone among youth there has also been an increase in reported evidence of musculoskeletal disorders related to smartphone usage. [5]The morphological measure involves circumference of little finger and thumb and the functional measure involves ROM of little finger and the thumb of the dominant

hand among secondary school adolescents due to chronic smartphone usage. Many studies have investigated the relation between smartphone and neck, wrist pain, also poor head and neck posture. [6,7,8]A strong correlation between smartphone addiction and neck pain was found .[9] A positive correlation between neck and shoulder pain and the total time spent using a mobile phone .[10] But there are very few studies in literature which actually considered the effects of smartphone on fingers which is the most used part while using or even simply holding a smartphone. There are certain studies which tried to put a light on this but they were more focused on either a single aspect of a finger or only the thumb. Previously, studies have shown that repetitive movement using smartphone can lead to conditions like SMS thumb and can also cause paraesthesia or swelling of thumb or fingers. [11]A study revealed that postures and the type of phone affected muscle activity and thumb positions .[12]

In 2019 a study revealed that smartphone pinky is a deformity usually seen at the level of the middle phalanx of the 5th finger, which can also cause atrophy and pain along the little finger .[13]

However, even after so many evidences regarding smartphone related hand disorders there is a gap in literature about the different single-handed smartphone holding techniques which can cause morphological and functional changes in the little finger and the thumb both since these two fingers are more prone to be affected in different types of smartphones holding techniques. A study compared the morphological changes in the little finger due to smartphone usage but did not find any significant difference in results due to limited smartphone usage period .[14] A study on effects of grip span in one-handed thumb interaction along a smartphone, where along with other findings a decrease in thumb ROM by grip span due to single handed smartphone use was also observed but it was calculated only in vertical direction. [15]Thus, the objective of this study is to evaluate the morphological and functional changes of thumb and little finger of the dominant hand which is commonly involved in different smartphone usage among college going students.

MATERIALS & METHODS

Inclusion criteria consisted of the following: Randomized control trials and randomized clinical trials (RCT), the Publication year 2007- 2023, Secondary school students who use their smartphones for at least 3.5 hours per day. Exclusion criteria consisted of the following: Students having an injury of fracture or neurological symptoms. Any congenital deformity of hand and recent fracture, study with data not reliably extracted, duplicate, or overlapping data, abstract-only papers as preceding papers, conference, editorial, and author response theses and books case reports, case series, and systematic review studies, articles without available full text.

Search strategy: A search of existing literature from the years 2007-2023 was completed from the following databases: PubMed, Google Scholar, Cochrane Library, PEDro (physiotherapy evidence database), and ResearchGate using keywords such as smartphone addiction, thumb, little finger, morphology of fingers, nomophobia.

REVIEW OF LITERATURE

SL.NO	TITLE/ AUTHOR/YEAR	METHODOLOGY	CONCLUSION
1.	L Atiparmak et.al (2023) conducted a study on Investigation of the Effects of Smartphone Use on the Dominant Thumb and Wrist of University Students. [16]	Wrist and thumb ROMs were measured with a manual goniometer with a sensitivity of 1 degree, and hand grip strength was measured with a hand grip dynamometer in a	Excessive usage of smartphones affects the ROM of thumb flexion and abduction, the ROM of wrist radial deviation, and the proprioception of thumb

		total of 100 volunteer university students with a mean age of 18- 25. Smartphone Addiction Scale-Short Form (SAS-SF) and Patient Rated Wrist and Hand Evaluation (PRWHE) questionnaire were applied to the students. Statistical analyses were made using the SPSS 25 program	abduction, and it does not affect the hand grip strength. The findings of research will be a source for future studies.
2.	Sohel ahmad et. al (2022) conducted a cross-sectional study on Smartphone addiction and its impact on musculoskeletal pain in neck, shoulder, elbow, and hand among college going students.[17]	A cross-sectional study was carried out by a random sampling method from recognized institute in Bangladesh and India. Three hundred twenty-six participants, including male and female, aged between 18 and 30 years participated in this study. Candidates were requested to fill-up a performa containing demographics, Smartphone addiction scale-short form (SAS-SF), Shoulder pain and disability index (SPADI), Neck disability index (NDI), Oxford elbow score (OEC), and Cornell Hand Discomfort Questionnaire (CHDQ).	Smartphone addiction negatively impacted and positively related with the musculoskeletal pain in neck, shoulder, elbow, and hand. Care should be given towards the proper use of smartphone and increase public awareness regarding the negative consequences of this serious issue.
3.	Jasraj kaur bhamra et. al (2021) conducted a study on Effect of Smartphone on Hand Performance and Strength in the Healthy Population. [18]	The qDASH (Questionnaire for Disabilities of the Arm, Shoulder, and Hand) is widely used to determine the extent of the impact of smartphones on hand performance and strength. Excessive smartphone use was assessed among 195 medical students which suggested students suffer from a high level of smartphone addiction. It also demonstrated the strong link between this smartphone addiction and lower sleep quality along with higher stress levels, which is a cause for medical concern. Smartphone usage and addiction when assessed in 1,519 young people had provided the first insights into smartphone addiction as well as its use, and smartphones as a medium of addiction in youngsters. By focusing on the impact that the smartphone has created on education, psychology, and social	In this review, we found that young adults have a significantly higher rate of smartphone addiction. Females were shown to be more addicted to their smartphones. However, the upper-limb disability is more prominent in males. Hand strengths were found to be normal and strong on the dominant-hand side with smartphone use. There is a negative influence on hand function and performance due to the overuse of smartphones. It was also 13 found that there is a non-significant positive connection between smartphone addiction and upper extremity dysfunction.

		aspects, the good and bad effects of smartphones on students have been identified.	
4.	D. Fuentes -ramirez et. al (2019) conducted a study on Morphologic changes of the fifth phalange secondary to smartphone use.[19]	University students were invited to participate. Photographs of the dorsal region of both hands were taken using a millimetre paper as background. After calibrating the ImageJ software, photographs were analysed in pairs obtaining areas of asymmetry. Sociodemographic information and technique of use was collected through a survey. The data were analyzed using SPSS ver. 20.	No asymmetric changes were evident between left and right small fingers in relation to the holding technique of a smartphone in a young adult population.
5.	Sarah m. Coppola et. al (2018) conducted a study on Tablet form factors and swipe gesture designs affect thumb biomechanics and performance during two-handed use. [20]	Sixteen adult (8 female, 8 male) participants completed 320 tablet gestures across four swipe locations, with various tablet sizes (8″ and 10”), tablet orientations (portrait and landscape), swipe orientations (vertical and horizontal), and swipe directions (medial and radial). Three-dimensional motion analysis and surface electromyography measured wrist and thumb postures and forearm muscle activity, respectively. Postures and muscle activity varied significantly across the four swipe locations ($p < .0001$). Overall, swipe location closest to the palm allowed users to swipe with a more neutral thumb and wrist posture and required less forearm muscle activity. Greater thumb extension and abduction along with greater wrist extension and ulnar deviation was required to reach the target as the target moved farther from the palm. Extensor Carpi Radialis, Extensor Carpi Ulnaris, Flexor Carpi Ulnaris, Extensor Policis Brevis, and Abductor Pollicis Longus muscle activity also increased significantly with greater thumb reach ($p < 001$). Larger tablet size induced greater Extensor Carpi Radialis, Extensor Carpi Ulnaris, Flexor Carpi Ulnaris, Flexor Carpi Radialis, and Abductor	The study results demonstrated that, for a two-handed grip on a tablet, thumb swiping time, thumb/wrist posture, forearm muscle activity, and self-reported discomfort vary across swipe locations.

		Pollicis Longus muscle activity ($p < .0001$).	
6.	Hyun k. Kim et. al (2018) conducted a study on Analysing thumb interaction on mobile touchpad devices. [21]	The 3.5-inch mobile device was used in an experiment in which the subject pressed a single target. A total of 24 right-handed subjects participated in the experiment. The breadth and length of the thumb of each subject were measured. Task performance times and the number of errors were analysed. The results showed that task performance times increased as the target size decreased and that the target location was in the lower-right corner. In terms of the length of the thumb, the group of the longest thumb had the lowest performance.	In the case of the screen using the touchpad, it is recommended that the target size be a minimum 11.7 mm and that the target should be designed to avoid the bottom right edge of the screen.
7.	N. Firatokan et. al (2015) conducted a study on Effects of Dexterity Level and Hand Anthropometric Dimensions on Smartphone Users' Satisfaction.[22]	A multistage measurement process is designed to collect the data. The study is conducted with 36 participants. Firstly, each participant is asked to answer the questionnaire that includes questions about demographics, smartphone choices, habits, and satisfaction. Secondly, hand and finger dimensions of participants are measured. Finally, each participant performs the Minnesota Manual Dexterity Test.	Results indicates that thumb length, hand length, and dexterity level of the users have notable effects on users' satisfaction with smartphones. Based on the results, a new approach that includes both gross motor skills and physical measurements is suggested to see hidden indirect relations with satisfaction
8.	Joanna bergstrom-lehtovirta et. al (2014) conducted a study on Modelling the Functional Area of the Thumb on Mobile Touchscreen Surfaces. [23]	A predictive model for the functional area of the thumb on a touchscreen surface: the area of the interface reachable by the thumb of the hand that is holding the device. This 18 derives a quadratic formula by analysing the kinematics of the gripping hand. Model fit is high for the thumb-motion trajectories of 20 participants. The model predicts the functional area for a given 1) surface size, 2) hand size, and 3) position of the index finger on the back of the device. Designers can use this model to ensure that a user interface is suitable for interaction with the thumb. The model can also be used inversely – that is, to infer the grips assumed by a given user interface layout.	Although the results supported the potential of this modelling approach, more work is needed, to validate it further. Planned to collect a larger sample, with a broader distribution of device form factors, to adjust the model's constant coefficient values.
9.	Burcinakcay et. al (2013)	The study included 127	The groups had no

	conducted a study on Effect of Smartphone Addiction Level on Manual and Finger Dexterity, Hand Grip Strength, Pinch Grip Strength, and Thumb Pressure Pain Threshold in University Students. [24]	university students aged 19–25 years. Smartphone usage level was assessed with the Smartphone Addiction Scale Short Form, pressure pain threshold with an algometer, pinch grip strength with a pinch meter, hand grip strength with a hand dynamometer, and dexterity with the Purdue pegboard test and the Minnesota manual dexterity test.	difference in hand and pinch grip strength, thumb pressure pain threshold, and dexterity ($p > .05$). Females with and without smartphone addiction had similar results ($p > .05$), and males with smartphone addiction showed differences in some dexterity parameters and palmar pinch strength ($p < .05$)

RESULT

According to the investigations, there were not much morphological and functional changes in thumb and little finger of dominant hand in college going students.

DISCUSSION

The increasing use of smartphone among college going students has raised concerns about its potential impact on various aspects of health including the morphology and functionality of thumb and little finger, especially in the dominant hand. Morphologically, excessive smartphone use might lead to increased muscle strain in the thumb due to repetitive movements such as typing and swiping. This could potentially result in hypertrophy or changes in muscle tone. Prolonged use of smartphones, particularly in onehanded operations, may impact the bone density and structure of the thumb and little finger. Increased stress on these areas could lead to morphological adaptations. Frequent use of smartphones may affect joint flexibility in the thumb and little finger. Reduced range of motion or increased flexibility could be observed as a consequence of specific repetitive movements. The constant flexion and extension motions can result in overuse of certain muscles leading to hypertrophy in some areas and potential atrophy in others. Repetitive movements associated with smartphone use can put stress on the thumb joints, potentially leading to changes in joint morphology over time. Prolonged and awkward postures during smartphone use might contribute to the development of thumb deformities, such as trigger thumb or a deviation in the alignment of the thumb joints. Frequent use of little finger for typing or holding the smartphone may contribute to inflammation of the flexor tendons, potentially altering the fingers morphology. Constant bending of the little finger while holding the smartphone may result in joint stiffness, affecting the finger's range of motion over time. The small muscles of the little finger may experience fatigue due to prolonged and repetitive activities potentially leading to changes in muscle structure. 23 The functional changes emphasize overuse of thumb in smartphone-related activities might lead to a decreased range of motion, impacting the ability to perform fine motor tasks. Muscle imbalances and overuse can contribute to reduced grip strength, affecting the thumb's ability to perform everyday activities efficiently. Continuous use of little finger for smartphone-related tasks may result in decreased dexterity, impacting tasks that require precision and fine motor skills. Functional changes may manifest as pain and discomfort in the little finger, affecting overall hand functionality. Smartphone usage involves precise motor skills, especially in terms of touch screen interactions. Analysing how these activities affect overall motor skills development in college going students can provide insights into the functional changes. Assessing the impact of smartphone use on grip strength, particularly in the thumb and little finger, can shed light on how these devices influence the physical capabilities of the

dominant hand. Understanding whether prolonged smartphone usage affects hand dominance could be crucial. Students might develop stronger dominance in the hand they use more frequently for smartphone activities. Smartphone usage often involves specific postures and hand positions. Investigating the ergonomic aspects of these postures and their impact on the overall musculoskeletal health of students is crucial. Excessive smartphone use might lead to discomfort or pain in the thumb and little finger. Studying the prevalence of such issues and their correlation with usage patterns can provide valuable information. Examining the potential long-term consequences of smartphone-related morphological and functional changes is essential. This includes understanding whether these changes persist into adulthood and if they contribute to any chronic conditions. Considering the findings, there might be a need for educational interventions regarding proper smartphone usage, breaks, and exercises to mitigate potential negative effects on hand health.

CONCLUSION

In conclusion, the impact of smartphone usage on the thumb and little finger of the dominant hand among college going students is a multidimensional topic that involves aspects of anatomy, physiology, ergonomics, and behavioural patterns. Research in this area could provide valuable insights into the evolving relationship between technology and human anatomy, especially in the context of the younger generation.

Declaration by Authors

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