

The Effect of Smartphones on Human Health Relative to User's Addiction: A Study on a Wide Range of Audiences in Jordan

T. Qasim, M. Obeidat, S. Al-Sharairi

Abstract—The objective of this study is to investigate the effect of the excessive use of smartphones. Smartphones have enormous effects on the human body in that some musculoskeletal disorders (MSDs) and health problems might evolve. These days, there is a wide use of the smartphones among all age groups of society, thus, the focus on smartphone effects on human behavior and health, especially on the young and elderly people, becomes a crucial issue. This study was conducted in Jordan on smartphone users for different genders and ages, by conducting a survey to collect data related to the symptoms and MSDs that are resulted from the excessive use of smartphones. A total of 357 responses were used in the analysis. The main related symptoms were numbness, fingers pain, and pain in arm, all linked to age and gender for comparative reasons. A statistical analysis was performed to find the effects of extensive usage of a smartphone for long periods of time on the human body. Results show that the significant variables were the vision problems and the time spent when using the smartphone that cause vision problems. Other variables including age of user and ear problems due to the use of the headsets were found to be a border line significant.

Keywords—Smartphone, age group, musculoskeletal disorders (MSDs), health problems.

I. INTRODUCTION

THE widespread usage of smartphones around the world has attracted the focus of several researchers to study the behavior of smartphone users and the consequential effects on their health and wellbeing. A study in Singapore by Ong [1] focuses on the typing force and thumb motion during texting on a cell phone. Typing forces were measured using four load cells in a force plate arrangement fitted into the phone casing, while the thumb motion was captured based on a motion capturing system working at a frame rate of 120 Hz using a 6-camera reflective marker. This study did not find any incidence of peak forces in the right column of the keypad. The results of the research indicated that the incidence of peak force was linked to high angular displacement in flexion of the IP joint (end joint of the fingers) and in thumb opposition of the metacarpophalangeal joints (MCP) joint [1].

A study about the relationship between life stress and smartphone addiction was performed by Chiu at Taiwan University [2].

T. Qasim is with the Industrial Engineering Department, Jordan University of Science and Technology, Irbid, Jordan (corresponding author, phone: +962 (2) 720 1000, fax: +962 (2) 720 1074, e-mail: tqasim@just.edu.jo).

M. Obeidat and S. Al-Sharairi are with the Industrial Engineering Department, Jordan University of Science and Technology, Irbid, Jordan (e-mail: msobeidat1@just.edu.jo, sabreenthaer@yahoo.com).

Although numerous studies have examined the factors that influence smartphone addiction, few have analyzed the potential protective factors inherent to individuals that may benefit future intervention programs for smartphone addiction [2]. Thus, Chiu study established a model for analyzing the mediating effects that social self-efficacy and learning self-efficacy have on the relationship between students' smartphone addiction and perceived life stress [2].

In another study by Sharan et al. about the upper extremities' MSDs, they concluded that cell phones and gadgets that promoted the predominant only thumb usage or only one finger usage during texting or control usage were associated with a higher MSDs prevalence [3]. They also found that an effective treatment way is performed using a sequenced rehabilitation protocol [3].

Berolo et al. performed a study in a Canadian university population to achieve three goals: Specifying seven measures of cell phone use distribution, determining the distribution of the MSDs of upper extremity, upper neck and back, and to find the relationship between MSDs and cell phone use [4]. Results of this study revealed that 84% of participants reported pain in at least one part of the body and the most common pain was at the bottom of the right hand thumb [4]. In another study by Eapen et al. in India aiming to find the prevalence of MSDs in the upper extremity associated to smartphone use [5], they found that the overall prevalence of MSDs in the upper extremity is found to be 18.5%. The most significant symptom was found in the thumb. The most common symptoms reported by the respondents were pain and fatigue [5].

Chany et al. compared small cellular clamshell phones and traditional office phones in the development of discomfort and muscle fatigue over time when using phones [6]. They found that the development of discomfort and fatigue during phone use is influenced by phone design and human anthropometry [6]. In addition, the design of the phone dictated the style of the grip, resulting in differing fatigue levels and discomfort. The severity of the discomfort is influenced by the anthropometry and fatigue present in the hands and shoulders [6].

Another study conducted in the United Arab Emirates aiming to investigate smartphones impacts on society and also how smartphones are going to transform culture, social life, the technology landscape and other diverse aspects of modern society [7]. The study summarized the impacts that smartphone's have on society and also concluded how these impacts affect the society [7]. The study also recommended

solutions to reduce the negative impacts of smartphones and add more benefits of this exiting technology.

In recent years, the ownership and usage of smartphones have become widespread, especially among young people in Jordan.

II. METHODS

This study is focused on the associated health problems and MSDs on smartphones' users in our society (Jordan) and to compare them with the health problems and MSDs of cell phone users in other societies. The widespread use of smartphones and its impacts on the human body and health, especially the hands, fingers, thumbs, eyes, neck, and other parts of body, were studied utilizing a questionnaire. To increase the number of participants; social media, e-mail, and in-person interviews were conducted. The collected data were then uploaded to a small database to conduct a summary of the questionnaire and help drive the conclusions about the data collected.

A. Questionnaire

A survey targeted smartphone users of different ages between 10 years and 60 years to obtain information about smartphone user's gender and age, pattern of usage and the extent of the impact of smartphones on humans and how they can result in some syndromes or disorders in different parts of the body. By identifying the relationship between the time a person spends in using smartphones and health issues, possible precautions can be recommended to reduce their impacts on the human body including but not limited to the neck, eyes, thumbs and fingers.

B. Participants Population

This study was performed in Jordan based on a survey obtained from a total of 357 participants, divided between 228 females and 129 males. All of 357 responses of the questionnaire were considered for the analysis. Participants ranged in age between 10 years and 60 years. The results of analyzing the survey were divided into two sections. First, the pattern of usage which includes location, length of time and other utilities available in the phone, while the other section was related to prevalence of repetitive motion disorders such as pain in the hands (left, right and both hands), fingers, thumbs, wrists, and other problems such as headaches, vision problems and ear problems.

III. RESULTS AND DISCUSSION

The survey implemented in this study was designed to understand the extent of smartphones impacts on the human body, and how smartphones can result in some disorders or syndromes in the different parts and organs of the body. By identifying the times spent while using smartphones to perform different activities, possible precautions are recommended to reduce negative impacts of smartphone usage on the human body. As mentioned earlier the results were summarized in two sections as follows.

A. Pattern of Usage

In addition to general information about the smartphone users such as gender and handset verses headset, several variables were collected. The purpose of collecting these variables is to determine possible relationships between time spent when using smartphone for gaming, camera, Internet browsing, social media, texting, and other usages on several parts of human body such as the hands, fingers, thumbs, wrists, neck, etc. Fig. 1 provides histograms for four smartphones usage types obtained from the survey, these are Internet browsing, social media, texting and gaming. For each histogram, the frequency of smartphone users over different time periods is calculated. These periods are classified as follows: 1- do not use, 2- less than 30 minutes, 3- from 30 minutes to one hour, 4- from 1-2 hour(s), 5- from 2-3 hours and 6- more than 3 hours. For example, considering the social media histogram, a total of 124 respondents utilize their smartphone for social media purpose only for a period of more than 3 hours each day. As shown in Fig. 1, for the less than 30 minutes' period, text messaging has the highest frequency of 161 users.

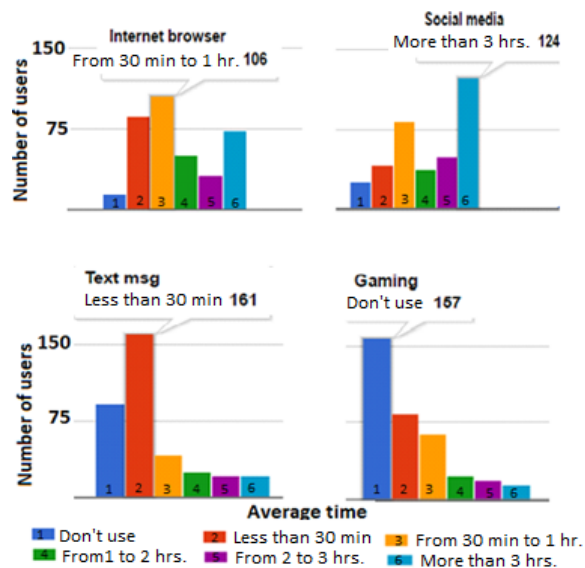


Fig. 1 Smartphone users' frequency over six categories of usages each day

Fig. 2 shows other possible activities that can be done while using the smartphone. These possible activities are eating, driving, walking, drinking and watching TV. According to Fig. 2, over 200 participants agree on using smartphone while watching TV and walking i.e. exercise, which sounds positive, however, most of them wear a headset during these activities which possibly could create ear or hearing problems in the long run. In addition, from a safety perspective, using headsets can block out surrounding noise, which could affect the safety of the user by putting him/her into a situation in which there is a danger of loss, harm, or failure. From Fig. 2, considering the histogram of driving, as shown, column 3 represents the frequency of participants who were disagreeing to the usage of

the smartphones while driving, the number of those participants is a little bit close to 300 participants, and this reflects a high level of awareness for participants.

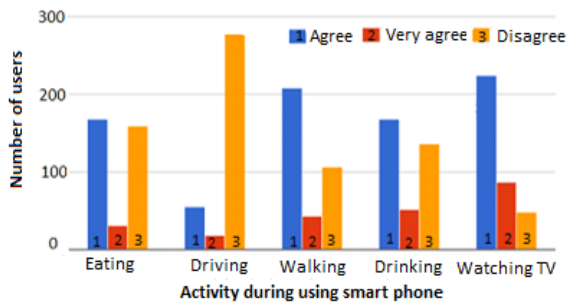


Fig. 2 Possible daily activities that can be performed in combination with smartphones

B. Prevalence of Repetitive Motion Disorders (RMD)

Several disorders were examined in relation to the pattern of smartphone usage variables in the survey. Disorders or pains in hands, fingers, thumbs, wrists, and neck along with headache, vision and ear problems were considered. Fig. 3 shows participants' responses related to headache, vision and ear problems. What is alarming is that most smartphone users who participated in the survey confirmed that they suffer from headaches (65.5%), eye irritation (66.7%) and ear problems (72.5%). The issue of the combination of ear problems and headaches from using phone headset is in agreement with the findings of the study by Ratzuzi et al. [8].

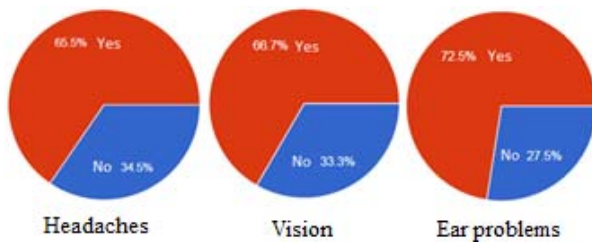


Fig. 3 Headaches, vision and ear problems related to smartphone usage. Note that ear pain is attributed to the use of headsets

The questionnaire in this study addresses using smartphones with one hand only (left or right) and with two hands together to study the resulting pain, numbness and in which part of the hand exactly the pain is located. For the participants, the distribution of participants who are using the smartphone with two hands or by either the right or the left hand is as follows: About 48% use the right hand, about 44% use two hands and about 7% use the left hand. We did not ask participant to determine the dominant hand in the survey. As an example, Fig. 4 shows the different pains that may occur in different parts of the thumb and fingers for those both hand users of the smartphone. Based on the figure, most users experience some pain in the thumb (tip, middle and base) as well as in the other fingers. This finding is in agreement with the findings of Gerr et al. [9].

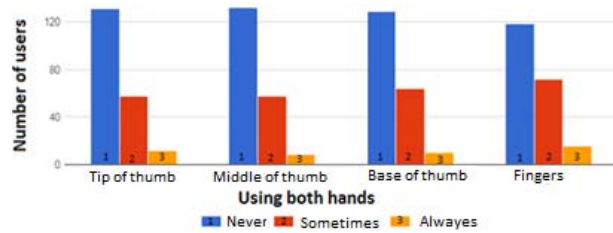


Fig. 4 Pains in thumb and fingers for two-handed smartphones users

IV. STATISTICAL ANALYSIS

To enhance the smartphone study and how using it for long time period may affect the human body, a statistical analysis was performed considering several variables, as shown in Table I. Data were collected from the questionnaire being described previously from 357 participants. Statistical Analysis System (SAS) software was used to analyze the collected data.

TABLE I
THE STUDIED VARIABLES

No.	Effect
1	Gender
2	Age
3	Time of using camera
5	Time of browsing internet
6	Time of gaming
7	Time of text messaging
8	Time of using Social media
9	Time of using other utilities
10	Using smartphone while eating
11	Using smartphone during driving
12	Using smartphone while walking
13	Using smartphone while drinking
14	Using smartphone while watching TV
15	The number of hours that cause headache
16	Having ear pain
17	Having vision problems
18	The time of usage that cause vision problems
19	Which hand(s) is (are) used
20	Tip of right Thumb pain
21	Middle of right thumb pain
22	Base of right thumb pain
23	Pain in right fingers
24	Pain in Tip of left thumb
25	Pain in middle of left thumb
26	Pain in base of left thumb
27	Pain in Tip of both thumbs
28	pain in Middle of both thumbs

The statistical analysis was performed considering a significant level of 0.05, which means, for any tested variables, if its p-value less than or equal to 0.05, this variable will be significant. To perform an advanced statistical analysis, type 3 tests of fixed effects of the regression model between all the considered variables in Table I was conducted. Insignificant variables were removed one after the other based on the p-value, so the variable of the highest p-value was removed first, the variable with the next p-value was removed

next, and so on; this procedure was repeated until we achieved the final regression model which is usually called the reduced model. Table II shows the type 3 tests of fixed effects for the final (reduced) regression model for the considered variables. Based on Table II, the p-value of vision problems and the time of using the smartphone that cause vision problems are 0.0018 and 0.0142, respectively. Since these p-values are less than 0.05, this means that these variables are significant. Significant in our case means that there is strong relation between the time spent when using the smartphone (at different applications) and these variables (vision problems and the time of usage that cause vision problems). In addition, in statistics, when a real data is used, variables with p-values close to the considered significant level are considered a border line significant. In some cases, a border line variable may provide a big indicator about something important. For example, increasing the sample size may convert this border line significant variable into a significant variable (meaning that its p-value falls below 0.05). Here, there are two other variables in our study considered as border line variables as shown in Table II: Age, and ear pain, because their p-value is close to 0.05. For the age and the ear pain, there might be some possible relation between the time spent when using the smartphones and these two variables.

TABLE II
TYPE THREE TESTS FOR FIXED EFFECTS FOR THE FINAL REGRESSION MODEL

Effect	Degree of Freedom	F Value	p-value
Age	40	1.38	0.0707
Having ear pain	1	3.10	0.0795
Having vision problems	1	9.88	0.0018
The time of usage that cause vision problems	9	2.35	0.0142

V.CONCLUSIONS

According to the statistical analysis of the survey, using smartphones for long period of time is critical for users because some problems tend to evolve over time. There is a strong connection between the amount of time a person spends using a smartphone and the extent and types of pains that may occur in the human body. In the long-term, the most significant pains or symptoms that can result from excessive smartphones use were identified as headaches, vision and ear problems, while most of the disorders were associated with the fingers, including the tip, middle and base of the thumbs. According to the survey, excessive and long-term smartphone usage may also result in numbness in the hands, fingers and thumbs.

According to the statistical analysis which was performed to study the effects of excessive usage of smartphone for long periods of times on the human body, the results show that the significant variables were vision problems and the amount of time of using the smartphone that cause vision problems. Other variables including the age and the ear problems due to the use of the headsets were found to be a border line significant variables.

Based on results obtained from this study, we must put

some controls on the bad habits when using smartphone devices and their accessories such as headsets, and we must reduce as much as possible the time spent while using smartphones, due to the understood detrimental physical effects on the human body especially on the hands, thumbs, fingers, eyes, ears, and wrists.

REFERENCES

- [1] F. Ong, "Thumb Motion and Typing Forces during Text Messaging on a Mobile Phone," in *2008 ICBME Conf. Proceeding*, pp. 2095–2098.
- [2] S. Chiu, "Computers in Human Behavior. The relationship between life stress and smartphone addiction on Taiwanese university student: A mediation model of learning self-efficacy and social self-efficacy," 34, pp.49-57. 2014.
- [3] D. Sharan, M. Mohandoss, R. Ranganathan, and J. Jose, 2014. 'Musculoskeletal Disorders of the Upper Extremities Due to Extensive Usage of Hand Held Devices,' *Annals of Occupational and Environmental Medicine*, 26: 22. 2014.
- [4] S. Berolo, R. Wells, and B. Amick, "Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: A preliminary study in a Canadian university population," *Applied Ergonomics*, 42(2), pp.371-378. 2011.
- [5] C. Eapen, B. Kumar and A. Bhat, "Prevalence of Cumulative Trauma Disorders in Cell Phone Users," *Journal of Musculoskeletal Research*, 13(3), pp. 137-145. 2010.
- [6] A. M. Chany, W. S. Marras and D. L. Burr, "The Effect of Phone Design on Upper Extremity Discomfort and Muscle Fatigue," *Human Factors J*, 49(4), pp. 602-618. 2007.
- [7] M. Sarwar and T. R. Soomro, "Impact of Smartphone's on Society," *European Journal of Scientific Research*, 98(2), pp. 216-226. 2013.
- [8] R. Patuzzi, J. Milhinch and J. Doyle, "Acute aural trauma in users of telephone headsets and handsets," 2000. *Neuro-Otological Society of Australia Annual Conference*, Melbourne.
- [9] E. Gerr, M. Marcus, C. Ensor, D. Kleinbaum, S. Cohen, A. edwards, E. gentry, D. Ortiz, C. Monteilh, "A Prospective Study of Computers Users: I. Study Design and Incidence of Musculoskeletal Symptoms and Disorder" *American J of Industrial medicen*, 41, pp. 221-235. 2002.