Effects of Using Smartphone on Pinch Strength

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Abstract

The present study is planned to explore the effects of smartphone use on pinch strength and to investigate the pinch strength after using smartphone for a certain segmentation of time. Seventy-one volunteers (52 male & 19 female) participated in this study. Pinch strength for dominant hand was used by using Digital Pinch/Grip Analyzer. Volunteers were asked to use smartphone for one and a half hour by their dominant hand and three different size of smartphone was given to each individual. A measurement of pinch strength was obtained before using smartphone and the next measurement of the pinch strength was obtained after each thirty minutes. Bivariate Pearson Correlation was done between the obtained pinch strength separately for male and female. For smartphone width of 68.1 mm Pearson Correlation value was found .928** for male and .826** for female after the use of smartphone for ninety minutes. For smartphone width size 73.9 mm Pearson Correlation was found .826** for male and .874** for female at ninety minutes. For smartphone width of 77.26 mm Pearson Correlation value was found .758** for male and .883** for female. Correlation was significant at the .001 and .005 level. Kolmogorov-Smirnov test was done to see the normality of the distribution. It was found normal and a graph was conducted to show the mean of the values found.

Keywords
Smartphone, Pinch Strength, Digital analyzer.

1. Introduction
Smartphone is a major extension of human life. It is hard to find a modern student who is updated in technology but does not use smartphone. Having a wide range of facilities and applications to make life easy, smartphone now became a significant time spending tool and communication medium. But severe usage of smartphone has some adverse effects also [1]. These effects range from physical to mental, hand to brain, neck to eye and many more. Students of modern era are a big market for smartphone users. The extensive use of smartphone for social media and virtual games have made it more of addictive tool rather than a useful device. A Student usually writes a lot and also uses smart phones for a long time every day. This can affect their writing strength which may result in slow writing speed during exam time. Pinch strength is a Tip-pinch is a situation where one has difficulty in opposing the tips of the index finger and thumb when trying to pick up and hold small objects [2]. Measurement of grip strength or pinch strength is important not only can be used to quickly evaluate one's general muscle or pinch strength, but it has been related with various medical conditions across various age groups [3].

2. Literature Review
The widespread usage of smartphones around the world has attracted the focus of several researchers to study the consequential effects on their health and wellbeing. A study in Singapore by Ong focuses on the typing force and thumb motion during texting on a cellphone [4]. 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 [4]. A study about the relationship between life stress and smartphone addiction was performed by Chiu at Taiwan University [5]. In another study, Sharan et al. discussed about the upper extremities' Musculoskeletal Disorders (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 [6]. Qasim et al. in their paper titled "The Effect of Smartphones on Human Health Relative to User's Addiction: A Study on a Wide Range of Audiences in Jordan" tried to investigate the effect of the excessive use of smartphones and some effects on the human body which led to some musculoskeletal disorders (MSDs) and health problems [7]. Miakotko in his paper titled "The impact of smartphones and mobile devices on human health and life" concluded recent scientific facts and research analysis of the smartphones on human health and life. Uddin et al. in their paper titled," Effects of Anthropometric Factors on Grip Strength and Work Capacity**"** investigated the relationship of grip strength with anthropometric parameters and also the relationship of work capacity with grip strength and anthropometric variables. Multiple regression model was used to find the factors affecting most for the grip strength and work capacity [8]. Đnal et al. in their paper titled "Effects of Smartphone Overuse on Hand Function, Pinch Strength, and the Median Nerve" investigated the flexor polices longus (FPL) tendon and median nerve in smartphone users by ultrasonography to assess the effects of smartphone addiction on the clinical and functional status of the hands. Smartphone Addiction Scale (SAS), grip and pinch strengths, visual analog scale (VAS), the Duruöz Hand Index (DHI) and the cross-sectional areas (CSA) of the median nerve [9].

3. Objectives

a) To explore the effects of smartphone, use on pinch strength.
b) To investigate the pinch strength after using smartphone for certain segmentation of time.

4. Experimental method

The analysis was performed on the students of department of Industrial and Production Engineering, SUST, Sylhet, Bangladesh. Sample size was obtained by using Slovin's formula on .07 precision. 71 volunteers performed this study although the sample size was supposed to be 107. There was a shortage of subjects as the volunteers were not willing to spend time on the research. Research with reduced sample size is also available in the literature (S. M. Uddin et al., 2019). Participants were given three different smartphones with different screen sizes (screen width: 68.1 mm, 73.9 mm, 77.23 mm). Detailed description for the various experimental procedures used to show relationship of pinch strengths at different time interval. A comparison of pinch strength between male and female was also described.

4.1 Description of subjects

The present study is based on the selection of 107 unrelated, average and healthy participants among them 71 participated. Among the 71 participants 52 were male and 19 were female. The age of the participants was between 19-22 years old as the study was conducted on the undergraduate level students. Age, hand dominance, any medical history of the past and current injury to hand which might diminish normal pinch strength; this information is determined by the declaration of the participants. Subjects were informed about the purpose and procedure of the study.

4.2 Measurement of pinch strength

Experiments to determine pinch strength was done with the help of Digital Pinch Analyzer. It is a dynamometer manufactured by MIE Medical research Ltd. (U.K). The performance of the instrument is very high. This consists of adaptable two flat padded pieces mounted parallel to each other maximum of 3.5 cm distant. The handle's sensors are designed exceptionally so that if someone holds the handle anywhere within the black area below the red indicating line (fig.1), the performer should get the correct reading at each time. For neutralizing the reading the performer need to press or hold zero button before every start. Newton (N) was taken as the measurement of the pinch strength unit. The participants were told to grip the handle as the way the grip pen or any tool that needs to be pressed by the pinch of the hand. For each test the participants were told to press the handle by the pinch with utmost effort for 2/3 seconds [10].

5. Analysis and Results

Statistical Packages for the social sciences, SPSS version 25.0, was used for statistical analysis. Microsoft Excel was used to plot the bar graph showing the trend of pinch strength for male and female at different interval of time for three different sizes of smartphone. Percentages of male and female participants was also showed by the Microsoft Excel in figure 2. Percentages of participants of different ages was shown in Figure 3. Pearson Correlation was used to find the significance and relationship between the time variables. Kolmogorov Smirnov test was conducted for identifying the normality of the distribution and based on the test the mean was plotted.

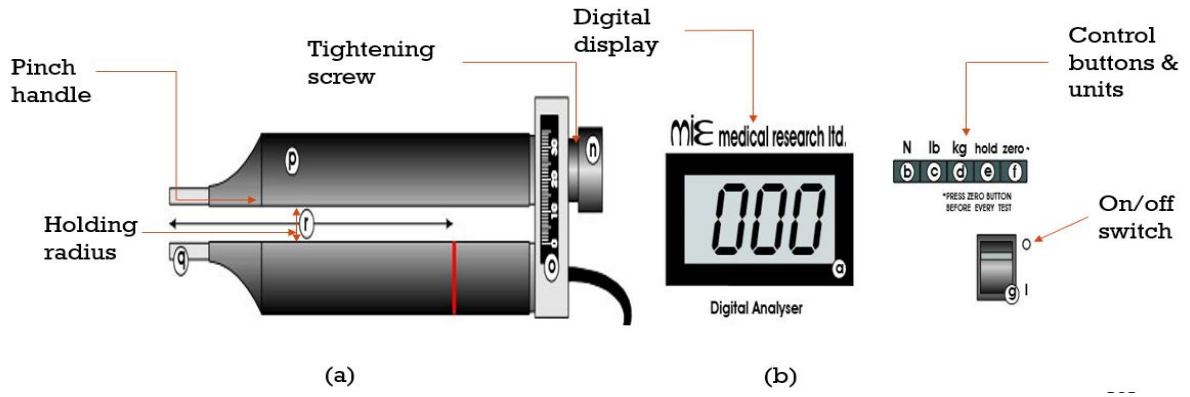


Figure 1: Parts of the Digital Pinch/Grip analyzer: (a) Grip Transducer;(b) Front view of the digital analyzer

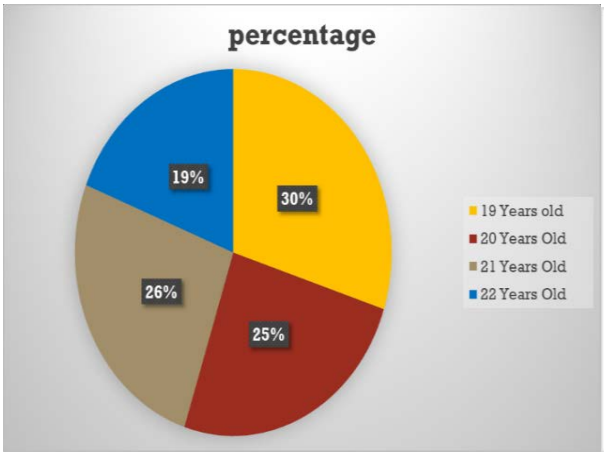
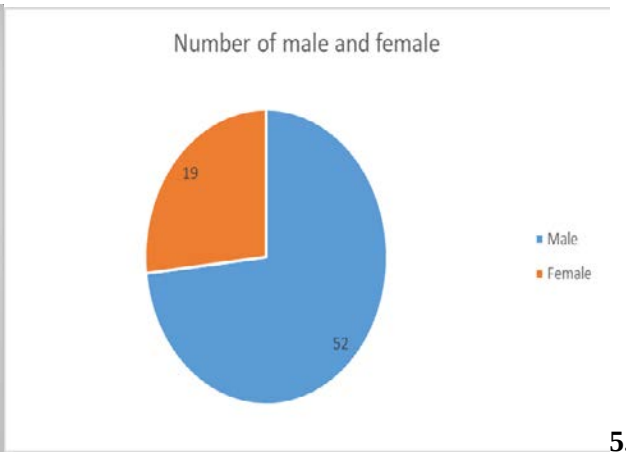


Figure 2: Number of male and female participants



5.1

Figure 3**:** Percentages of participants of different ages

Pinch strength comparison

As three different sizes of smartphone (smartphone width: 68.1 mm, 73.9 mm, 77.23 mm) was given to participants, three different table of mean for each time strength was measured. Initially, pinch strength was measured before using smartphone. Then the participants were asked to use the smartphone for one and a half, hour by their dominant hand. After each thirty minutes of interval pinch strength was measured of each individual. The mean was calculated separately for male and female for each time strength was measured. The mean shown in the Table 1 and Table 2. Table 3 shows the comparison of average pinch strength of male and female at different ages of the participants (doesn't concern with using smartphone).

Table 1: Mean of pinch strength for male

For male	width 68.1 mm	width 73.9 mm	width 77.26 mm
Starting Pinch Strength	28.83	28.83	28.83
Pinch Strength After 30 mins	26.87	25.83	24.77
Pinch Strength After 60 mins	22.75	20.98	19.29
Pinch Strength After 90 mins	18.54	16.52	14.25

Table 2: Mean of pinch strength for female

For female	width 68.1 mm	width 73.9 mm	width 77.26 mm
Starting Pinch Strength	23.53	23.53	23.53
Pinch Strength After 30 mins	21.68	20.84	19.79
Pinch Strength After 60 mins	18.21	17.21	16.29
Pinch Strength After 90 mins	14.21	13.21	11.95

Table 3: Comparison of average pinch strength between male and female at different ages

Year	Mean Pinch strength (male)	Mean Pinch strength (female)
19 years old	24.7619	24.6
20 years old	23.7838	23.5
21 years old	24.8261	22.4
22 years old	22.5625	23.67

From Table 3, a line chart has been plotted to find the average pinch strengths for male and female which is shown in Figure 4.

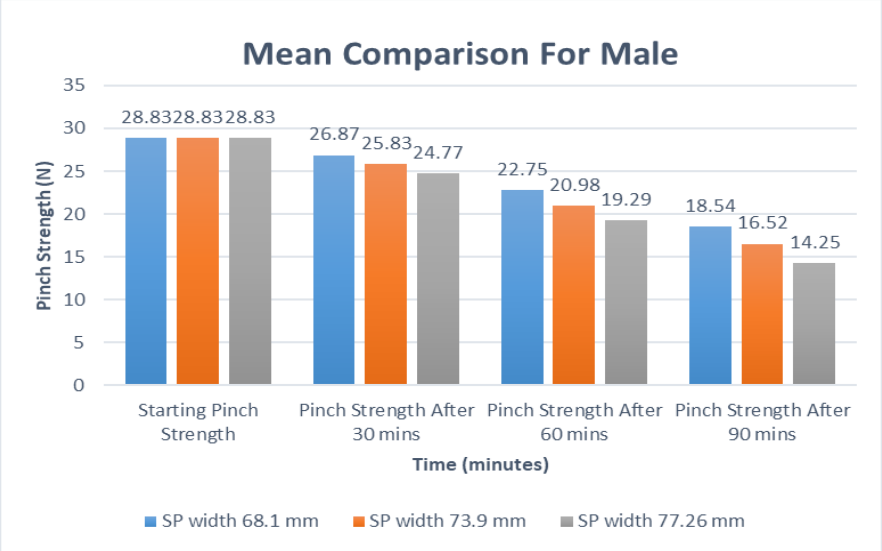


Figure 4: Comparison of mean pinch strength at different ages for male and female.

From Figure 4, it is seen that the average pinch strength of the participants who are 19 years old have24.76 N for male and 24.6 N for female. The average pinch strength of the participants who are 20 years old are 23.78 N for male and 23.5 N for female. The average pinch strength of the participants who are 21 years old are 24.82 N for male and 22.4 N for female. The average pinch strength of the participants who are 22 years old is 22.56 N for male and 23.67 N for female. The result indicated that the male participants who were 21 years old has the highest average pinch strength,

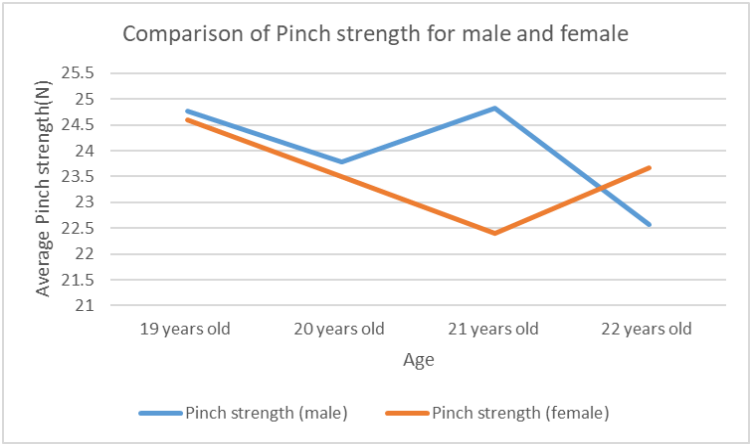


Figure 5: Mean pinch strength at different time interval for different phone sizes (male)

Figures 5 and 6 showed the trend of pinch strength at each interval for different sizes of smartphone for male and female separately. Figure 5 showed that the value of pinch strength for male participants has reduced over every thirty minutes interval due to the variation of screen width of smartphone. It was also observed that the value of pinch strength also reduced due to the increase of smartphone width.

Figure 6 showed that the value of pinch strength for female participants has reduced over every thirty minutes interval due to the variation of screen width of smartphones. It was also observed that the value of pinch strength also reduced due to the increase of smartphone width.

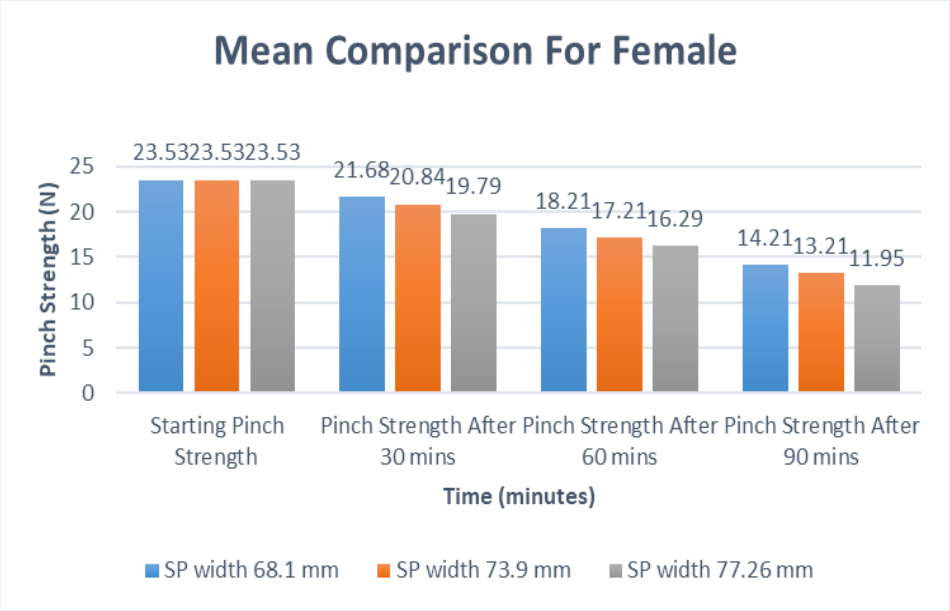


Figure 6: Mean pinch strength at different time interval for different phone sizes (female)

5.2 Correlation between the pinch strength at each time for different smartphone sizes

Bivariate Pearson Correlation was done between the obtained pinch strength separately for male and female. For smartphone width of 68.1 mm Pearson Correlation value was found .928** for male and .826** for female after the use of smartphone for ninety minutes. For smartphone width size 73.9 mm Pearson Correlation was found .826** for male and .874** for female at ninety minutes. For smartphone width of 77.26 mm Pearson Correlation value was found .758** for male and .883** for female. Correlation was significant at the .001 and .005 level. Kolmogorov-Smirnov test was done to see the normality of the distribution. Table 4 - Table 9 showed the correlation between the time variables. It showed that the time segment has the significant relationship with before using smartphone values for each smartphone size for male and female separately.

The test was done in SPSS with 1-tailed correlation. Table-4shows that the highest correlation was with the time segment of 90 minutes for screen width 69.1 mm. Table 5 shows the correlation for the same screen width for female. Table 6 shows the correlation between the pinch strength at different time interval for screen width 73.9 mm for male and table 7 shows the correlation between the pinch strength at different time interval for screen width 73.9 mm for female. Table 8 shows the correlation between the pinch strength at different time interval for screen width 77.23 mm for male and Table 9 shows the correlation between the pinch strength at different time interval for screen width 77.23 mm for female.

Table 4: Pinch strength for smartphone width 68.1 mm (male)

Correlations

		Pinch strength before using smartphone	after_30_mins	after_60_mins	after_90_mins
Pinch strength before using smartphone	Pearson Correlation	1	.923**	.783**	.680**
	Sig. (1-tailed)		.000	.000	.000
	N	52	52	52	52
after_30_mins	Pearson Correlation	.923**	1	.845**	.773**
	Sig. (1-tailed)	.000		.000	.000
	N	52	52	52	52
after_60_mins	Pearson Correlation	.783**	.845**	1	.928**
	Sig. (1-tailed)	.000	.000		.000
	N	52	52	52	52
after_90_mins	Pearson Correlation	.680**	.773**	.928**	1
	Sig. (1-tailed)	.000	.000	.000	
	N	52	52	52	52

**. Correlation is significant at the 0.01 level (1-tailed).

Table 5: Pinch strength for smartphone width 68.1 mm (female)

Correlations

		Pinch Strength Before using Smartphone	Pinch Strength after 30 mins	Pinch Strength after 60 mins	Pinch Strength after 90 mins
Pinch Strength Before using Smartphone	Pearson Correlation	1	.794**	.564**	.390*
	Sig. (1-tailed)		.000	.006	.049
	N	19	19	19	19
Pinch Strength after 30 mins	Pearson Correlation	.794**	1	.806**	.640**
	Sig. (1-tailed)	.000		.000	.002
	N	19	19	19	19
Pinch Strength after 60 mins	Pearson Correlation	.564**	.806**	1	.826**
	Sig. (1-tailed)	.006	.000		.000
	N	19	19	19	19
Pinch Strength after 90 mins	Pearson Correlation	.390*	.640**	.826**	1
	Sig. (1-tailed)	.049	.002	.000	
	N	19	19	19	19

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Table 6**:** Pinch strength for smartphone width 73.9 mm (male)

Correlations

		Pinch Strength Before using Smartphone	Pinch Strength after 30 mins	Pinch Strength after 60 mins	Pinch Strength after 90 mins
Pinch Strength Before using Smartphone	Pearson Correlation	1	.857**	.733**	.667**
	Sig. (1-tailed)		.000	.000	.000
	N	52	52	52	52
Pinch Strength after 30 mins	Pearson Correlation	.857**	1	.758**	.679**
	Sig. (1-tailed)	.000		.000	.000
	N	52	52	52	52
Pinch Strength after 60 mins	Pearson Correlation	.733**	.758**	1	.874**
	Sig. (1-tailed)	.000	.000		.000
	N	52	52	52	52
Pinch Strength after 90 mins	Pearson Correlation	.667**	.679**	.874**	1
	Sig. (1-tailed)	.000	.000	.000	
	N	52	52	52	52

**. Correlation is significant at the 0.01 level (1-tailed).

Table 7: Pinch strength for smartphone width 73.9 mm (female)

Correlations

		Pinch Strength Before using Smartphone	Pinch Strength after 30 mins	Pinch Strength after 60 mins	Pinch Strength after 90 mins
Pinch Strength Before using Smartphone	Pearson Correlation	1	.794**	.564**	.416*
	Sig. (1-tailed)		.000	.006	.038
	N	19	19	19	19
Pinch Strength after 30 mins	Pearson Correlation	.794**	1	.822**	.674**
	Sig. (1-tailed)	.000		.000	.001
	N	19	19	19	19
Pinch Strength after 60 mins	Pearson Correlation	.564**	.822**	1	.895**
	Sig. (1-tailed)	.006	.000		.000
	N	19	19	19	19
Pinch Strength after 90 mins	Pearson Correlation	.416*	.674**	.895**	1
	Sig. (1-tailed)	.038	.001	.000	
	N	19	19	19	19

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Table 8: Pinch strength for smartphone width 77.23 mm (male)

Correlations

		Pinch Strength Before using Smartphone	Pinch Strength after 30 mins	Pinch Strength after 60 mins	Pinch Strength after 90 mins
Pinch Strength Before using Smartphone	Pearson Correlation	1	.829**	.651**	.622**
	Sig. (1-tailed)		.000	.000	.000
	N	52	52	52	52
Pinch Strength after 30 mins	Pearson Correlation	.829**	1	.720**	.643**
	Sig. (1-tailed)	.000		.000	.000
	N	52	52	52	52
Pinch Strength after 60 mins	Pearson Correlation	.651**	.720**	1	.785**
	Sig. (1-tailed)	.000	.000		.000
	N	52	52	52	52
Pinch Strength after 90 mins	Pearson Correlation	.622**	.643**	.785**	1
	Sig. (1-tailed)	.000	.000	.000	
	N	52	52	52	52

**. Correlation is significant at the 0.01 level (1-tailed).

Table 9: Pinch strength for smartphone width 77.23 mm (female)

Correlations

		Pinch Strength Before using Smartphone	Pinch Strength after 30 mins	Pinch Strength after 60 mins	Pinch Strength after 90 mins
Pinch Strength Before using Smartphone	Pearson Correlation	1	.802**	.594**	.388
	Sig. (1-tailed)		.000	.004	.050
	N	19	19	19	19
Pinch Strength after 30 mins	Pearson Correlation	.802**	1	.819**	.642**
	Sig. (1-tailed)	.000		.000	.002
	N	19	19	19	19
Pinch Strength after 60 mins	Pearson Correlation	.594**	.819**	1	.883**
	Sig. (1-tailed)	.004	.000		.000
	N	19	19	19	19
Pinch Strength after 90 mins	Pearson Correlation	.388	.642**	.883**	1
	Sig. (1-tailed)	.050	.002	.000	
	N	19	19	19	19

**. Correlation is significant at the 0.01 level (1-tailed).

6. Findings

The study reveals that the pinch strength for both male and female participants decreases over each time interval (30 min, 60 min. and 90 min.). The average pinch strength value of the participants (male) was reduced from 28.83 N to 26.87 N, 25.83 N and 24.77 N for smartphone width 68.1 mm, 73.9 mm and 77.26 mm respectively. The values of pinch strength after using smartphone for 60 minutes and 90 minutes followed the same trend similar to the use of smartphone of different width. Similarly, the average pinch strength of the participants (female) was reduced from

23.53 N to 21.68 N, 20.84 N and 19.79 N for using smartphone of width 68.1 mm, 73.9 mm and 77.26 mm. The values of pinch strength after 60 minutes and 90 minutes use followed the same trend as mentioned above.

The research finding also showed that the correlation of pinch strength before using smartphone and after using smartphone for 90 minutes had the weakest relation among all correlation for the male participants who used smartphone of 68.1 mm width screen size. The correlation was found .680 for before using smartphone and after using smartphone for 90 minutes. On the other hand, the weakest correlation was found .390 before using smartphone and after using smartphone for 90 minutes by female participants.

For the screen width of 73.9 mm, the correlation of pinch strength before using smartphone and after 90 minutes of using smartphone had the weakest relation among all correlation. The correlation 0.667 was found before using smartphone and after using smartphone for 90 minutes. On the other hand, the weakest correlation was found .416 before using smartphone and after using smartphone for 90 minutes by the female students.

For the largest screen width 77.23 mm, the correlation of pinch strength before using smartphone and after using smartphone for 90 minutes had the weakest relation among all correlations. The correlation was found as 0.622 for before using smartphone and after using smartphone for 90 minutes. On the other hand, the weakest correlation was found as 0.388 before using smart phone and after using smart phone for 90 minutes by the female students.

7. Discussion

This study was done on the pinch strength of students. The correlations between strength before using smart phone and strengths after using smartphone (for interval of 30 min, 60 min and 90 min) showed some significant result. For male category of data, Pearson correlation was the lowest for pinch strength after 90 minutes. This result showed that pinch strength value is very low when the subjects uses phones for 90 minutes. However, the result was not expected for female category due to the low percentage of female participants.

8. Conclusion and Future Work

Pinch strength was measured according to the standards of the American Society of Hand Therapists (ASHT) where they defined some rules for pinch strength measurement (reliability and validity of grip strength evaluations, 1984). The result showed that the value of pinch strength of every subject reduced after using smart phone. This may be a normal case for regular human beings but in case of students reduced strength of writing hand have a significant effect on their daily work especially during written examination. Frequent use of smartphone may reduce the writing speed of students. Future work of this research may be extended to identify the pinch strength of users if smart phone is used by both hands simultaneously.

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Biographies

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