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CORRELATION BETWEEN SMARTPHONE USAGE DURATION AND HANDGRIP STRENGTH IN ADOLESCENTS AGED 18-24 IN TULUNGAGUNG

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ABSTRACT

Generally, a person will spend quite a long time using his smartphone. Prolonged use of smartphones can cause musculoskeletal disorders. This event can make the function of the biomotor component decrease. One of the decreased biomotor components is handgrip strength. The role of physiotherapy is needed to educate in avoiding the risk of decreased grip strength. Therefore, this study aims to determine the relationship between smartphone usage duration with handgrip strength in adolescents aged 18-24 years. This research is an analytical observational study using a cross-sectional approach. Sampling using a purposive sampling technique. Fifty women aged 18-24 years who had met the participating criteria were the participants in this study. Handgrip strength was measured using a Camry Handgrip Dynamometer. Smartphone usage duration was obtained from recording the average daily screen time for a month. The average smartphone usage duration the participant's smartphone was 453.88 ± 159.16 minutes. Based on Pearson correlation analysis, there is a significant negative relationship weak to moderate strength between smartphone usage duration and handgrip strength (r=-0.51; p=0.00 dominant handgrip, r=-0.33; p=0,02 non-dominant hand grip). Linear regression showed variations in the strength of the dominant handgrip as much as 26.4% and the non-dominant hand grip as much as 11% can be explained by the smartphone usage duration ($p<0.05$). The conclusion is smartphone usage duration is correlated with a decrease in handgrip strength. The longer using a smartphone, the weaker the grip strength.

Keywords: screen time, smartphone, grip strength

INTRODUCTION

The smartphone is one of the gadgets that makes it easier for humans to communicate and interact. As the desire to communicate grows, so does the number of smartphone users. After China and India, Indonesia has seen the greatest increase in smartphone users. The number of smartphone users in Indonesia is expected to reach 92 million in 2019[1]. With a penetration rate of 97 percent in 2017, the 18-24 year age group had the highest penetration of smartphone use[2]. According to the Internet Trends report by Kleiner Perkins Caufield & Byers, the average smartphone user checks their phone 150 times per day[3]. Meanwhile, according to another publication, the average person spends 14 hours per day on their smartphone in their spare time and about 3 hours per day at work[4]. Excessive smartphone use can result in musculoskeletal issues.

Musculoskeletal problems do not develop solely in elderly age. Musculoskeletal difficulties are likely to occur at some point in a person's life. According to the World Health Organization (WHO), one out of every three persons (including children) suffers from musculoskeletal discomfort, and 20% - 33% of people globally suffer from painful musculoskeletal diseases[5] . Musculoskeletal diseases (MSD) in the hands, wrists, and arms have become more common practically everywhere in the world. In 2001, there were 355,344 cases of injury and illness in the European Union. In the Netherlands, Germany, and the

United Kingdom, musculoskeletal diseases accounted for 21 percent to 28 percent of absence days from work in 2017-2018[6]. Repetitive strain injury is one of the most common ailments (RSI). In the United Kingdom, the prevalence of RSI in the upper extremity was 730 cases per 100,000 workers in 2014, with computer typing (14.3 percent) being a significant risk factor, and each case of RSI in the upper extremity resulting in a loss of 18 days of work, for a total loss of 4.1 million workdays in 2014. Understanding RSI and regulating rest intervals are crucial elements in avoiding this event[7].

RSI is an injury caused by repetitive and vigorous motions, poor posture, and illness as a result of working conditions and non-ergonomic positions. Using a computer mouse, typing, playing games with a joystick, using a vibration device, and using a smartphone are all activities that might cause RSI. Using a smartphone is one of the activities that might induce RSI because most smartphone users keep their hands in a suboptimal posture for long periods of time and use their fingers and thumbs repeatedly[8] .According to one assessment of the literature, smartphone use increases biomechanical stress on the body, particularly on the neck, wrists, and thumbs, as a result of poor posture, muscular tension, and repetitive movements[9]. This is proven by smartphone users who report that 52.6 percent of people have thumb symptoms, 13% have wrist complaints, and 11.9 percent have finger complaints[10].

According to research, repetitive quick movements of the mother might produce muscle exhaustion, implying that this form of repetition over time can lead to muscle injury accumulation. Of course, this can impair the function of the biomotor components. Strength is one of the reduced biomotor components[11]. It was revealed that 42 percent of study participants had medium to severe handgrip strength weakness as a result of smartphone use[12]. Hand muscle strength decreases as a result of microtrauma in myofilaments during activities that cause repeated strain injuries. Handgrip strength is lower in those who have complaints of musculoskeletal diseases (MSD) than in people who do not have the disorder, according to research published in the journal. So, using a smartphone for an extended period of time might cause RSI, and one of the indications of RSI is a decline in handgrip strength[13].

The purpose of this study was to prove whether there is a relationship between smartphone usage duration and handgrip strength in adolescents aged 18-24 years in Tulungagung Regency.

METHODS

a. Methodology

Study design

This is an analytic observational study with a cross-sectional design. The study was approved by the Research Ethics Commission (KEP) Medical Faculty of Udayana University/Sanglah Hospital Denpasar before participants were recruited, with ethical clearance number 1783/UN14.2.2.VII.14/LT/2021. The study was conducted at the State Islamic University of Sayyid Ali Rahmatullah Tulungagung at the student association room from November to December 2021.

Subject recruitment

To begin, the survey was done in November 2021 to establish a total sample of 110 people, of whom 110 were chosen and measured in December 2021. Participants that meet the eligibility requirements are female, aged 18-24 years, do not smoke, have a normal BMI (18.5-22.9) Asia Pacific categorization, and a normal physical activity value (5.6-7, 9) index baecke[14]. Participants with a history of finger and wrist fractures or musculoskeletal injuries, neck pain radiating unilaterally or bilaterally, congenital upper limb abnormalities, a history of surgery or neurological disease such as CTS, and other motor problems in the upper extremities exclude from study.

Sampling technique

Purposive sampling was used to collect the sample. This technique chooses a sample based on predetermined parameters. Participants were informed about the study's benefits, objectives, and brief

procedures. In addition, participants completed Baecke's questionnaire, were measured for height and weight, and were interviewed about inclusion and exclusion criteria. Participants who satisfied the requirements were then asked to collect data on smartphone usage time and handgrip strength.

b. Material and procedure

Material

This study observes the relationship between the independent variable and the dependent variable. The smartphone usage duration is the independent variable, while the handgrip strength is the dependent variable. To reduce bias, several variables were controlled, namely age, gender, BMI, temperature, smoking activity, and physical activity. The smartphone usage duration was obtained from recording the average daily screen time for one month from *Your Hour* application which the participant downloaded from the playstore. Handgrip strength was measured using a Camry handgrip dynamometer model EH 101. Body mass index (BMI) was measured using a weight and height scale. Temperature was measured using a room thermometer. Physical Activity was measured using the questionnaire Barthel index. Age, gender, and smoking activity was obtained from the interview.

Procedures

From the research participants who are teenagers aged 18-24 years in Tulungagung district given information on the benefits, objectives, and brief procedures of the study. Furthermore, research participants filled out Baecke's questionnaire, measured height and weight, were interviewed regarding inclusion and exclusion criteria. Subjects who met the criteria then collected data smartphone usage duration and measured hand grip strength.

c. Assessment

The smartphone usage duration is measured objectively using an application downloaded from the play store with the concept of taking screen-on-time data on a smartphone for a day. From 30 days the data obtained were then averaged. These are processed automatically by the system of the application and the results cannot be intervened by either the user or the researcher. The results measured are in the form of numbers in minutes. The result of the measurement is a Ratio scale. The value of handgrip strength can be obtained by gripping the handgrip dynamometer instrument as tightly as possible in a sitting position according to the ASHT (American Society of Hand Therapists) procedure[15]. The grip must be done gently, there should be no sudden movements. The measurement takes about 3 to 5 seconds. Performed 3 times with a pause of 15 seconds on each side of the hand, both dominant and non-dominant to prevent fatigue and the average of the three experiments was taken. The result of the measurement is in kilograms (Kg) and is a ratio scale.

d. Data analysis

Data were analyzed using IBM (SPSS) version 25. To determine the characteristics of the participant using descriptive analysis. Next, to find a relationship between smartphone usage duration and handgrip strength using Pearson correlation analysis and to find out smartphone usage duration affects handgrip strength using simple linear regression analysis.

RESULTS

Out of 110 adolescents aged 18-24 years in Tulungagung Regency, as many as 50 adolescents have met the eligibility criteria. The remaining 60 teenagers did not meet the eligibility criteria.

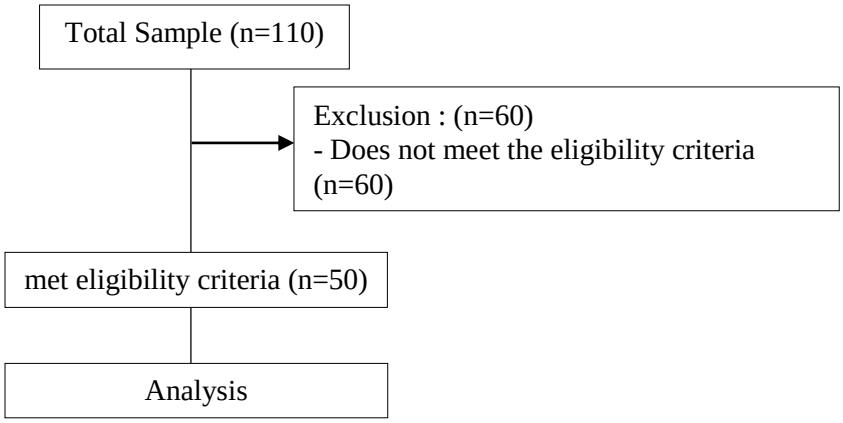

Figure 1. Flow Diagram Sample

The characteristics of the participants in this study were based on age, age using mobile phones, smartphone usage duration, dominant and non-dominant hand grip strength. Following are the results of the analysis of the characteristics of the participant.

Tabel 1 Characteristics of Research Participants

Variable	N	Max Value	Min Value	Mean	SD
Age	50	22	18	20,3	1,16
Smartphone usage age	50	13	3	8,8	2,49
Smartphone usage duration (minute)	50	878	142	453,9	159,16
Dominant handgrip strength (Kg)	50	23,7	10,467	18,8	3,27
Non dominant handgrip strength (Kg)	50	26,833	9,033	16,6	2,93

Based on table 1, it is known that the total number of participants is 50 where the lowest age of the participant is 18 years and the highest age is 22 years, the average smartphone usage age is 8.8 years with a standard deviation of 1.165. The lowest smartphone usage age is 3 years and the highest is 13 years. All participants are active mobile phone users with the lowest duration of time using a mobile phone is 142 minutes or 2 hours 22 minutes and the highest is 878 minutes or 14 hours 38 minutes. The average participant used his smartphone for 453.88 minutes or 7 hours 34 minutes with a standard deviation of 159.157. The average value of the dominant hand grip strength was 18.84 kg with a standard deviation of 2.932617 and the non-dominant hand grip strength of 16.61 kg with a standard deviation of 3.276697.

Table 2. Pearson correlation test

variable correlation	Correlation Value (r)	p value
Smartphone usage duration and dominant handgrip strength	-0,514	0,000**
Smartphone usage duration and non dominant handgrip strength	-0,331	0,019*

**. Corelation is significant at the 0,01 level
* . Corelation is significant at the 0,05 level

Based on table 2, it shows that there is a significant relationship between the smartphone usage duration with the dominant hand grip strength having a p value of 0.000 ($p < 0.05$) and the non-dominant hand with

a p value of 0.019 (p < 0.05). For the correlation value of the long time using a mobile phone with the dominant hand grip strength of r = -0.514 which means there is a moderate negative relationship. For the correlation value of the relationship between the smartphone usage duration with the strength of the non-dominant hand grip of r = -0.331 which means that there is a low or weak negative relationship. This negative relationship shows that the higher the smartphone usage duration, the lower the hand grip strength and vice versa. Furthermore, to find out how much influence the smartphone usage duration predicts hand grip strength, that is by using a simple linear regression analysis. The results of the analysis can be seen in table 3 below:

Table 3. Linear regression analysis

variable correlation	R^2	p value
Smartphone usage duration and dominant handgrip strength	0,264	0,000
Smartphone usage duration and non dominant handgrip strength	0,110	0,019

Table 3 shows the R Square value between the smartphone usage duration with the dominant hand grip strength having a value of 0.264 with a p value of 0.000 (p < 0.005) and a non-dominant hand grip strength of 0.110 with a p value of 0.019 (p 0.005). The value of R Square or the value of the coefficient determination is the value of how much a variable x can affect the variable y. So from the results of the analysis 26.4% of the variation in the high and low of the dominant hand grip strength is influenced by the smartphone usage duration, the remaining 73.6% is caused by other factors. Meanwhile, for the variation of high and low hand grip strength, 11% is influenced by the smartphone usage duration, the remaining 89% is influenced by other factors.

For the linear regression model, the relationship between the smartphone usage duration and hand grip strength is described in table 4 as follows:

Table 4. Linear regression model

variable correlation	Coefficients		Std Error	p value
Smartphone usage duration and dominant handgrip strength	B	-0,009	0,002	0,000
	Constant	23,133	1,096	0,000
Smartphone usage duration and non dominant handgrip strength	B	-0,007	0,003	0,019
	Constant	19,707	1,347	0,000

The simple linear regression model has the formula y=a+bx. Where in the relationship between the length of time using a cell phone and the strength of the dominant hand grip, the model has y=23.133+(-0.009)x which means that in the sample of this study if the length of time using a cell phone is 0 then the dominant hand grip strength is 23.133 kg and each addition 1 minute of time using a mobile phone will reduce the strength of the dominant hand grip by 0.009 kg. Meanwhile, in the relationship between the length of time using a cell phone and the strength of the non-dominant hand grip, the model is y=19,707+(-0,007)x, which means that in the sample of this study if the length of time using a cell phone is 0 then the strength of the non-dominant hand grip is 19,707 kg and for every 1 minute addition of mobile phone usage time, the dominant hand grip strength will decrease by 0.007 kg. The value of the coefficient B of these two equations has a negative sign which means that the length of time using a cellphone has a negative effect on both dominant and non-dominant hand grip strength, this decrease can be seen from the line graph of a descending linear regression

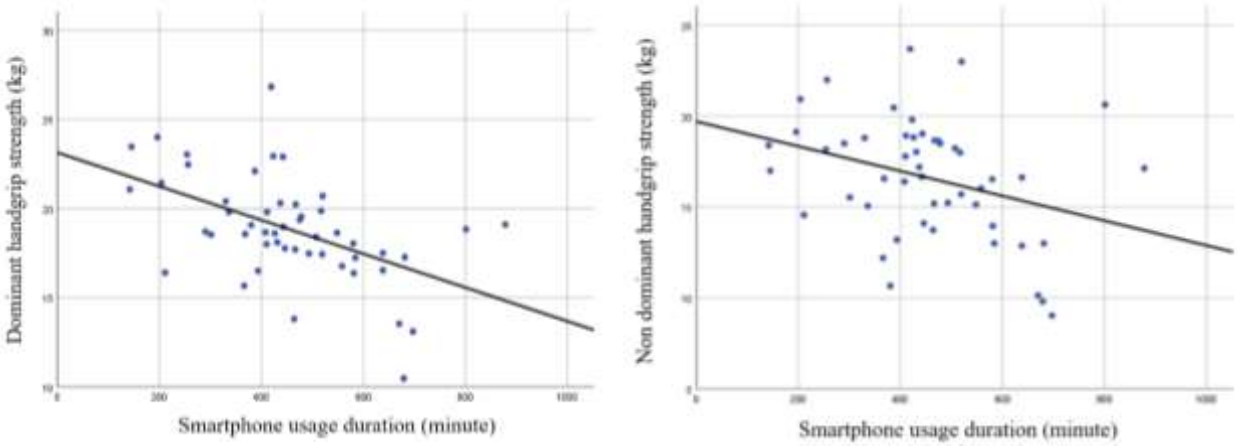

Figure 2. Linear regression graph of the relationship between the smartphone usage duration with hand grip strength

DISCUSSION

The participants' ages range from 18 to 22 years old, and they are all students who are actively studying and use smartphones. The age range for using smartphones ranged from 3 to 13 years, with an average of 8.8 years. Mechanical loading provided constantly for four years, according to studies, can cause musculoskeletal problem[16].

The smartphone usage duration the participant's smartphone also varied from the lowest 2 hours 22 minutes to the highest 14 hours 38 minutes with an average of 7 hours 34 minutes. It was reported that the average smartphone usage duration in students was more than 3.5 hours/day associated with the onset of symptoms of pain at the base of the thumb[17]. The presence of pain indicates that there is tissue damage in the area, where tissue damage can cause a decrease in hand grip strength. Of the 50 participants, only 4 participants had a long usage time of less than 3.5 hours/day.

The results of observations on the grip strength of 50 participants have different grip strengths with an average grip strength of 18.8 kg in the dominant hand and 16.6 kg in the non-dominant hand with the lowest value of 9 kg and the highest value of 26.8 kg. According to the Asian Working Group for Sarcopenia (AWGS), the Foundation for the National Institutes of Health (FNIH), and the Korea National Health and Nutrition Examination Survey (KNHANES) the lower threshold value for a woman's grip strength is said to be weak if it is less than 18kg according to the AWGS, 16kg according to the AWGS. FNIH, and 16.4kg according to KNHANES in 2015[18]. This shows that the average of the 50 participants studied are active smartphone users with a usage age of more than 2 years and have grip strength above the threshold value for dominant hand grip while for non-dominant hand grip it tends to approach the threshold value and average. The average smartphone usage duration from 50 participants tends to be higher than the recommended one, so it's categorized as excessive smartphone user[19].

From the results of the analysis of parametric Pearson data in table 2, the value of $p = 0.000$ ($p < 0.05$) with an r value of -0.514 for the relationship between the smartphone usage duration with the dominant hand grip strength, and $p = 0.019$ ($p < 0.05$) with an r value of -0.331 for the relationship between the smartphone usage duration with a non-dominant hand grip strength. This p value <0.05 indicates that H0 is rejected and Ha is accepted where the alternative hypothesis is that there is a relationship between the smartphone usage duration and hand grip strength. In this study, it was also found that there was a moderate relationship between the smartphone usage duration and the strength of the dominant hand grip, with a negative value, which means that the higher the duration of using a smartphone, the lower the hand grip strength. This finding is similar to a previous study by Osailan which concluded that prolonged use of a smartphone was associated with poor hand grip strength. Osailan's research found that there was a weak relationship between the smartphone usage duration and hand grip strength with p value = 0.03 and r value = -0.22[15].

In İNal's study found similar results, there was a relationship between smartphone usage duration and hand grip strength, besides that the study found a positive relationship between the ratio of median

nerve thickness and the ratio of the thickness of the flexor policis longus tendon to the smartphone usage duration. This thickening indicates damage to the FPL tendon and also to the median nerve, which results in weakened grip strength. Nerve damage that occurs can cause a decrease in nerve conductivity so that the motor unit innervation of the hand grip muscles is reduced so that the hand grip strength decreases[20].
Not only on the median nerve, according to Samaan's research findings, too long using a smartphone causes a decrease in the speed of conductivity of the ulnar nerve. Tissue damage that occurs is in accordance with the Cinderella hypothesis where this hypothesis states that activities that take place continuously in certain motor units with low levels of contraction have a loading effect on the motor unit which causes damage to the motor unit. Using a smartphone is one of the activities that affect this network damage because when playing the smartphone tends to repeat its movements with low intensity[21].

Table 3 shows the variation of the dominant hand grip strength as much as 26.4% can be explained by the smartphone usage duration, the remaining 73.6% is explained by other factors besides age, gender, BMI, physical activity value, smoking activity, and temperature because in this study these factors have been controlled. Meanwhile, in the non-dominant hand grip strength, the variation can only be explained by 11% by the smartphone usage duration.

This shows that the effect of time using a mobile phone is greater in the right hand than in the left hand. This finding may indicate that the dominant hand is used more often to operate the mobile phone than the non-dominant hand. The effect of the smartphone usage duration is explained by making an estimation of a linear regression model from the research sample data so that in Table 4 it is found that for every 1 minute addition of the average daily use of a smartphone there is a decrease in the dominant hand grip strength of 0.009 kg.

This happens because each additional smartphone usage duration will increase the biomechanical stress on the motor unit of the hand area due to continuous isometric movement of the flexor extensor muscles of the fingers and wrist and the repetitive motion of the thumb muscles. Excessive biomechanical stress will cause the following 3 things: (1) Reorganization of the Central Nervous System, (2) Damage or compression of the motor unit tissue, (3) Remodeling of the motor unit tissue. Reorganization of the CNS will cause changes in motor response due to excessive mechanical loads that reduce motor skills. Damage to the motor unit tissue will cause acute inflammation, repeated acute inflammation can cause chronic inflammation and cause tissue fibrosis. In addition, there will be remodeling of the motor unit tissue, the remodeling that occurs is pathological remodeling, this will cause the tolerance to biomechanical loading to decrease and will increase the risk of damage to the motor unit tissue. These three things will overlap each other causing a decrease in hand grip strength.

Although this study found a negative correlation between the smartphone usage duration and hand grip strength, the researchers found several studies that had different results where the research showed the opposite result, namely a positive correlation between the smartphone usage duration and hand grip strength. According to study, someone who can manage their activities efficiently and use their smartphone in moderation can maintain or grow their hand grip strength[22]. This happens because of adaptation in the form of enlargement of the FPL tendon in the hand so that the hand grip strength increases.[18] This influence does not arise only from physical factors but also from psychosocial factors such as stress levels, sleep quality, perceptions, workload, etc[23].

CONCLUSION

According to the findings, smartphone usage among teenagers in Tulungagung Regency aged 18 to 24 has a relationship with hand grip strength. The relationship is inversely proportional, the higher the value of smartphone use, the value of hand grip strength decreases, and vice versa. So, the longer a person use smartphone it can cause a decrease in hand grip strength, but if the person lower their smartphone usage, they can maintain their hand grip strength and even increase it. So it is recommended that smartphone user can manage their time using their smartphone.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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