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ประโยชน์ของประสิทธิภาพของการพิมพ์สัมผัส ต่อการทำงานของกล้ามเนื้อ ความรู้สึกไม่สบาย ในช่วงเวลาการทำงานกับคอมพิวเตอร์ 4 ชั่วโมง

The benefit of touch-typing performance on muscle activity and pain over 4 hours of work

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บทคัดย่อ: *ทักษะการพิมพ์เป็นความสามารถของบุคคลที่เป็นความต้องการสำหรับงานที่ต้องใช้แป้นพิมพ์มากๆ การพิมพ์ที่มีทักษะมากสามารถช่วยให้ทำงานเสร็จได้เร็วขึ้น อย่างไรก็ตามการพิมพ์ส่งผลต่อท่าทางที่อยู่นิ่งของศีรษะ คอ และบ่า เมื่อเปรียบเทียบกับคนที่มีทักษะน้อยกว่า การศึกษาครั้งนี้เปรียบเทียบคลื่นไฟฟ้ากล้ามเนื้อของ กล้ามเนื้อ* trapezius, deltoid *และ* splenius capitis *และความรู้สึกไม่สบายในการทำงาน 4 ชม ของกลุ่ม ที่พิมพ์งานหญิง ทั้งพิมพ์สัมผัสและไม่สัมผัส กลุ่มทดลอง 2 กลุ่ม คือพิมพ์ดีดสัมผัสมีผู้เข้าร่วมการวิจัย 21 คนและ กลุ่มพิมพ์ไม่สัมผัสมีผู้เข้าร่วมการวิจัย 20 คน ทำการพิมพ์ต่อเนื่อง 240 นาที ทำการเก็บคลื่นไฟฟ้ากล้ามเนื้อจาก* upper trapezius, anterior deltoid and splenius capitis *จำนวนคำที่พิมพ์ได้ และความรู้สึกไม่สบายบริเวณคอ บ่า และแขน ผู้เข้าร่วมการวิจัยจะได้รับการวัดตัวแปรทั้งหมดซ้ำทุก 40 นาที คลื่นไฟฟ้ากล้ามเนื้อ ค่า* EMG *ถูกนำมาแปลงให้เป็น* %MVC *ค่า* %MVC *ของ* anterior deltoid *ในกลุ่มพิมพ์สัมผัสมีค่ามากกว่ากลุ่มพิมพ์ไม่สัมผัส (8-9%* vs. *5.4-5.5%) อย่างมีนัยสำคัญทางสถิติ ณ นาทีที่ 40, 80 และ 160 ระดับความรู้สึกไม่สบายของกลุ่มพิมพ์ไม่สัมผัสมีค่ามากกว่ากลุ่มพิมพ์สัมผัสที่คอ (2.1* cm. vs. *3.2* cm.) *และบ่าข้างขวา (3.5* cm. vs. *2.2* cm.) *ที่นาทีที่ 240 อย่างมีนัยสำคัญทางสถิติ ในกลุ่มพิมพ์ดีดสัมผัสพบว่ามีการเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติของ* %MVC *จากนาทีที่ 5 ถึงนาทีที่ 240 ของ* anterior deltoid *(8.0%* vs.*10.8%) และ* splenius capitis *(15.0%*vs. *20.6%) พบว่ามีการลดลงอย่างมีนัยสำคัญทางสถิติของ จำนวนคำที่พิมพ์ได้ และมีการเพิ่มขึ้นของระดับความรู้สึกไม่สบาย ณ ส่วนของร่างกายที่ทำการศึกษา อย่างมีนัยสำคัญทางสถิติทั้ง 2 กลุ่ม ส่วนในกลุ่มพิมพ์ไม่สัมผัสพบว่ามีการเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติของ* %MVC *จากนาทีที่ 160 ถึง นาทีที่ 240 ของ* upper trapezius *(7.4%* vs. *8.6%) และจากนาทีที่ 5 ถึง นาทีที่ 240 ของ* splenius capitis *(20.7%* vs. *22.9%). ผลการศึกษาแสดงว่ากลุ่มพิมพ์สัมผัสมีระดับความรู้สึกไม่สบายและทำงานของ* upper trapezius *น้อยกว่า กลุ่มพิมพ์ไม่สัมผัสดังนั้นจึงควรมีการฝึกพิมพ์ดีดสัมผัสสำหรับผู้เริ่มต้นหัดพิมพ์ดีด*

ABSTRACT: *Typing skill is one of personal skill required for serious keyboard work. Those with higher skill can help to complete work quicker. However, it introduces more static posture of head, neck and shoulders, when compared to those with lower typing skill. This study compared electromyographic activities (EMG) of trapezius, deltoid, and splenius capitis muscles and discomfort over 4 hours of among 2 typing work among healthy female touch and non-touch typists. Two groups of typists comprising 21 touch typists and 20 non-touch typists performed a continuous typing task for 240 minutes. The EMG activities were recorded from right upper trapezius, splenius capitis and right anterior deltoid muscles. Word counts, and visual analogue scale (VAS) at neck, shoulder and arm areas were also recorded for every 40 minutes. EMG of those muscles were normalized to be %MVC. It was found that % MVC of anterior deltoid in the touch typist group was significantly higher than the non-touch typist group (8-9% vs. 5.4-5.5%) at minutes 40, 80 and 160. VAS in the non-touch typist group were significantly higher than the touch typist group in neck (3.19 cm. vs. 2.10 cm.) and right shoulder (3.49 cm. vs. 2.18 cm.) at minute 240. In touch group, % MVCs significantly increased from minute 5 to 240 at anterior deltoid (8.04% vs. 10.80%) and splenius capitis (15.03% vs. 20.63%). Moreover, word counts significantly decreased over times. In addition, VAS at studied areas significantly increased over typing time in both groups. In non-touch group, percentage of MVCs significantly increased from minute 160 to 240 at upper trapezius (7.38% vs. 8.59%) and from minute 5 to 240 at splenius capitis (20.71% vs. 22.89%). The study demonstrated that touch typists had advantage in discomfort and more productivity. Therefore, touch typing practice should be recommended to novice typists.*

คำสำคัญ: *การพิมพ์สัมผัส คลื่นไฟฟ้ากล้ามเนื้อ ประสิทธิภาพการทำงาน*

Keywords: Touch typing, Electromyography, Task performance

1. INTRODUCTION

Nowadays, computer work forced the operators to infrequent move of trunks, but repetitive move of hands and arms in their workstations. The characteristics of this work are repetitive cycle work and sitting for long times and concentrating for non-variety task these lead to have high prevalence of developing the musculoskeletal disorders (MSD). The high repetitive motion of hand, wrist or forearm also commonly involves static loading of the muscles of neck and shoulder. The symptoms reported were pain, stiffness, cramps, numbness, swelling, tremor, burning and fatigue. These symptoms also occurred with various body parts at various frequencies: daily or occasionally [1].

Typing is the work that mostly uses the keyboard. The movements and muscles work occur at neck, shoulder, forearm, wrist and hand areas. The light-touch keyboard induces speed of typing and expectation of high work performance in limited time. This would be one cause of the wide epidemic of WMSD among office workers. The typing test can divide typists into two groups, one is touch typist group and the other is non-touch typist group. The touch typist is a person who can look at the document while typing and do not need to look at the keyboard, with the average of typing speed over 50 words per minute [2].

There are many differences in movements of neck, shoulder and arm while typing and typing productivity between touch and non-touch typists. The postures in touch typists are the static holding in neck neutral position, slightly shoulder flexion and repetitive wrist and hand movements during typing. While postures of non-touch typists are the static holding in neck flexion position (finding the letters), repetitive neck flexion/extension (for reading document and look at keys) and only right hand used during typing. There are three muscles involved in these actions. There are upper trapezius, anterior deltoid and splenius capitis muscles.

Therefore, that is interesting to study the electromyographic activities, discomfort scale and typing performances within touch and non-touch typists in age between 18-45 years. The aims of this study are to determine electromyographic activities from right upper trapezius, anterior deltoid and splenius capitis muscles, discomfort, and typing performances between touch and non-touch typists.

2. METHODS

2.1 Participants

Twenty one touch typists and 20 non-touch typists healthy female workers with aged between 18-45 years, participated in this study. They had normal or corrected eyesight, excepted bifocal and progressive lens, and regularly works with typing more than 4 hours a day. They had no musculoskeletal and neurological disorders in head, neck, and upper extremity areas. For those whose typing speed 60 or more than 60 words per minute were in touch typing group and less than that were in non-touch typing group.

2.2 Procedure

All participants answered the questionnaire and passed physical examination by the researcher to ensure they meet the criteria. They were tested for their typing speed by following the testing document within ten minutes and typing speeds were recorded. The skin areas at right neck, shoulder and anterior aspect of arm were scrubbed and cleaned with alcohol and SEMG electrodes were placed.

Each subject was asked to perform two times of 5-second maximum contraction for each muscle. The load for creating resistant was from pulling the handles of the Kinedyne™ with arms stretched (shoulder elevation) for trapezius muscles, arms bent 90 degree for deltoid muscles, and using myometer for splenius capitis muscles. The SEMG from the maximum contraction of those muscles were used to normalize the EMG to be percent MVC.

After the maximal voluntary isometric contraction tests, each subject was asked to perform the typing task continuously for 5 minutes with their best. Then EMG activities were recorded at before and every 20 seconds for 40 minutes. Lastly, subjected were rated their discomfort on VAS for 10 areas within 10 seconds. After all recorded parameters done, the subjects were asked to type continuous and they were asked to stay at workplace for limit unnecessary movements. These processes were done every 40 minutes until 4 hours.

3. RESULTS

3.1 Participants

The characteristics of subjects including age, weight, height, body mass index (BMI), physical activity level and typing speed were shown in table1. There was no significant difference in age, weight, height, BMI and physical activity level between touch and non-touch typists ($p>0.05$). While there was a significant difference in typing speed between touch and non-touch typists ($p<0.001$).

Table 1: Comparison of age, weight, height, body mass index (BMI), physical activity level and typing speed between touch (n=21) and non-touch typists (n=20).

Parameters	Touch typists (mean±SD)	Non-touch typists (mean±SD)	p-value[a]
Age (Years)	22.42±1.88	22.65±2.08	0.723
Weight (kg.)	50.38±4.48	49.60±4.17	0.568
Height (cm.)	159.23±4.80	159.45±9.03	0.925
BMI (kg/m^2)	19.86±1.55	19.12±1.19	0.100
Physical activity level	7.66±0.79	7.65±0.93	0.951
Typing Speed	110.520±26.08	43.23±7.08	0.001*

a = Independent Sample t-test; *Statistical significant at $p<0.05$

3.2 EMG (%MVC)

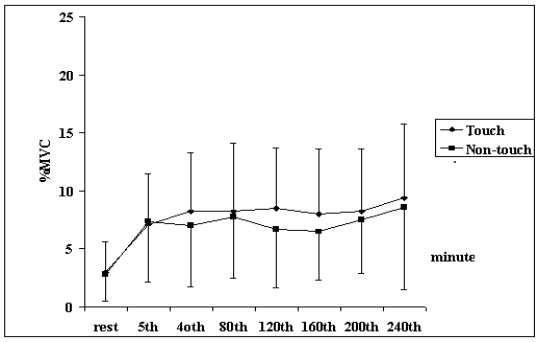
For comparison of %MVC of right upper trapezius, deltoid and splenius capitis muscles before typing, typing period at 5th, 40th, 80th, 120th, 160th, 200th and 240th minutes, there were significant differences of right deltoid muscle only at typing period at 40th, 80th and 160th minutes between two groups between touch typists and non-touch typists (figure 1b). While within group comparison, there were significant differences over times. Within touch typing group, there were no significant changes in %MVC of right trapezius muscle over times, significant differences in %MVC of right anterior deltoid muscle between 5th and 160th, 5th and 240th, and 40th and 240th minutes, and 200th and 240th minutes, and significant difference in %MVC of right splenius capitis muscle between typing period at 80th and 240th minutes. While within non-touch typists, there were a significant difference of %MVC of right upper trapezius muscle between typing period at 160th and 240th, no significant difference of %MVC of right anterior deltoid muscle, and significant differences between typing period at 5th and 200th, 5th and 240th, 80th and 200th, 80th and 240th, 120th and 200th, and lastly between 120th and 240th minutes.

Table 2: Comparison of %MVC of right upper trapezius, right anterior deltoid muscle before typing, typing period at 5th, 40th, 80th, 120th, 160th, 200th and 240th minutes between and within touch typists (TT, n=21) and non-touch typists (NTT, n=20).

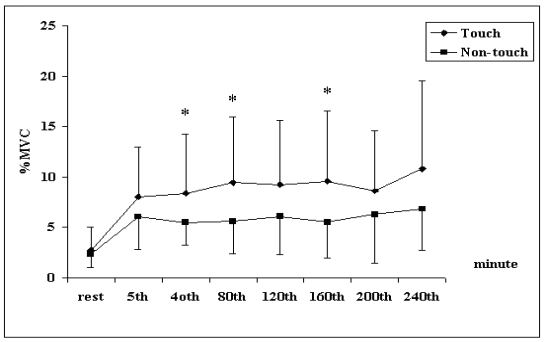
Time	%MVC of right Upper Trapezius (mean±SD)				%MVC of right anterior deltoid (mean±SD)				%MVC of right anterior deltoid (mean±SD)			
	TT	NTT	F	p-value [b]	TT	NTT	F	p-value [b]	TT	NTT	F	p-value [b]
Before typing	2.9±2.6	2.8±2.3	0.051	0.822	2.8±2.2	2.3±1.3	0.497	0.485	2.7±2.2	2.3±1.3	0.497	0.485
At 5th min	7.1±4.3	7.4±5.2	0.027	0.870	8.0±4.9	6.1±3.3	2.283	0.139	8.0±4.9	6.1±3.3	2.283	0.139
At 40th min	8.2±5.0	7.0±5.3	0.556	0.460	8.4±5.9	5.5±2.2	4.281	0.045*	8.4±5.9	5.5±2.2	4.281	0.045*
At 80th min	8.2±5.9	7.7±5.3	0.075	0.786	9.4±6.6	5.6±3.2	5.606	0.023*	9.4±6.6	5.6±3.2	5.606	0.023*
At 120th min	8.5±5.2	6.7±4.9	1.299	0.261	9.2±6.4	6.1±3.7	3.662	0.063	9.2±6.4	6.1±3.7	3.662	0.063
At 160th min	8.0±5.6	6.5±4.2	0.961	0.333	9.6±6.9	5.5±3.6	5.424	0.025*	9.6±6.9	5.5±3.5	5.424	0.025*
At 200th min	8.2±5.4	7.5±4.6	0.197	0.659	8.6±6.0	6.3±4.8	1.867	0.180	8.6±6.0	6.3±4.8	1.867	0.180
At 240th min	9.4±6.4	8.6±7.1	0.136	0.715	10.8±8.8	6.8±4.1	3.420	0.072	10.8±8.6	6.8±4.1	3.420	0.072
F	4.33	3.81			5.152	1.807			5.152	1.807		
p-value [b]	0.001*	0.001*			0.001*	0.001*			0.001*	0.001*		

TT = touch typing, NTT= non touch typing,

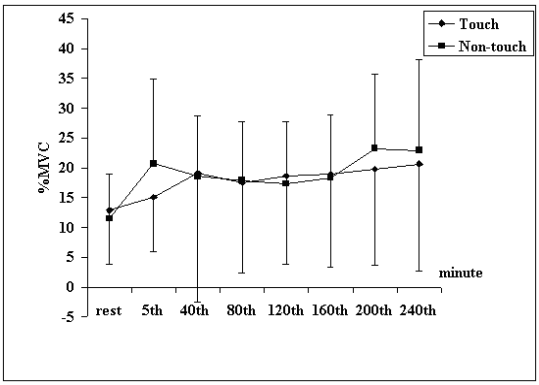
b= two-ways ANOVA mixed design; *Significant difference at $p<0.05$



1a. Right trapezius muscle



1b. Right deltoid muscle



1c. Right splenius muscle

Figure 1: Percentage of MVC of right trapezius, anterior deltoid, and splenius capitis muscle before typing, typing period at 5th, 40th, 80th, 120th, 160th, 200th and 240th minutes between touch (n=21) and non-touch typists (n=20) (* denoted the statistical significant difference at p<0.05).

3.3 Word counts

The word counts were also compared between both groups and significant differences were found between both groups at each observing period (Figure 2)

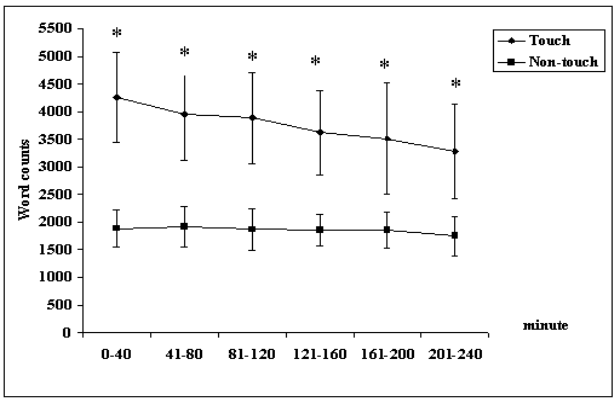


Figure 2: Comparison of word counts between two groups in each typing period (* denoted the statistical significant difference at p<0.05).

3.4 Discomfort

There were significant difference of VAS of neck and right shoulder at typing period at 240th minute between two touch and non-touch typists (2.1 cm. vs 3.2 cm. for neck area, and 2.2 cm. vs 3.5 cm. for right shoulder area). While, there were no significant difference of VAS of right arm between touch and non-touch in all periods.

For the VAS in neck of touch typists, there were significant differences not only between typing period at 40th and all periods except at 120th minute but also between typing period at 80th and all periods except at 120th minute. In addition, typing period at 160th minute was found significantly differences with all periods except at 240th minute. For non-touch typists, the significant differences were found in typing period at 40th minute which was significantly difference with typing period at 160th, 200th and 240th minutes and the similarly pattern was found as at 80th minute. Moreover, there were significant changes between typing period at 120th and 200th and also between at 120th and 240th minutes.

For VAS of right shoulder of touch typists, there were significant differences in VAS of right shoulder between typing period at 40th minute compared to 120th, 160th, 200th and 240th minutes. In addition, there were also significant differences of VAS of right shoulder at typing period at 80th minute compared to 160th, 200th and 240th minutes. These significant differences were also found in non-touch typists.

For VAS of right arm of touch typists, there were significant changes between typing period at 240th and 40th minutes, 240th and 80th minutes, 240th and 120th minutes. In addition to VAS of right arm at typing period at 200th minute was significant difference when compared to 40th and 80th minutes. These significant differences were also found in non-touch typists. Especially VAS of right arm at typing period at 240th minute was a significant difference with 160th minute.

4. DISCUSSION

This study could not find significant differences of right trapezius and splenius capitis activities during typing between touch and non-touch typists. While the anterior deltoid muscle was found to have higher %MVC of the touch typists than those of the non-touch at 40th, 80th and 160th minute. These findings may indicate that the touch and non-touch typists did not elevate shoulder and bend neck much. Since, the trapezius muscle works to elevate shoulder and the splenius capitis muscle works to hold neck when head and neck are in bending position. The touch typists tended to have their shoulders abducted since deltoid muscle had higher activity. This result may indicate that non-touch typists may be better than touch typists, since there was less muscle activity.

Although, the anterior deltoid muscle in touch typists worked more than non-touch typists, the discomfort in neck, right shoulder showed less when compared between groups. The discomfort levels in all areas seemed to be greater when duration of work was longer. This increase of discomfort finding was in the same way as the result from the increase of muscle activities (%MVC). In the touch typing group, VAS of neck showed significant increase almost all typing

period. These supports the study of Fahrbach and Larry [3] that the self-reported health problems in heavy typing has increased of discomfort at neck. An explanation could from holding neck posture while perform the repeated movement of neck to see the monitor and documents. The action of splenius capititis muscle was stabilizing the head and neck. Therefore, reported VAS may refer from this muscle.

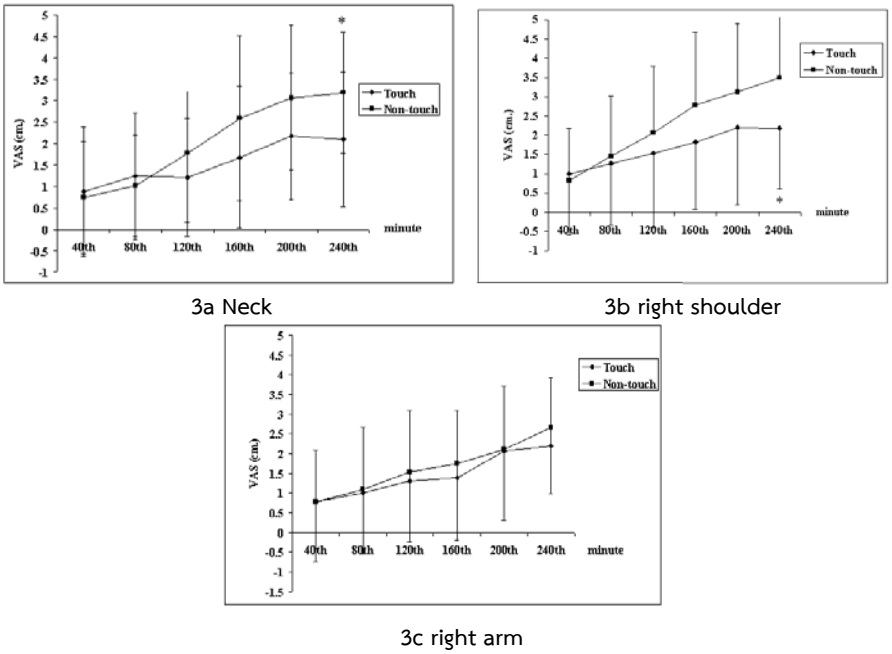
Table 3: Comparison of VAS of neck, right shoulder, and right arm in typing period at 40th, 80th, 120th, 160th, 200th and 240th minutes within and between touch (n=21) and non-touch typists (n=20).

Times	VAS of Neck (mean±SD)				VAS of right shoulder (mean±SD)				VAS of right arm (mean±SD)			
	TT	NTT	Z	p-value	TT	NTT	F	p-value	TT	NTT	Z	p-value [c]
40th min	0.9±1.5	0.7±1.3	-0.117	0.907	1.0±1.6	0.8±1.6	0.151	0.700	0.8±1.3	0.8±1.5	-0.401	0.688
80th min	1.2±1.5	1.0±1.2	-0.067	0.946	1.3±1.6	1.5±1.6	0.129	0.722	1.0±1.7	1.10±1.6	-0.097	0.923
120th min	1.2±1.4	1.8±1.6	-1379	0168	1.5±1.9	2.1±1.7	0.825	0.369	1.3±1.8	1.5±1.8	-0.659	0.510
160th min	1.7±1.7	2.6±1.9	-1.700	0.089	1.8±1.8	2.8±1.9	2.902	0.096	1.4±1.7	1.8±1.9	-0.661	0.509
200th min	2.2±1.5	3.1±1.7	-1.644	0.100	2.2±2.0	3.1±1.8	2.356	0.133	2.1±1.7	2.1±1.8	-0.288	0.774
240th min	2.1±1.6	3.2±1.4	-2.101	0.036 [c*]	2.2±1.6	3.5±2.0	5.354	0.026 [b*]	2.2±1.7	2.7±1.7	-0.940	0.347
Chi-square	4.448	59.574			3.086	11.120			40.186	49.143		
p-value	0.010 [d*]	0.001 [d*]			0.001 [b*]	0.001 [b*]			0.001 [d*]	0.001 [d*]		

TT = touch typing, NTT= non touch typing,

b= two-ways ANOVA mixed design c = Mann-Whitney U test; d = Friedman test

* Significant difference at p<0.05



3a Neck

3b right shoulder

3c right arm

Figure 3: Comparison of VAS of neck, right shoulder, and right arm in typing period at 40th, 80th, 120th, 160th, 200th and 240th minutes between two groups (*significant difference at p<0.05).

The result from discomfort level support the touch typing group. The definitely higher word counts in the touch than the non-touch group in all periods were unquestionable and could be the only thing that support the touch typist group. This means touch typists may have higher anterior deltoid muscle activity, but no difference in discomfort, and in substitution they have much more work done.

From the results, word counts at last typing period significant decreased when compare to first typing period, particularly in touch typing group. This supported the study of Brandis and Straker in 2002 [4] that long typing period could induce fluctuation of fingers, fatigue and decreased of concentration.

This study had some limitations which could be beneficial to address. During performing typing there are varieties of movement, and a lot of muscles working around. More EMG from those muscles as well as postural observation should be added.

In conclusion, this study advocated that typing skill is important and should be encourage for keyboard users, since it showed no difference in both trapezius and splenius capitis muscle activities. The exception was for anterior deltoid muscle, but less discomfort level and high productivity were presented.

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