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Susilo T.E., Hanifah M.F., Wijianto., Sudaryanto W.T., Fatmarizka T., Fitriyah Q.F., Farizi M.H.A., Hendra Z. & Jannah N.I
Fisiomu.2025,Vol 6(1): 45-52
DOI : https://10.23917/fisiomu.v6i1.7237

The Effect of Dual-Task Texting on Cervical Muscle Activity in Smartphone Users

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Submition : 2024-11-20; Accepted : 2024-12-05; Published : 2025-01-01

ABSTRACT

Introduction: Current technological developments are very fast making it easier for people to carry out all activities via *smartphone*s. One of the frequently used *smartphone* functions is typing and sending messages. Typing and sending messages can be done anytime and anywhere. Typing messages on a *smartphone* while walking falls into the dual-task category. This study aims to analyze the effect of using dual-task texting on cervical region muscle activity on *smartphone* users, where *smartphone* users type messages while walking. **Methods:** The method used is a single-group repeated experimental design. A total of 36 subjects consisted of 19 women and 17 men with an age range of 21.28 ± 0.97 years. The parameter measured is the upper trapezius muscle activity. Subjects were asked to walk in five conditions, namely baseline walking, texting flashcard 1, texting flashcard 2, texting flashcard 3, and texting flashcard 4. All experiments recorded upper trapezius muscle activity using an electromyograph. **Results:** The results of repeated measure ANOVA stated that typing on a *smartphone* had a significant effect ($p < 0.05$) on young respondents increasing activity of the upper trapezius muscle. **Conclusion:** Dual-task texting significantly affects cervical region muscle activity, particularly in the upper trapezius muscle on the right side, which has the potential to increase the risk of muscle fatigue in smartphone users.

Keywords: *smartphone, dual-task, texting, muscle activity*

INTRODUCTION

The acceleration of contemporary technology has facilitated individuals to manage various daily activities through the use of smartphones. The phenomenon of personal smartphone ownership is now common in society. In 2022, global data shows that around 83.07% of the world's population, or around 6.64 billion people, use smartphones. Specifically in Indonesia, there were 204.7 million users in early 2022, a slight increase from the number of users in 2021 which was 202.6 million. (Annur, 2022).

The increase in the number of smartphone users can be attributed to the emergence of various new functions on the device. In addition to functioning as a communication tool, smartphones are now also equipped with various features such as fast internet access, the ability to send e-mail, a Global Positioning System (GPS) navigation system, music and video players, and the ability to watch movies or series, take photos, and make videos. The advancement of this function has a significant impact on various aspects of the lives of its users. The impact of the existence of smartphones is very much felt in the world of education, where students can access information quickly, learn foreign languages for free, facilitate communication during the learning process, expand learning networks, and function as entertainment media. (HAMID, 2018; Pitri

ISSN 2722 – 9610
E –ISSN 2722 - 9629

DOI : https://10.23917/fisiomu.v6i1.7237

Sari, 2021). Smartphones, with all the convenience they offer, also allow their users to shop through available applications, look for jobs, and make financial transactions. The practical form allows users to operate smartphones while doing other activities. A real example is cooking while following a video tutorial on YouTube via a smartphone. Chen (2018) added that pedestrians can use smartphones for various activities such as calling, typing, surfing social media, and playing games, showing the flexibility and multifunctionality of this device in everyday life. (Chen & Pai, 2018).

Along with the rapid spread of smartphones, of course, there are negative impacts caused by smartphone use. The negative impacts that arise due to smartphone use in adolescents are making adolescents dependent on the features provided, easily accessing pornographic sites via the internet, reducing social interaction due to the use of chat applications on smartphones, to copyright infringement (Prasetiyo, 2019). In addition, research in 2018 stated that the phenomenon of excessive smartphone use causes a decline in academic achievement in students (Alt & Boniel-Nissim, 2018). In a study conducted by Lee et al in 2015, it was found that smartphone use can increase fatigue in the upper trapezius muscles (Lee et al., 2015). In addition, heavy smartphone use can also produce quite a lot of pressure on the cervical bones, causing pain in the muscles around the neck (Park et al., 2015).

The use of smartphones carried out together with other activities will certainly cause side effects for the body (AlAbdulwahab et al., 2017; Hyong, 2015). Typing on a smartphone while walking shows the highest muscle activity compared to browsing in a sitting or standing position. Typing with two hands also results in increased activity of the neck extensor muscle strength caused by the dynamics of the head when walking with the head facing down (Yoon et al., 2021).

Based on the statement above which discusses the various effects of smartphone use carried out simultaneously with other activities, researchers are interested in conducting this study by combining cognitive aspects with muscle activity.

The purpose of this study is to determine the effect of using dual-task texting on cervical muscle activity in smartphone users. The benefits of this study for the author are to increase insight and skills in the field of physiotherapy, especially on muscle activity produced when performing two tasks simultaneously.

METHODS

This study used a quantitative study with an observational study design through a single-group repeated measurement approach. Subject involvement has been approved by the Research Ethics Committee of the Hospital TK.II 04.05.01 dr. Soedjono number 169/EC/I/2023. Subjects were students recruited through Google form with purposive sampling technique. Data collection was carried out in January 2023 at the Gymnasium Laboratory of the Faculty of Health Sciences, Muhammadiyah University of Surakarta. The inclusion criteria are as follows: (1) Aged 18-35 years, (2) have had a smartphone for more than one year, (3) use a smartphone for at least 1-3 hours a day. Subjects were excluded if: (1) Type one obesity with a Body Mass Index >35, (2) doing heavy physical activity that causes fatigue in the last 24 hours. Subjects were excluded during the study if: (1) unable to walk 10 meters, (2) unable to complete the tasks given during the study.

The data collection protocol used the Noraxon electromyograph MyoMuscle USA. Electrodes were attached to the upper trapezius muscle which would then be recorded via an electromyograph in mA units. Subjects walked on a treadmill for 15 seconds for each condition.

Data analysis used SPSS software version 25.0 with a significant value of $p < 0.05$. The data normality test used Shapiro-Wilk to determine the nature of the data distribution. Then the repeated measures ANOVA test was carried out to determine the effects of several conditions (basic walking, texting flashcard 1, texting flashcard 2, texting flashcard 3, and texting flashcard 4) on muscle activity. Further post hoc Bonferroni test to determine the details of the effect on each condition.

ISSN 2722 – 9610
E –ISSN 2722 - 9629

Fisiomu.2025,Vol 6(1): 45-52
DOI : https://10.23917/fisiomu.v6i1.7237

RESULTS

Respondent characteristics

Characteristics of subject data and details of smartphone usage are shown in Table 1. The number of subjects in this study was 36 right-handed dominant students consisting of 19 females and 17 young adult males. The age range was between 21.28 ± 0.97 years. The majority of them had owned smartphones since 10.44 ± 13.36 years with an average usage of 7.03 ± 3.43 hours per day.

Table 1. Respondent Characteristics

Variables	**Mean ± Standard Deviation**
Gender: female / male (n)	19/17
Age (yrs)	21.28 ± 0.97
Body Weight (Kg)	60.22 ± 10.53
Height (Cm)	162.78 ± 8.28
BMI (Kg/m2)	22.63 ± 2.94
Duration of smartphone ownership (yrs)	10.44 ± 13.36
Duration of smartphone use (hours/day)	7.03 ± 3.43

Effect of Smartphones on Muscle Activity

In this study, statistically, the use of texting on smartphones has a significant effect on young respondents in the parameters of right upper trapezius muscle activity ($F(4, 140) = 3.921$, $p < 0.05$), left upper trapezius muscle activity ($F(4, 140) = 1.446$, $p > 0.05$), and the average of right and left upper trapezius muscle activity ($F(4, 140) = 3.440$, $p < 0.05$). For this information, it is presented in Table 2 which shows a comparison of the upper trapezius muscle activity variables in the conditions tested.

Table 2. Effects of Texting on Muscle Activity

Variables	**Condition**					
	BW	FC1	FC2	FC3	FC4	*P value**
Average	21.20 ± 6.62	23.56 ± 6.29	22.48 ± 6.31	23 ± 6.29	23.55 ± 6.21	0,010
Right Upper Trapezius	18.82 ± 8.91	21.82 ± 8.81	20.25 ± 8.61	21.59 ± 8.83	22.58 ± 8.85	0,005
Upper Trapezius Left	23.58 ± 7.93	23.34 ± 7.34	24.71 ± 7.00	23.39 ± 7.15	24.52 ± 7.33	0.222

BW: Baseline Walking, FC1: Flashcard 1 condition, FC2: Flashcard 2 condition, FC3: Flashcard 3 condition, FC4: Flashcard 4 condition.
*p-value is obtained from the results of the Repeated Measurement (RM) ANOVA test.

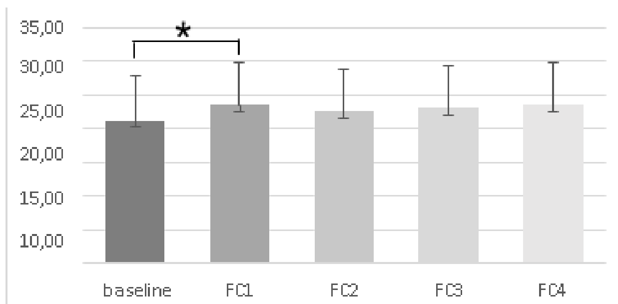

Figure 1. Graph of average Upper Trapezius muscle activity data.

ISSN 2722 – 9610
E –ISSN 2722 - 9629

DOI : https://10.23917/fisiomu.v6i1.7237

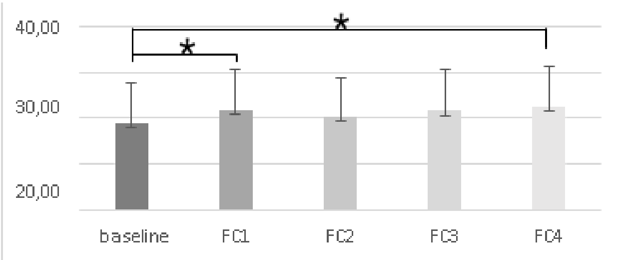

Figure 2. Graph of right upper trapezius muscle activity data.

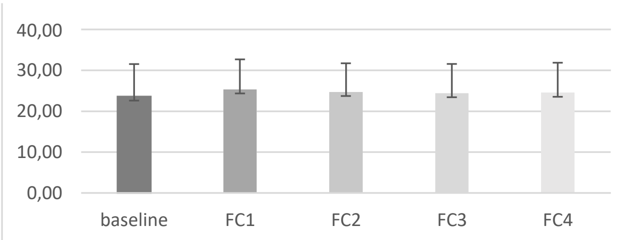

Figure 3. Graph of left upper trapezius muscle activity data.

In the analysis using post hoc Bonferroni, there was a significant difference in the right upper trapezius muscle activity parameters and the average of the right and left upper trapezius muscle activity, but there was no significant difference in the left upper trapezius muscle activity parameters ($p > 0.05$) (table 3).

In the average parameters of the right and left upper trapezius muscle activity, there was a significant difference in the baseline walking and flashcard 1 conditions ($p < 0.05$). However, there was no significant difference in the baseline walking and flashcard 2, baseline walking and flashcard 3, baseline walking and flashcard 4, flashcard 1 and flashcard 2, flashcard 1 and flashcard 3, flashcard 1 and flashcard 4, flashcard 2 and flashcard 3, flashcard 2 and flashcard 4, and flashcard 3 and flashcard 4 ($p > 0.05$).

In the right upper trapezius muscle activity parameters, there were significant differences in the baseline walking and flashcard 1 conditions and baseline walking and flashcard 4 ($p < 0.05$). However, there were no significant differences in the baseline walking and flashcard 2, baseline walking and flashcard 3, flashcard 1 and flashcard 2, flashcard 1 and flashcard 3, flashcard 1 and flashcard 4, flashcard 2 and flashcard 3, flashcard 2 and flashcard 4, and flashcard 3 and flashcard 4 ($p > 0.05$).

In the parameters of left upper trapezius muscle activity, there was no difference in the conditions of baseline walking and flashcard 1, baseline walking and flashcard 2, baseline walking and flashcard 3, baseline walking and flashcard 4, flashcard 1 and flashcard 2, flashcard 1 and flashcard 3, flashcard 1 and flashcard 4, flashcard 2 and flashcard 3, flashcard 2 and flashcard 4, and flashcard 3 and flashcard 4 ($p > 0.05$).

Table 3. Pairwise Comparison Table of Texting on Smartphones

Variable	Pairwise Comparison									
	BW vs FC1	**BW vs FC2**	**BW vs FC3**	**BW vs FC4**	**FC1 Vs FC2**	**FC1 Vs FC3**	**FC1 Vs FC4**	**FC2 Vs FC3**	**FC2 vs FC4**	**FC3 vs FC4**
Average	**0.047**	1.000	0.636	0.091	1.000	1.000	1.000	1.000	1.000	1.000
Right Upper Trapezius	**0,022**	1.000	0.400	**0.023**	1.000	1.000	1.000	1.000	0.566	0.717
Left Upper Trapezius	0.831	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

*BW: Baseline Walking, FC1: Flashcard 1 condition, FC2: Flashcard 2 condition, FC3: Flashcard 3 condition, FC4: Flashcard 4 condition

DISCUSSION

The results of this study prove the hypothesis that the effect of using dual-task texting can increase muscle activity in smartphone users in the young adult group. Smartphone use increases muscle activity in the average right and left upper trapezius muscles and the right upper trapezius muscle due to the additional task given, but there

ISSN 2722 – 9610
E –ISSN 2722 - 9629

DOI : https://10.23917/fisiomu.v6i1.7237

is no difference in the activity of the left upper trapezius muscle.

Based on the data in Table 2 and Figure 1, there was a significant increase in muscle activity from the baseline walking condition to the texting flashcard 1 condition. This was found to be the same as the research conducted by Tang in 2021, namely an increase in upper trapezius muscle activity when typing messages while walking on a treadmill. The increase in muscle activity is due to the body's efforts to maintain the position of the shoulders and forearms during typing and walking conditions (Tang et al., 2021). Greater muscle activation is associated with using a smartphone in a tilted head position when looking at it. This tilt of the neck position produces a greater flexion moment in the cervical spine which then produces higher contractions to maintain posture compared to walking upright (Yoon et al., 2021).

Based on the data in Table 2 and Figure 2, there is a significant increase in muscle activity from the baseline walking condition to the texting flashcard 4 condition. Meanwhile, in Table 2 and Figure 3, no significant results were found in all conditions. This finding is almost similar to the research conducted by Marker et al in 2016, where there was a higher increase in right upper trapezius muscle activity compared to left upper trapezius muscle activity (Marker et al., 2016). In addition, a study conducted by Yoon et al in 2021 found that the activity of the dominant side of the neck extensor muscles during typing and walking was higher than the non-dominant side with the same conditions. When typing using two hands, holding a smartphone in front of the body will require greater effort from the upper extremity muscles compared to holding it with one hand, so users move the smartphone closer to the body to reduce the burden on the arm and shoulder muscles. Holding a smartphone close to the body forces the user to look down further with greater head flexion, which then results in larger EMG amplitudes (Yoon et al., 2021).

Based on the principle of the class 1 lever, when the fulcrum is in the middle, the load is directed downward and the force is applied upward. This is in line with the position when the head is lowered to see the smartphone screen, where the neck extensor muscles provide force or effort, the neck is the fulcrum, and the weight of the head is the load. When the head is lifted, the neck extensor muscles contract and the neck becomes the fulcrum of both (Hall & Lysell, 1995). To reduce the burden on the hands, smartphone users usually place the smartphone closer to the body when typing messages which then results in less visibility. Reduced visibility causes greater head tilt and neck flexion to see the smartphone close to the body, which then results in greater activation of the neck extensor muscles (Yoon et al., 2021). Typing while walking requires gross and fine motor tasks. These gross motor skills include carrying a smartphone and fine motor skills, namely finger dexterity when typing, which is important to avoid typing errors. Therefore, tactile or proprioceptive sensation deficits can interfere with typing performance (Krasovsky et al., 2017). Visual information is important in guiding locomotion by providing feedback in performing motor performance. Visual information in the lower visual field specifically contributes to correcting the trajectory of the lower extremities or foot placement during walking. However, in the posture of using a smartphone that is directed to the frontal field of view, the visual information in the front of the feet is blocked by the smartphone and the upper extremity body. Decreased visual input affects movement control and can lead to instability situations such as decreased walking speed (Crowley et al., 2021). When walking, arm movements are used as a strategy to increase walking stability, which affects the natural movement of the lower limbs. When typing, the upper limbs remain in front of the body to reduce and limit body movement, while the hands are in a position holding the smartphone. Concentrating on a small screen makes the user's neck and head bend forward which reduces their movement. This posture affects the activity of the neck muscles and the function of the vestibular system (Kim et al., 2020).

Typing using two hands results in lower upper trapezius muscle activity compared to typing using one hand. Different smartphone

ISSN 2722 – 9610
E –ISSN 2722 - 9629

sizes also cause differences in upper trapezius muscle activity. Large smartphones increase muscle activity due to supporting the weight of the smartphone (Kietrys et al., 2015). Slower typing speed can affect the time spent typing messages. Someone who types at a higher speed will have a shorter duration of muscle load in the neck and back. Typing duration or daily typing habits affect typing speed (Gustafsson et al., 2017).

In this study, there are still shortcomings, namely respondents who typed too short from what was instructed so that respondents finished before the specified time ended. In addition, the use of smartphones that are not uniform in size results in biased muscle activity results. Therefore, it is hoped that in further research researchers will ask whether respondents understand the instructions given well and whether the smartphones used can be standardized so that the results obtained are not biased.

Walking while using a smartphone has become a daily activity in society. Based on the primary data of this study, it can be concluded that dual-task texting can affect the activity of cervical region muscles in young adult smartphone users. However, there was no change in the activity of the left side muscles. The effect of using dual-task texting caused an increase in the average upper trapezius muscle and the right upper trapezius muscle.

CONCLUSION

Based on the primary data of this study, it can be concluded that dual-task texting significantly affects the activity of cervical region muscles in young adult smartphone users. The results showed an increase in the activity of the right upper trapezius muscle with an increase of 20% compared to the baseline walking condition ($p < 0.05$). The average activity of the right and left upper trapezius muscles also increased significantly ($p < 0.05$). However, the activity of the left upper trapezius muscle did not show a significant change ($p > 0.05$). These findings indicate that smartphone use in dual-task texting conditions can increase the workload of the cervical region muscles, especially on the right side, which has the potential to cause muscle fatigue if done repeatedly over a long period.

This research is expected to be a useful finding for all parties related to the effects of dual-task texting on the activity of the cervical region muscles in smartphone users. For smartphone users to be more aware of the impacts caused by dual-task texting. Meanwhile, further research is expected to perfect this research.

ACKNOWLEGMENT

The author would like to extend their express their deepest gratitude to Research and Innovation Unit (LRI) Universitas Muhammadiyah Surakarta for their support and encouragement throughout the research process. Their dedication and contribution have been instrumental in ensuring the success of this study. We deeply appreciate their assistance in facilitating this research and fostering a collaborative environtment.

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