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Touch-Screen Technology and Pediatric Population; Hand Skills, Pain and Quality of Life: A Narrative Review

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ABSTRACT

Background: Screen media are omnipresent in the lives of individuals of all ages. Research has indicated that parents frequently exhibit a motionless facial expression while engaging in quiet reading on their mobile devices while replying to text messages. Instances of disturbances in parent-child interactions have been noted when parents engage in media use, such as texting. We cannot fathom a life without our intelligent mobile devices. Prolonged use of smartphones might impair the manual abilities of our hands and fingers, such as dexterity and coordination, as a result of continuous gripping and tapping on the screen.

Objective: In this review, we aimed to highlight the relationship between media screen use and handgrip strength, musculoskeletal pain, and quality of life among typically developing school-age children.

Methods: An extensive literature search was conducted across multiple databases, including PubMed, Scopus, Science Direct, and Google Scholar, to identify studies related to media screen use and its positive and negative effects in children and adolescents.

Conclusion: New technologies have clearly influenced the way children and adult communicate with others, families with their environment, and learn about the world. It is also associated with poor cognitive, linguistic, psychological, social and emotional skills. The negative impact of screen media use on the pediatric population includes obesity, mental health problems, decreased physical activity, unhealthy eating, headaches, sleep disturbances, psychosocial disturbances, musculoskeletal abnormalities, multi-located pain, hand function problems and associated reduced health-related quality of life.

Keywords: Children, Hand function, Pain, Quality of life, Screen media.

INTRODUCTION

Children's lives are becoming inseparable from digital technology. Digital devices are rapidly emerging as cultural instruments in the household, educational institutions, and the society. The increasing number of youngsters engaging with digital devices on a daily basis has brought attention to the duration of their technology usage, which has become a widely discussed subject. The duration of time spent engaging with screens, such as televisions, tablet computers, smartphones, and laptop/desktop computers, has attracted considerable attention and apprehension. Modern touch screen technology, exemplified by devices like the iPad or iPhone, is swiftly supplanting older gadgets such as computer calculators and push-button phones. This technology necessitates individuals to actively engage their fingers, manual dexterity abilities, visual perceptual skills, and eye-hand coordination skills in order to type or press buttons [(1)].

Screen time encompasses the duration during which an individual is actively involved with a television, computer, video game console, smartphone, or portable display device like an iPad or tablet. Smartphone usage has gained significant popularity, particularly among the youth, for several purposes beyond communication, such as gaming and internet browsing. Increased usage of smartphones is strongly correlated with significant difficulties, particularly weakness in the hand and wrist[(2)].

This weakness arises from the repetitive bending and straightening of the wrist, thumb, and fingers, resulting in musculoskeletal disease [(2)].

The dependence of children's motor development on their motor experience raises concerns regarding the use of interactive technology. As youngsters interact with items in their environment using their hands and fingers, they engage in activities that require motor coordination, joint stability, muscle strength, visual perception, and tactile ability. Nevertheless, the utilization of touch screen technology requires less motor coordination, muscle power, and dexterity in comparison to activities like painting, handwriting, or playing with items and toys. In the last 25 years, advancements in technology have significantly impacted the way children and teenagers interact with people, gain knowledge about their surroundings, and acquire information about the globe [(3)].

Prolonged use of screens in children is linked to inadequate language, social, and cognitive-emotional abilities. In recent years, various academics have recorded the utilization of digital devices by young children in different countries. While TV and PCs reigned as the dominant technology in the 2000s, the use of touch screen devices like tablets and smartphones has significantly increased since the 2010s. Consequently, children currently allocate a greater amount of time to utilizing mobile devices compared to watching television [(1,4)].

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Recent study from the United States indicate that 97% of families possess at least one smart phone, 75% of households own a tablet computer, and 44% of young children possess their own tablet computer [5]. The utilization of tablet computers by children has shown a substantial rise between 2010 and 2019 within the territory of the United Kingdom [5], while in Australia, **Hatzigianni *et al.*** [4] observed that every family possesses at least one television, and over 90% of households possess a touch screen tablet, laptop, or mobile phone. The device is used for 80 minutes each day for TV, 20 minutes for tablets, and 10 minutes for mobile phones.

Adolescents allocate a significant amount of time engaging with their smartphones as a result of their regular usage of social media platforms. Consequently, their susceptibility to the adverse consequences of smartphone usage is heightened as a result of their aptitude for quickly adjusting to technological advancements. Furthermore, they exhibit a high level of susceptibility to the impact of their peers and the surrounding environment. Gaming applications can engender phone addiction in individuals, who may remain oblivious to the potential ramifications on their physical well-being, including bodily deformities and postural issues, as well as psychological challenges. This can result in musculoskeletal abnormalities such as forward neck position, hyperlordosis, and increased neck and upper extremity discomfort. Teenagers are also susceptible to smartphone addiction. This addiction, stemming from the excessive utilization, has a detrimental impact on their emotions, behaviors, social interactions, and academic performance, and leads to conflicts with family members. During adolescence, which is a crucial stage for brain development, excessive use of smartphones has a negative impact on the functional connectivity in the anterior insula and the primary motor cortex [6].

Excessive television use is linked to the postponement of the acquisition of basic physical abilities in younger children, as well as a lack of physical exercise in older children and adolescents. Consequently, there is a potential danger of developing obesity, cardiovascular ailments, and other conditions associated with modern society. Nevertheless, certain applications or games have the potential to motivate children and adolescents to engage in increased physical activity. Digital media can serve as a source of positive role models or a platform for engaging in physical activity. Engaging in computer games, particularly those specifically created to enhance executive functions, can potentially enhance these cognitive abilities in children. Nevertheless, the desired outcomes in this domain can indeed be attained by limited to moderate screen usage [7].

There is a current controversy over the potential correlation between the extensive and quick utilization of screen devices, such as smartphones and mobile games, and the heightened prevalence of depression. Current research on the relationship between screen-based behavior and depression yields conflicting results, with studies reporting negative effects [8], positive effects [9], no effects, or varying effects depending on the specific content and context of screen time, as well as individual characteristics of participants such as age and sex [10,11]. Traditionally, screen-based behavior is evaluated by measuring the amount of time individuals spend watching television, using computers, and playing video games. Nevertheless, contemporary forms of screen engagement, such as streaming movies (e.g., YouTube), utilizing social media platforms (e.g., Facebook, Twitter, and Instagram), and playing online games, are becoming increasingly prevalent among children and adolescents [1]. Crucially, data indicates that various forms of screen use are linked to depression in diverse ways [10,11].

The phrase "text neck" is now used to describe the detrimental and hazardous condition that arises from prolonged and vigorous use of mobile phones. This condition, referred to as a worldwide burden, affects the majority of mobile phone users and is prevalent across all genders, age groups, and societies [12]. Excessive use of smartphones can lead to the expansion of the median nerve, resulting in thumb pain, as well as a decrease in pinch strength and hand function. High smartphone users exhibit a notable enlargement in the cross-sectional area of the median nerve in their dominant hands, as opposed to their non-dominant hands [13].

Mobile phones are electronic devices that enable long-distance communication, are easily carried, and operate without the need for physical connections. In recent times, smart phones have supplanted conventional mobile phones in fulfilling an individual's requirements. As the globe has advanced, there has been an increasing demand for speedier communication, which has resulted in the widespread adoption of cutting-edge technologies. As a result, the smart phone was developed, which is a compact device that incorporates innovative methods of communication. The proliferation of smart phones is supplanting traditional computers in our everyday existence, hence engendering a multitude of adverse consequences. Prolonged use of a mobile phone might subject the thumbs and fingers to excessive strain that exceeds their normal capacity, potentially resulting in pain and musculoskeletal diseases. The dimensions of the mobile phone have been enlarged to accommodate user-friendly designs accessible to all [1,14].

Due to this prevailing pattern, prominent phone manufacturers are producing phones with increased dimensions; yet, research has indicated that smaller devices generally exhibit superior performance compared to larger smartphones. Despite this, individuals continue to depend on purchasing fashionable items rather than

those that are more appropriate for their well-being. The use of smartphones often leads to individuals adopting unnatural postures, which can result in increased stress on the body over an extended period. This, in turn, can lead to the development of many health conditions, including ruptured cervical discs, upper cross syndrome, and tingling sensations in the hands, feet, and shoulders. Moreover, those who use mobile phones are susceptible to developing a range of repetitive strain injuries including carpal tunnel syndrome [12,15]. **Baabdullah *et al*.** [16] noted that extended usage of portable gadgets commonly caused pain in the thumb and forearm. This pain was sometimes accompanied by a burning and tingling sensation around the thenar portion of the palm.

Health-related quality of life (HRQoL) is a metric that assesses both the physical and psychological aspects of an individual's health. It is a significant health indicator that is influenced by a person's experiences, beliefs, and views of their own health. Several questionnaires, including the 'Significant Quality of Life Measure' (SigQOLM), have been created to assess HRQoL [17]. Although the correlation between physical exercise and HRQoL is widely recognized in the adult population, there is insufficient data to support this association in children or adolescents. The HRQoL, or Health-Related Quality of Life, tends to diminish when children transition to secondary education and continues to worsen as they mature, particularly among girls. The connection between HRQoL and sedentary behaviors, such as using screen-based media for non-educational purposes (such as watching TV, playing video games, or using the computer), is not well understood. However, higher levels of physical activity have been linked to better HRQoL, while increased sedentary time has been associated with lower HRQoL in children and adolescents [18].

Prior studies have demonstrated a correlation between inadequate levels of physical activity in children and adolescents and the development of adverse health disorders, including obesity, cardiovascular disease, and mental health issues. Approximately 80% of the global youth population fails to satisfy the physical activity standards set by the World Health Organization (WHO) for adolescents. Prolonged exposure to screens is associated with obesity and a range of non-communicable diseases. Nevertheless, due to technological progress, the amount of time adolescents dedicate to watching television or using mobile phones has become a significant aspect of their daily routine. The current pattern of reduced physical activity and heightened screen usage may jeopardize the health of teenagers. Engaging in optimal physical activity might help reduce the detrimental impact of extended screen time on one's quality of life. However, even if one follows the recommended standards for physical activity, exceeding the recommended screen time can still lead to an increased risk of psychological distress [11, 18].

However, the utilization of mobile phones offers numerous advantages, such as granting students the freedom to manage their time and space, enhancing the efficiency of teaching and learning, facilitating personalized learning, promoting group discussions, and increasing participation and the generation of ideas in seminars [19]. Furthermore, mobile phones have been employed to remotely monitor heart failure patients at their residences for a duration of 6 months. This monitoring includes daily assessment of weight, reading of blood pressure, and doing an electrocardiogram (ECG) once a week [20]. The diverse applications of mobile phones across several fields underscore the notion of prolonged utilization.

Development of hand skills

Motor development is typically categorized into two main types: fine motor development and gross motor development. Gross motor development pertains to the progression of movements that engage the major muscles of the body and contribute to the acquisition of locomotor abilities. Acquiring motor abilities such as crawling, walking, or running is crucial for facilitating movement and ensuring adequate bodily stability throughout the exploration of the surroundings. On the contrary, fine motor abilities refer to the utilization of small muscles to execute precise motions that include the manipulation of things by the limbs. These skills are crucial for cultivating fundamental self-care abilities [21].

The human hand is a sophisticated anatomical mechanism that is specifically adapted for the purpose of manipulation. It serves as a conduit for transmitting sensory information to the brain regarding the warmth and texture of the items it manipulates. The hand is an essential and unavoidable aspect of human anatomy. The functions of this include a wide range of tasks, from precise movements to larger movements involving the whole body. Various daily tasks and athletic activities necessitate significant manual dexterity. The muscles of the hand and forearm play a crucial role in determining grip strength. Hand grip strength is a measure of the maximal force generated by the combined contraction of the muscles in the hand, both from the muscles located outside the hand (extrinsic) and those located within the hand (intrinsic). This force is used to control the movement of the hand joints [22, 23].

Hands serve as instruments utilized to achieve tasks, engage in recreational activities, and carry out critical everyday functions, thus necessitating proficient manual abilities for effective interaction with the surroundings. Manual skills are complex actions that usually depend on the use of touch, body position, and sight to ensure precision. These patterns can be succinctly

described as reaching, gripping, carrying, voluntary release, in-hand manipulation, and bimanual skills [21].

Fine motor abilities are distinct from gross motor skills, as they necessitate a higher level of precision in execution. **Dosman *et al.*** [24] have provided a description of the developmental milestones for fine motor skills, which can be summarized as follows: Infants gradually develop the ability to extend their arms and bring their hands together within the first year of life. As the infant's innate reflexes diminish, they start to intentionally grip items and demonstrate voluntary release. This era is characterized by the infant's ability to move objects from one hand to the other, often about six months of age. At 10 months of age, infants are capable of propelling a cube into a container or intentionally releasing objects onto the floor. By 12 months, newborns have the ability to independently control the muscles in their hand, enabling them to isolate and manipulate their index finger. As a result, they may use their well-developed pincer grasp to pick up little pieces of food and bring them to their mouths.

Between the ages of 2 and 3, children develop the ability to manipulate objects by grasping them and using their hands to use them correctly. In addition, they have the ability to construct a tower using blocks and replicate both vertical and horizontal lines. At this stage, children are capable of independently washing and drying their hands, utilizing scissors, and correctly placing objects into corresponding slots, such as solving puzzles. Between the ages of four and five, children further develop their fine motor abilities by demonstrating the ability to replicate shapes and letters, manipulate scissors, and enhance their pencil control. Between the ages of five and seven, youngsters exhibit the necessary abilities to commence and excel in school [21,24].

The hand grasp is a crucial element of human functionality and serves as a distinctive characteristic that sets humans apart from primates. Hand grip strength is a widely recognized measure of muscular strength. Hand grip strength is a crucial component for several activities including rock climbing, wrestling, handball, tennis, swimming, etc. It is regarded as a determining element in attaining optimal performance and control. Handgrip strength is the outcome of forcefully bending all finger joints using an individual's maximum voluntary force under typical biological conditions [23,25].

Grip strength and pinch strength are essential for executing precise hand movements and daily muscular tasks, relying on well-coordinated power and precision muscles. Hand grip strength and manual dexterity are crucial for school-going children as many of their school activities require manual skills [26,27].

New technology and hand skills

Regular use of touch screen technology limits children's engagement in physical activities and may impede the acquisition of advanced manual dexterity. A study found that typically developing preschool children who did not use touch screen technology for 24 weeks showed improvement in manual dexterity, fine motor integration, and fine motor precision compared to children who frequently interacted with touch screen technology [13,28]. This discovery corroborates the hypothesis that excessive utilization of touch screen technology for non-targeted activities, such as gaming and video consumption, can impede the development of children's hand dexterity.

The proliferation of smart phones has resulted in addictive behavior, particularly among 50% of adolescents. Although smart phones are designed to be used with both hands, young people tend to prefer using them with just one hand. One-handed use predominantly depends on the thumb's movement to access and press the keys, while the remaining part of the hand is utilized for gripping [15,16].

Factors such as the age and gender of the children, the parents' educational level, the number of siblings, and the socioeconomic situation of the family should also be considered as potential influences on children's manual abilities, in addition to their use of touch screens. Children from higher socioeconomic backgrounds demonstrated superior manual dexterity in comparison to children from lower socioeconomic backgrounds due to their early exposure to diverse educational activities during their formative years. The functioning of the body is crucial for the development of hand abilities. Various developmental elements have a substantial impact on the effectiveness of hand use, such as children's visual skills, sensory integration, visual perception, cognition, skeletal integrity, social factors, and culture [21].

The heightened frequency and nature of on-screen activities have a detrimental impact on children's fine motor abilities, visual motor integration, in-hand manipulation, manual dexterity, grip strength, and other hand skills. The growing utilization of technology is also influencing the manner in which youngsters participate in play and leisure activities, with a significant number now opting for more sedentary forms of play rather than active ones [28,29].

According to the survey, college students spent an average of 3.5 hours each day using their smartphones, which resulted in experiencing soreness at the base of their thumb. Potential complications and negative consequences arising from excessive smartphone usage may encompass dry eyes, computer vision issues, neck and shoulder ailments, De Quervain's tenosynovitis, and weakening in the thumb and wrist. Thumb and wrist weakness is a result of the repetitive flexion and extension movement of the wrist and fingers, which intensifies with prolonged use of smartphones, ultimately leading to

discomfort and exhaustion. As the frequency of smartphone usage increases, the hand strength and pinch grip of individuals decrease in comparison to those who use smartphones less frequently [13]. A separate study found no discernible disparity in pinch grip strength among young adults who use smartphones frequently and those who use them infrequently [30].

Media screen and quality of life

Health related quality of life encompasses various dimensions, such as an individual's subjective perspectives on physical, psychological, functional, and social elements of health. It is shaped by both personal and environmental factors. The Pediatric Quality of Life Inventory is a standardized tool used to assess the Health-Related Quality of Life (HRQoL) in individuals between the ages of 2 and 18. A higher quality of life is linked to a more robust feeling of community and enhanced emotional, physical, and overall well-being [31].

Elevated levels of screen time have been linked to depressed symptoms and diminished psychological self-esteem starting from early adolescence, when children allocate a substantial portion of their time to engaging in social media and online gaming activities. Nevertheless, children and adolescents who engage in extended periods of sedentary activities tend to have a diminished Health-Related Quality of Life (HRQoL) in the areas of physical, mental, and social well-being [9,18].

Research has revealed a correlation between the usage of social media and the development of body image problems and eating disorders. Social media use can intensify feelings of jealousy and inferiority. Research has shown that problematic use of social media is linked to a greater occurrence of sadness and anxiety. Additionally, spending excessive time on screens can negatively affect the quality of interactions with friends and family. The repetitive bending and straightening of the wrist is recognized as one of the primary factors contributing to carpal tunnel syndrome. These complications can gradually impair hand function and perhaps result in psychological issues, including a reduced quality of life [4,10,13,32].

Media screen and pain

The extensive utilization of technology by children in educational and domestic settings is linked to numerous physiological consequences. Research has shown that both school and home computer use can lead to musculoskeletal pain in children. Several studies have documented this discomfort, as well as the postural hazards connected with using devices like computers and tablets. Specific factors such as an uneven standing position of the legs and keeping a posture for more than one minute may significantly increase the risk of postural problems. Additionally, using a tablet instead of a laptop may lead to prolonged bending of the neck [12,14,33].

Recent research further indicates a rise in neck problems linked to the use of TV, phones, and tablets. Additionally, visual symptoms are specifically associated with increased usage of phones and tablets. The utilization of electronic gadgets, such as laptops or tablets, has resulted in children adopting uncomfortable body positions. As a result of frequent mobile device usage, end-users experience musculoskeletal issues in their hands, forearms, arms, and necks. Moreover, research has indicated that the use of digital screens can lead to headaches, eye strain, and musculoskeletal pain in the upper body among children and adolescents [14,16,33].

Sedentary behaviors, which refer to activities that include sitting and do not involve exercise, can have substantial impacts on the musculoskeletal system. Screen usage, particularly on mobile devices with compact screens, has been found to impact posture and result in musculoskeletal strain and discomforting symptoms. These symptoms may arise from the repetitive and vigorous motions of the wrist and arm, as well as frequent tilting of the head during video game play. Research has demonstrated a detrimental correlation between the amount of time males dedicate to playing video games and their bone mineral density. The amount of time girls spend watching screens is inversely correlated with the mineral composition of their femur and spine [12,16,34].

Early use of smart devices and the Internet can have several positive effects. Firstly, it allows young children to develop basic digital literacy skills, which will later contribute to their understanding of digital citizenship. Additionally, effective use of the Internet can facilitate self-expression and the formation of identity, while also fostering a sense of connection with peers and family members through activities such as email, messaging, virtual world play, and video conferencing [4,19,35].

CONCLUSION

Children and adolescents are especially vulnerable to the adverse consequences of smart phone use due to the extensive and quick adoption of screen devices like smart phones and portable games. These adverse impacts encompass several aspects of development and have an impact on social, mental, and physical health, as well as behavioral, learning, and attentional abilities. The growing prevalence and variety of screen activities have a direct effect on children's fine motor skills, hand manipulation, manual dexterity, grasp strength, and other hand-related abilities. Additionally, it might result in musculoskeletal diseases, thumb and forearm pain, vision issues, headaches, depression, and addiction to smartphones. Additionally, the utilization of

screens over an extended period of time may have an impact on an individual's Health-Related Quality of Life (HRQoL).

Conversely, mobile phones and displays have advantages such as aiding kids in their education and being capable of monitoring certain vital signs, such as heart rate, in a home setting. They facilitate seamless communication through the use of email, instant messaging, and video conferencing. Additionally, they can efficiently facilitate self-expression and the development of one's individuality.

Parents' awareness of both the positive and negative effects of excessive screen media usage on their children's health, development, and quality of life is crucial for helping them manage and reduce screen time. This can be achieved by increasing their understanding, setting boundaries, and implementing behavioral controls.

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