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A Literature Review on the Effects of the Smartphone Use from Anatomy Point of View

Anatomik Bakış Açısından Akıllı Telefon Kullanımının Etkileri Üzerine Bir Literatür Çalışması

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ABSTRACT
Smartphones have been recognized as one of the most important technological innovations in human history, and with improving customer satisfaction from 7 to 70 years. Smartphones have become an indispensable part of daily life. Smartphones, approximately firstly put forward by Motorola in 1973, and made available from 1984, have affected almost the world over the years. However, smartphone addiction manifests itself as a pandemic in the 21st century and excessive use of smartphones, accompanied by many health problems. Depression and visual impairment are the most common health problems associated with excessive use of smartphones.
The most important problem in the anatomically is the discomfort of the musculoskeletal system. The most reported musculoskeletal system complaint is pain symptom that can be seen in many parts of the body, especially in the fingers, wrist and shoulders. As the duration of smartphone use increases, these complaints also increase. In addition, the use of smartphones affects certain areas of the brain, such as the white matter of the internal capsule and stria terminalis.
The excessive use of smartphones and the rapidly decreasing age of use have become important risk factors for public health. Therefore, it is very important to define health complaints related to excessive use of smartphones and provide users with special preventive measures. In this review, the results of limited studies investigating the relationship between smartphone use effect on common health, especially on the musculoskeletal system diseases are brought together.
Keywords: Smartphone, Health Problems, Musculoskeletal System Symptoms

ÖZET
7'den 70'e müşteri memnuniyetini hedefleyerek en önemli teknolojik yeniliklerden biri olarak bilinen akıllı telefonlar, günlük hayatımızın önemli bir parçası olmuştur. İlk olarak 1973 yılında Motorola tarafından piyasaya sunulan ve yaklaşık olarak 1984 yılından itibaren şatışa sunulan cep telefonları, yıllar içinde neredeyse tüm dünyayı etkilemiştir. Ancak, akıllı telefon bağımlılığı 21.yy'da kendini bir salgın olarak göstermekte ve akıllı telefonların aşırı kullanımı pek çok sağlık problemini de beraberinde getirmektedir. Depresyon ve görme bozukluğu akıllı telefonların aşırı kullanımıyla ilişkili en yaygın sağlık sorunları arasında gelmektedir. Anatomik açıdan en önemli problem ise kas iskelet sistemi rahatsızlıklarıdır. En çok bildirilen kas iskelet sistemi şikayeti özellikle parmaklar, el bileği ve omuz başta olmak üzere vücudun pek çok kısmında görülebilen ağrı semptomudur. Akıllı telefonların kullanım süresi arttıkça bahse konu olan şikayetler de artmaktadır. Ayrıca, akıllı telefonların kullanımı stria terminalis, capsula interna beyaz cevher gibi beynin de belli bölgelerini etkilemektedir. Akıllı telefonların aşırı kullanımı ve kullanım yaşının hızlıca düşmesi önemli bir sağlık sorunu haline gelmektedir. Bu nedenle cep telefonunun aşırı kullanımı nedeniyle gelişen sağlık problemlerini belirlemek ve kullanıcılara özel koruyucu önlemler almak oldukça önem kazanmaktadır. Bu derlemede, akıllı telefon kullanımın genel sağlık üzerindeki etkisinin özellikle kas iskelet sistemi hastalıkları üzerindeki ilişkisini araştıran sınırlı sayıda çalışmanın sonuçları bir araya getirilmiştir.
Anahtar kelimeler: Akıllı telefon, Sağlık problemleri, Kas iskelet sistemi semptomları

Introduction

Smartphones are powerful communication devices. They were created by Motorola in 1973 and have been in the market since 1984[1,2]. In recent years, smartphones have become a basic part of people's lives[1,2]. Even when the user forgets the smartphone, he / she immediately takes the smartphone back, he / she will not go out without the smartphone[3]. People use smartphones for various activities, such as making voice /

video calls, accessing internet searches, taking pictures, browsing social media, reading news and books, managing contacts and appointments, keeping calendars, sending emails, playing games, and participating in educational / academic activities[3]. On the other hand, they affect their users physically and psychologically. One of the main reasons for smartphone usage is texting. Subjects (18-25 years old) mainly use mobile phones for text messaging and playing games[4]. Smartphone abuse has become a major problem in the world population, including physical problems such as eye disease, muscle pain or thumb/wrist vulnerability, cervical pain and stiffness and hearing disorders, and some psychological risks including mental decline, work efficiency, sleep disorders, and anxiety[4-15]. To be occupied with the computer / smartphone can lead to constant use of certain muscles. This turns out myofibril hurt, ever increasing loss from acute trauma[4,16]. Repeated use is a common risk factor. The user looks down for a long time, often causing damage to the neck and shoulders due to the forward head posture[10,16-20]. Continuous exposure to electromagnetic fields and the transmission of signals from smartphones have an active role on pathophysiology and can cause many diseases, including brain tumors and sleep disorders[2]. In addition, many structures of the human brain are also affected by certain habits, such as smartphone and internet use or else[21].

The purpose of this study is to review the effects of frequent and long-term use of smartphones on common health, especially on the musculoskeletal system. As technology continues to advance, the use of these devices may increase. When establishing guidelines for the safe use of smartphones and tablets, musculoskeletal symptoms must be better understood.

Brief history of smartphones

Mobile phones which are efficient communication devices, firstly was known by Motorola in 1973 and broken into market in 1984[1,2]. Unlike today's mobile phone terms, the term Smartphone refers to portable computers[1,2]. Originally, smartphones were only built for business use not to whole society due to their cost[2]. They were integrated with the features of mobile phones and a personal digital assistant for managing calendars and contacts. The second phase of smartphones was reported to begin with the invention of the iPhone by Apple in 2007[2]. Subsequently, Google released the Android operating system which was adopted by many smartphone handset manufacturers and launched worldwide[2]. Nowadays, smartphones are available on all budgets and are widely used by individuals of all ages around the world.

The frequency of smartphones usage

The prevalence of smartphone ownership has increased exponentially over the past decade[22]. During this period, not only the number of smartphone owners has increased, but the time and frequency of use have also increased[17]. Various surveys show that most of the global smartphone users are young people[23]. According to reports, in 2011, 58% of adults and 84% of college students in South Korea owned smartphones[24]. While 85% of the population in United State of America is reported to own smartphones in 2020, it has been reported that users check their devices 52 times a day on average[17]. Another survey, in which users reported spending more than 20 hours per week for messaging, emailing, and social networking, supported this trend[17]. In the United Kingdom, the use of smartphones has increased among users of all ages. Among them, users aged 55-75 have the largest increase, and their use rate has increased from 40% in 2013 to 77% in 2018, interestingly[22]. According to records, the number of smartphone subscriptions in Turkey in 2017 was 77.8 million, and in 2016, 97.8% of Turkish households had smartphones[25].

The number of smartphone users in Turkey will reach approximately 61.34 million by 2022[25]. In addition, in China, smartphone usage exceeded 1.3 billion in 2016 (almost accounting for China's total population)[21]. The smartphone ownership rate accounts for 88% of the South Korean population and 77% of the Australians[26]. In a study conducted by Ataş and Çelik on 842 university students with an average age of 23.26 in Turkey, the students had been using smartphones for about 3 years, 5 hours a day, mainly in the evening/night[25]. The most common aims of smartphones are texting, making phone calls, checking social media (28 times a day on average), searching the web and shopping[25]. The study revealed that smartphones are most often used to spend time waiting for someone, bored and alone[25].

Currently, smartphones have become more and more popular all over the world, and have become a necessity for modern people. Therefore, smartphone users stopped leaving home without a device. This widespread use of smart phones is not surprising, because smart phones bring significant benefits to users, such as information acquisition, efficiency, and effectiveness. On the other hand, increasing use of smartphones is associated with more and more health problems.

Health problems related to smartphone addiction

Although smartphones make life easier, they also bring many side effects. Many physical and mental health problems are related to the increased frequency of smartphone use[4-6,8-15]. However, there are few studies on the negative effects of excessive smartphone use, which may be due to the rapid increase in smartphone use in a short period of time. Despite, few studies have shown consistent results.

Excessive use of smartphones can cause symptoms, reminiscent of mental illness caused by substance addiction, and is considered an addiction[14]. The definition of smartphone addiction is that excessive use will affect the user's daily life. Negative results from long-term use of smartphones are reported as anxiety, depression, memory and concentration problems, sleep disorders, upper limb muscle or joint damage, visual problems, tympanic membrane problems, cancer, brain tumors, neurological diseases, immune system diseases and eating behavior changes[6,8-15,26,27]. Depression is one of the most important problems associated with overuse of smartphones[8,9,28]. Several studies have shown that smartphone use time is positively correlated with depressive symptoms and suicidal thoughts[13]. Excessive use of smartphones can easily make you stay up late, leading to sleep disturbances, which can lead to stress and depression[8,13]. In fact, a study shows that more than 90% of the participants use smartphones before or while they sleep[11]. This reduces the efficiency of sleep and delays the onset of sleep[11]. There are a significant number of studies showing that the duration and quality of sleep is indeed associated with smartphone addiction[11,13]. Furthermore, in a study explaining the biological mechanism of smartphone addiction, the smartphone addiction group found higher levels of gamma-aminobutyric acid (GABA) compared to the control group[13]. High GABA levels cause a decrease in neuromodulation signals, which can lead to anxiety and depression[13]. Other psychological problems associated with smartphone addiction include obsessive-compulsive disorder, interpersonal sensitivity, psychosis, hypochondriasis, paranoia, hostility, and phobias[29]. Excessive use of smartphones can also interfere with physical activity. Functions such as sending and receiving text messages and browsing the Internet are defined as sedentary behaviors[6]. This sedentary behavior is associated with a variety of health problems, including obesity or metabolic syndrome, because it leads to low energy expenditure[6]. There is a positive correlation between sedentary behavior, higher body mass index and mortality from cardiovascular disease[6]. In fact, a study showed that participants with smartphone addiction had a significantly reduced average number of walking steps and consumed fewer calories per day[6]. These participants also had more fat and less muscle mass. In addition, long-term messaging is related to the static and tense spine position[6,16,17]. Thus, it is related to the permanent neck flexion and impaired neck muscle performance[6,16,17]. Carpal tunnel syndrome is the most common hand and wrist complication associated with overuse of smartphones[12]. With the widespread use of smartphones, a major danger is that children and young people now use more smart phones. Especially when children start to use smartphones since they are young, it may distract children from the actual interaction[1]. It makes children develop the habit of jumping from one choice to another, which leads to inattention[1]. In fact, smartphone addiction can greatly reduce students' academic achievement[6,21]. On the other hand, digital devices are an important environmental factor related to vision problems. Several studies have identified computer use as a risk factor for myopia. A study found that myopia is related to the closer working distance to the computer screen. Smart phone users usually use closer working distances than computer screens[15]. Therefore, it can be considered that the increasing exposure to smartphone screens may be a reasonable risk factor for the development or progression of myopia, especially in younger age groups[10,15]. In fact, the extensive use of smartphones has shown as a risk factor of visual symptoms clinically[10,15]. Reported visual symptoms include eye fatigue and dry eyes; however, there is no association between tablet use and visual symptoms, which may be due to the lower rate of tablet use than smartphone use[10,12]. In addition, it has been proposed that the blue light emitted by the screen increases the risk of age-related macular degeneration[10]. The positive correlation between smartphone addiction and health problems is concerning. At this point, while benefiting

from the convenience of life that smartphones provide, it is necessary to raise awareness about the harms of addiction.

The musculoskeletal system risks of smartphones

Frequent use of smartphones is associated with a variety of musculoskeletal symptoms[6,10,13,17-20,23,30]. When using a smartphone, static posture, long-term grip, and repetitive tasks and movements have been considered as risk factors that may lead to neck and upper limb diseases[6,10,13,17-20,23,30]. Generally, it can be observed that the posture adopted by the user when using a smartphone increases the risk of pain for a long time[10,17,18,19,20,23,30]. People who use smartphones always keep their necks bent without supporting their elbows[17,19]. Head flexion angle and head tilt increase during use. The neutral position of the head creates a load of 4.5 to 5.5 kg on the cervical spine. When the neck is tilted forward by 50 degrees, this load will increase to 27 kg[18]. This may cause excessive static charge damage. Devices with smaller touch screens can produce greater head flexion and shorter viewing distances[18]. Therefore, the symptoms of putting the smartphone on the leg level are higher than putting it on the table level[18,31]. Since people look down more while using a smartphone, muscle fatigue is emerging more easily with use of smartphones than computers[31]. Among musculoskeletal diseases, neck complaints have the highest prevalence. Especially those who are already suffering from neck pain, have stronger complaints[19]. Among smartphone users, musculoskeletal symptoms appear not only in the neck, but also in other parts of the body, including shoulders, elbows, arms, wrists, and fingers (especially the thumb)[10,17-20,23,30]. The symptoms reported are pain, fatigue, stiffness, weakness, and sensory problems such as burns, numbness, and tingling. Various musculoskeletal pathologies have also been reported among smartphone users. The most reported pathology is upper limb tendinitis, myofascial pain, and fibromyalgia syndrome[19]. When using a smartphone, repeated movements of the upper limbs will activate continuous muscle contractions, which may cause microscopic damage to the muscles[17]. This is a risk phenomenon of musculoskeletal diseases. Repetitive or static excessive use of the wrist and thumb during the use of a smartphone will increase the burden on the joints, increase carpal tunnel pressure, and reduce the space for movement of the median nerve[17,23]. Therefore, it causes the expansion of the median nerve and muscle tendons[17]. These complications limit the function of hand and can lead to a poor quality of life. People who use smartphones more frequently reportedly have enlarged median nerves, worsen thumb pain, decrease grip strength, and decrease hand function. The median nerve controls the flexor-pronator muscles of the forearm and most of the muscles of the hand[23]. These muscles include in the abduction of the fist, flexion of the hand and wrist, and flexion of the digital phalanx of the fingers[23]. Therefore, the reason for the decrease in grip strength can be explained by the by median nerve enlargement. In addition, when using a smartphone, the typical posture is to hold the device below the line of sight with one or two hands, look down, and then touch the screen with the thumb[17-19]. The user generally needs to keep the neck flexed for a long time. Using a smartphone in a sitting position causes more shift in the head-neck angle than in the standing position[17]. When standing, users tend to minimize changes in neck posture to avoid postural imbalance[20]. Consistent with this idea, it has been found that people who transpose more frequently (every 5 minutes) have a lower prevalence of musculoskeletal symptoms[20]. Additionally, user complaints will increase when performing sensitive tasks or touching small buttons[17]. One possible explanation for this is that the accuracy of the task will lead to higher muscle effort and more time spent on the smartphone. The device is generally held with one hand and operated with one finger. Previous research has shown that words held in one hand have more errors and pauses, and therefore fewer words are written[18]. This will increase the pressure on the thumb joint to reduce errors and increase the time spent on the device. It is said that 16 minutes after using the smartphone, the upper neck and back pain symptoms will begin, and as the time of use increases by 10 to 30 minutes, the possibility of musculoskeletal diseases (especially in the shoulder area) will increase[18]. In a study, 34 adults were divided into 3 groups based on the time spent on smartphones[16]. A significant increase is seen in the level of fatigue in the left upper trapezius muscles with 20 minutes use and in the left cervical erector spinae and bilateral upper trapeziuses with 30 minutes use[16]. There is a significant difference in the degree of fatigue of the left upper trapezius muscle between 10 minutes of use and 30 minutes of use[16]. Therefore, it is obvious that as the time of use of the phone increases, the muscle fatigue increases significantly. There appears to be a limited number of studies on the relationship between smartphone use and musculoskeletal problems. However, it is understandable

that posture, total time spent on the device, and the type of tasks performed on the device will change the association with musculoskeletal symptoms.

Brain regions affected by smartphone use

Many structures in the human brain are affected by certain habits, such as excessive use of smartphones[21]. As mentioned above, more than 90% of users use smartphones before going to bed[11]. This may cause to suppression of melatonin because of the blue light exposure during night. Melatonin is synthesized in in corpus pineale and is responsible for sleep time and circadian rhythm[21,32]. In humans, circadian rhythms can be observed in many physiological and psychological processes. A specific type of melanopsin-containing retinal ganglion cells is directly excited by blue light and send information to the suprachiasmatic nucleus via the retinal hypothalamic tract[33]. The output pathway projects into the corpus pineale[33]. In mammals, melatonin is produced at night and its secretion is inhibited by light[33]. Melatonin suppression and circadian rhythm disorders are the pathophysiological basis for depression[34]. Therefore, exposure to smartphone light at night may be responsible from the relationship between excessive smartphone use and depression by activating the retinohypothalamic tract and so inhibiting melatonin synthesis. In the study of Hu et al., they measured 49 young adults (24 subjects in the control group; 25 subjects in the smartphone addicted group), white matter unity in superior longitudinal fasciculus, superior corona radiata, internal capsule, external capsule, sagittal stratum, fornix /stria terminalis and midbrain structures were lower in smartphone addict group than in control group[21]. The fibers that reach the cerebral cortex pass through the thalamus, caudate nucleus caudatus and nucleus lentiformis in the telencephalon, and form the internal capsule, which gathers in bundles[21]. Many ascending and descending fibers, including corticospinal tract, fibropontine tract, corticonuclear tract etc., pass through the internal capsule[21]. The structural changes or abnormalities of the white matter in the internal capsule play a crucial role in many addictions, such as alcoholism, gambling and even Internet addiction[21,35]. In addition, it leads to the deterioration of proprioception and the reduction of discrimination[21,35]. Damage to the white matter structure in the internal capsule may play a role in the development of smartphone addiction, or it may be related to sensory symptoms that occur when the smartphone is overused. Unfortunately, research on this topic is still insufficient. One of the brain regions affected is the stria terminalis. The stria terminalis is one of the structures of the limbic system and is believed to be related to human stress-related mental diseases, including anxiety, post-traumatic stress disorder, sleep disorders and social dysfunction[36]. The relationship between changes in the stria terminalis and smartphone use behavior should also be investigated in the context of anxiety and depression.

Conclusion

In brief, smart phones have become an important part of daily life. The frequency of use of smartphones is increasing every year. The biggest problems are physical and psychological health problems that occur with higher intensity as the addictive use of smartphones and the frequency of use increases. Additionally, the decline in the age of smartphone use indicates a significant public health risk. The whole society, but especially healthcare professionals, should be aware of the impact of smartphone use on health problems. Therefore, in this review, based on the results of several studies, we have resolved the health problems that are believed to be caused by excessive use of smartphones.

Research shows that excessive use of smartphones forces users to stay in a position where musculoskeletal complaints are inevitable for a long time. On the other hand, the reliability of the surveys and tests used in the research should be questioned. The physical examination should be included more broadly in the work to be done in this area.

Moreover, the research results discussed in this review were obtained from different societies and age groups. Research suggests that sociodemographic factors may be important for smartphone addiction. It seems that it would be appropriate to consider the overall structure of the society, especially when assessing psychological problems. Similarly, when researching physical issues, it is important who is included in the research group. For example, the results obtained by workers who have been overworked by the musculoskeletal system may be different from those obtained by other classes of society.

The question of whether the health problems associated with smartphone use can be corrected by treatment should of course be asked. However, with the continuous development of smartphones and the development of technology, as well as the fact that smartphones have become easier to use, it is inevitable that there will be more and more pathologies related to the use of smartphones in the future. Based on current studies, it may be recommended to use the device at eye level with both hands and change positions at regular intervals during use, in addition to reducing the time of smartphone use, at least to reduce the risk of musculoskeletal problems. It seems that even these suggestions alone can reduce musculoskeletal discomfort. For this reason, we believe that research on the effects of excessive smartphone use should be increased, and specific recommendations should be provided to smartphone users based on the results of these studies.

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