Influence of Touch Screen Technology on Myoelectric Activity of Cervical Muscles (systematic review)

Mona Ibrahim Hassan[1], Prof. Dr. Haytham M. Elhafez [2], Dr. Mary Nassif Takla[3]

[1]Basic Science Department/Faculty of Physical Therapy/Cairo University

[2]Basic Science Department/Faculty of Physical Therapy/Cairo University

[3]Basic Science Department/Faculty of Physical Therapy/Cairo University

ABSTRACT

This systematic review aimed at evaluating the risk factors for cervical muscles and neck complaints associated with touch screen devices use. PubMed central, Science direct , Google scholar and Springer link were searched. The methodological quality of included studies was assessed. Strength of evidence for risk factors was determined based on study designs, methodological quality and consistency of results. This review demonstrates that the prevalence of musculoskeletal complaints among mobile device users ranges from 1.0% to 67.8% and neck complaints have the highest prevalence rates ranging from 17.3% to 67.8%. This review also finds some evidence for neck flexion, frequency of phone calls, texting and gaming in relation to musculoskeletal complaints among mobile device users. People using mobile touch screen devices have been exposed to the musculoskeletal disorder because of physical risk factors. Inconclusive evidence is shown for other risk factors such as duration of use and human-device interaction techniques due to inconsistent results or a limited number of studies.

Keywords: Cervical muscles, Mobile devices, Myoelectric activity, Tablets, Touch-screen technology and Smartphones.

INTRODUCTION

The introduction of touch screen technology has changed how people interact with their devices in comparison to traditional input devices. The different input devices were optimal based on age of the user and the type of task being performed (Rogers et al., 2005). Users may also adopt different postures depending on the type of device they are using. For example, Shin and Zhu (2011) found that participants placed touch screen desktop PCs significantly closer when using the touch screen and also preferred the display to be lower and with more of a tilt than when using a traditional mouse and keyboard.

The varieties of postures and types of input adopted when interacting with touch screen devices may have significant implications with regards to the ergonomic effects of touch interfaces (Muse, 2011).

Touch screen interfaces afford several advantages over traditional input devices (such as a keyboard and mouse) because gesturing can be mapped directly to the task and does not require the user to learn or remember commands, thereby reducing cognitive load (Mackenzie, 1995).

However, other research suggests using touchscreen devices can result in greater muscle fatigue (Nielsen et al., 2004; Shin & Zhu, 2011). In a similar vein,(Young et al.,2012) observed that use of touch screen tablets in various tasks resulted in head and neck flexion angles deviant from the neutral posture defined by current ergonomic standards. Due to the fact that touch screen technology is relatively new to consumer products, current research is scarce (Muse, 2011).

Furthermore, there are no design guidelines or standards developed for various touch screen devices such as tablets in comparison to current desktop and laptop computers (Young, et al., 2012).

PURPOSE OF THE STUDY:

To Systematically review the influence of touch screen technology use on the myoelectric activities of cervical muscles.

.

MATERIALS AND METHODS

The data bases which will be followed for eligibility criteria include: Science direct, Research Gate, PUBMED library and Springer link.

The search was started with each keyword alone then a combination of keywords was done in pairs then finally all the keywords were combined together.

Study selection:

Review Selection a major challenge to review selection is identifying all reviews relevant to the topic of interest, and of potential importance to answering the research question. An agreement of inclusion and exclusion criteria should be made before starting the review selection process. Aspects of this process might include decisions regarding the type of reviews that may be included in the systematic review.

Inclusive criteria:

1. All types and sizes of touch-screen technology devices.
2. Randomized controlled trials, pilot studies and case reports.
3. Studies that investigated the influence of touch-screen technology use on myoelectric activity of cervical muscles.

Exclusive criteria:

1. Other types of sample stratified as convenient samples.
2. Published articles in non-English language.

Quality Assessment:

Overwhelming evidence shows the quality of reporting of randomized controlled trials (RCTs) is not optimal. Without transparent reporting, readers cannot judge the reliability and validity of trial findings nor extract information for systematic reviews.

CONSORT 2010 Checklist:

The checklist includes the 25 items selected because empirical evidence indicates that not reporting the information is associated with biased estimates of treatment effect, or because the information is essential to judge the reliability or relevance of the findings **(Moher et al., 2010).**

Section/ Topic	Item No	Checklist item
Title and abstract **Introduction** Background and objectives **Methods** Trial design Participants Interventions Outcomes Sample size **Randomization:** Sequence generation Allocation concealment mechanism Implementation Blinding Statistical methods **Results** Participant flow (a diagram is strongly recommended) Recruitment Baseline data Numbers analyzed Outcomes and estimation Ancillary analyses Harms **Discussion** Limitations Generalizability Interpretation **Other information** Registration Protocol Funding	**1a** **1b** **2a** **2b** **3a** **3b** **4a** **4b** **5** **6a** **6b** **7a** **7b** **8a** **8b** **9** **10** **11a** **11b** **12a** **12b** **13a** **13b** **14a** **14b** **15** **16** **17a** **17b** **18** **19** **20** **21** **22** **23** **24** **25**	**Identification as a randomized trial in the title.** **Structured summary of trial design, methods, results, and conclusions.** **Scientific background and explanation of rationale** **Specific objectives or hypotheses.** **Description of trial design (such as parallel, factorial) including allocation ratio.** **Important changes to methods after trial commencement (such as eligibility criteria), with reasons.** **Eligibility criteria for participants.** **Settings and locations where the data were collected.** **The interventions for each group with sufficient details to allow replication, including how and when they were actually administered.** **Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed.** **Any changes to trial outcomes after the trial commenced, with reasons.** **How sample size was determined.** **When applicable, explanation of any interim analyses and stopping guidelines.** **Method used to generate the random allocation sequence.** **Type of randomization; details of any restriction (such as blocking and block size).** **Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned.** **Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions?** **If done, who was blinded after assignment to interventions (for example, participants, care providers, those, assessing outcomes) and how.** **If relevant, description of the similarity of interventions.** **Statistical methods used to compare groups for primary and secondary outcomes.** **Methods for additional analyses, such as subgroup analyses and adjusted analyses.** **For each group, the numbers of participants who were randomly assigned, received intended treatment and were analyzed for the primary outcome.** **For each group, losses and exclusions after randomization, together with reasons.** **Dates defining the periods of recruitment and follow-up.** **Why the trial ended or was stopped.** **A table showing baseline demographic and clinical characteristics for each group.** **For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups.** **For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval).** **For binary outcomes, presentation of both absolute and relative effect sizes is recommended.** **Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing Pre-specified from exploratory.** **All important harms or unintended effects in each group (for specific guidance see CONSORT for harms).** **Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses.** **Generalizability (external validity, applicability) of the trial findings.** **Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence.** **Registration number and name of trial registry.** **Where the full trial protocol can be accessed, if available.** **Sources of funding and other support (such as supply of drugs), role of funders.**

RESULTS

The aim of systematic review is to find the best answer to a specific question. This is done by synthesized the results of several research studies. In case of our study we will try to find the influence of using touch-screen technology on myoelectric activity of cervical muscles.

Search will conduct for published reports of clinical trials which are available in all electronic sources which are concerning to provide randomized clinical trials for physical therapy.

Table (1) : Statistical analysis of selected studies.

Study name	Odds Ratio	CI Lower limit	CI Upper limit	Weight
Areeudomwong et al., 2017	2.88	0.82	10.03	5.99%
Vasavada et al., 2015	1.96	0.86	4.49	13.62%
Xi et al., 2015	0.73	0.30	1.82	11.44%
Ning et al., 2015	1.63	0.87	3.02	23.91%
Kim et al., 2014	1.96	0.79	4.85	11.44%
Young et al., 2013	2.13	0.83	5.43	10.65%
Shin and Zhu 2014	0.88	0.33	2.38	9.47%
Straker et al., 2008a	2.95	1.05	8.25	8.79%
Straker et al., 2008b	1.29	0.31	5.30	4.69%

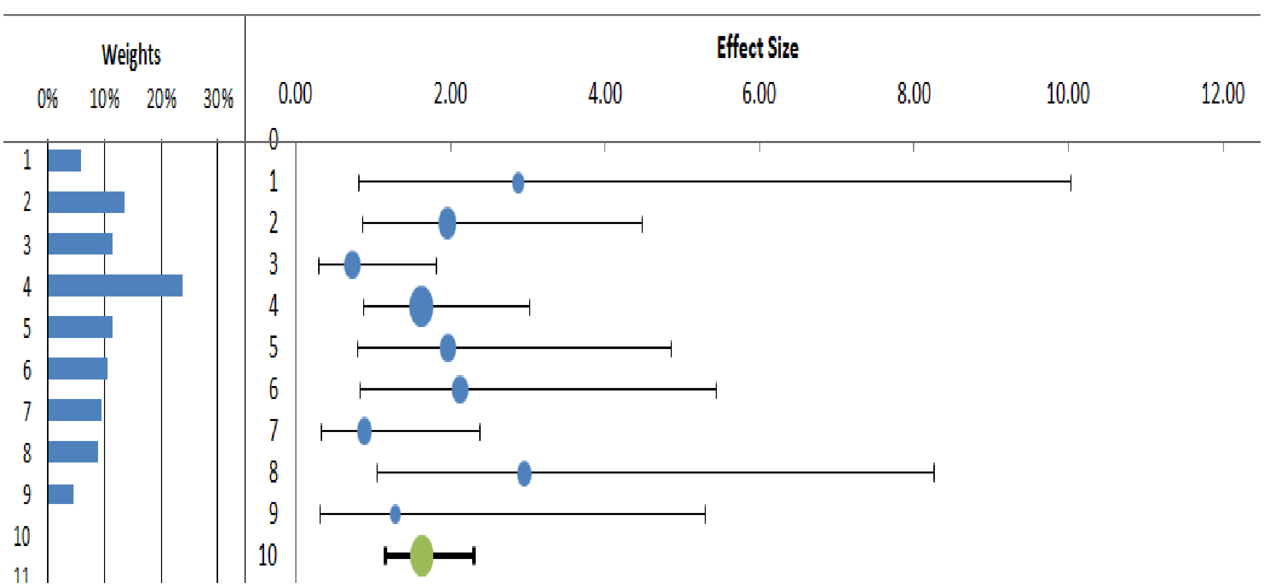

Figure (1): Forrest plot chart of selected studies.

Author(s)	**Title**	**Journal**	**year**	**consort**		**participants**
				yes	**no**	
1-Justin G. Young. **2-Matthieu B. Trudeau.** **3-Dan Odell.** **4-Kim Marinelli 5-Jack T. Dennerlein.**	Wrist and shoulder posture and muscle activity during touch-screen tablet use: Effects of usage configuration, tablet type, And interacting hand.	IOS Press	2013	16	21	Fifteen adults

Outcome measures:

Shoulder	Flexion		Abduction		Elevation	
	Mean (°)	St Dev (°)	Mean (°)	St Dev (°)	Mean (°)	St Dev (°)
Configuration	***p* = 0.000**	p = 0.0019	p < 0.0001	p < 0.0001	p < 0.0001	p < 0.0001
ANOVA	21 (2)C	9 (1)C	174 (19)C	4 (2)A	5 (1)D	101 (13)B
1H-game	26 (2)B,C	12 (1)A,B	181 (19)B,C	6 (2)A	6 (1)B,C	116 (13)B
1H-Web	25 (2)B,C	12 (1)A,B,C	156 (19)C	−1 (2)B	9 (1)A	179 (13)A
2H-Web	35 (2)A	11 (1)A,B,C	318 (19)A	−4 (2)B,C	6 (1)B,C,D	132 (13)A,B
Lap-Email	30 (2)A,B	11 (1)A,B,C	196 (19)B,C	−1 (2)B	7 (1)B,C	163 (13)A
Lap-Web	25 (2)B,C	10 (1)B,C	326 (19)A	−7 (2)C	6 (1)C,D	129 (13)A,B
Table-Email	23 (2)C	13 (1)A	228 (19)B	−3 (2)B	7 (1)A,B	
Table-Web						
Hand	p < 0.0001	p < 0.0001	p < 0.0001	p < 0.0001	p < 0.0001	p < 0.0001
ANOVA	32 (1)A	13 (1)A	302 (16)A	−3 (1)B	8 (1)A	169 (10)A
Dominant	20 (2)B	9 (1)B	148 (16)B	1 (1)A	5 (1)B	94 (10)B
Non-Dominant						
Tablet	p = 0.6274	p = 0.7390	p = 0.2477	p = 0.3587	p = 0.0903	p = 0.7412
ANOVA	26 (2)	11 (1)	231 (16)	0 (1)	6 (1)	130 (10)
Tablet 1	27 (2)	11 (1)	220 (16)	−1 (1)	7 (1)	133 (10)
Tablet 2						
Interactions[3]	p = 0.0502	p = 0.0036	p =0.0003	p < 0.0001	p = 0.0342	p = 0.4492
Hand x Config	p = 0.3798	p = 0.5846	p = 0.1792	p = 0.5407	p = 0.8149	p = 0.0509
Tablet x Config	p = 0.7788	p = 0.6583	p = 0.7382	p = 0.6391	p = 0.7382	p = 0.8203
Tablet x Hand						

Author(s)	**Title**	**Journal**	**Year**	**consort**		**participants**
				yes	**no**	
1Gwanseob Shin. 2-Xinhui Zhu.	User discomfort, work posture and muscle activity While using a touchscreen in a desktop PC setting.	Ergonomics.	2011	21	16	24 young participants (13 females and 11 males).

Outcome measures:

Mean NEMG	No touch LH/RH	Mixed use LH/RH	Full touch LH/RH
Right shoulder muscle	0.079/0.045	0.069/0.130	0.109/0.103
Left shoulder muscle	0.060/0.037	0.092/0.057	0.119/0.054
Mean elbow travel velocity (m/s)			
Right elbow	0.031/0.031	0.063/0.103	0.053/0.067
Left elbow	0.021/0.021	0.060/0.035	0.043/0.034

DISCUSSION

This systematic review aimed at evaluating the risk factors for cervical muscles and neck complaints associated with touch screen devices use. Pubmed, Science direct , Research Gate and Springer link were searched. The methodological quality of included studies was assessed. Strength of evidence for risk factors was determined based on study designs, methodological quality and consistency of results. This review demonstrates that the prevalence of musculoskeletal complaints among mobile device users ranges from 1.0% to 67.8% and neck complaints have the highest prevalence rates ranging from 17.3% to 67.8%. This review also finds some evidence for neck flexion, frequency of phone calls, texting and gaming in relation to musculoskeletal complaints among mobile device users. Inconclusive evidence is shown for other risk factors such as duration of use and human-device interaction techniques due to inconsistent results or a limited number of studies.

The introduction of touchscreen technology has remarkably changed how people interact with their devices. Users may adopt different methods of input depending on the type of device they are interacting with and the type of task being performed. Other study has revealed that females and individuals with current musculoskeletal symptoms are more likely to be at risk for neck and upper extremity symptoms during use of touch-screen tablet computers. In regards to sitting positions, sitting without back support and sitting with the device in the lap were significantly associated with symptoms; sitting without back support is the strongest postural predictors for symptoms during use of touch screen devices.

Neck flexion postures can lead to an increase in gravitational load moment, which increase cervical extensor muscle activity and causes strain on the neck extensors. Other study revealed that sitting without back support, resulting in a slumped position, during device use was identified as a significant factor for developing musculoskeletal symptoms. In a slump sitting position, greater cervical and thoracic extensor activities are required to support the head in the forward position and the combination of neck flexion and cervical extensor activities may produce specific stress regions and cause postural neck pain.

Previous studies found that there is low agreement between measuring exposures such as time spent on mobile devices by self- report questionnaires and by direct and objective measurements such as a phone bill, phone activity measure applications and activity monitors. Regarding the case-control studies included in this review, they employed direct measurements such as using surface electromyography and motion tracking systems to evaluate muscle activity and neck flexion angles. Future studies should confirm musculoskeletal complaints by physical examination and measure exposures to risk factors among users of mobile devices through direct measurements in order to provide more accurate data.

REFERENCES

1. Rogers WA, Fisk AD, Mclaughlin AC, Pak R. (2005).Touch a screen or turn a knob: Choosing the best device for the job. Human Factors. 2005;47:271–288.
2. Shin, G. & Zhu, X., (2011). Ergonomic issues associated with the use of touchscreen desktop PC. Proceedings of the Human Factors and Ergonomics Society 55th Annual Meeting, 55(1), pp. 949-953.
3. Shin, G., & Zhu, X. (2011). User discomfort, work posture and muscle activity while using a touchscreen in a desktop PC setting. Ergonomics, 54(8), 733–744.

https://doi.org/10.1080/00140139.2011.592604

4. MacKenzie, I. S. (1995):" Input Devices and Interaction Techniques for Advanced Computing". Virtual environments and advanced interface design. W. Barfield and T. Furness. Oxford, UK, Oxford University Press: 437-470.
5. Nielsen, M., Störring, M., Moeslund, T. B., (1) et al., (2004): "A procedure for developing intuitive and ergonomic gesture interfaces for HCI." In Gesture-Based Communication in Human-Computer Interaction, 409-420.
6. Young, J. G., Trudeau, M., Odell, D., Marinelli, K., & Dennerlein, J. T. (2012). Touch-screen tablet user configurations and case-supported tilt affect head and neck flexion angles. Work, 41, 81–91. https://doi.org/10.3233/WOR-2012-1337.
7. Muse, L., Peres, S.C., (2011) : "The Ergonomic Implications of Gesturing": Examining Single and Mixed Use with Appropriate Placement.
8. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, Elbourne D, Egger M, Altman DG. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials.
9. Young, J. G., Trudeau, M. B., Odell, D., Marinelli, K., & Dennerlein, J. T. (2013). Wrist and shoulder posture and muscle activity during touch-screen tablet use: Effects of usage configuration, tablet type, and interacting hand. Work, 45(1), 59–71. https://doi.org/10.3233/WOR-131604.
10. Areeudomwong, P., Oapdunsalam, K., Havicha, Y., Tantai, S., & Buttagat, V. (2018). Effects of Shoulder Taping on Discomfort and Electromyographic Responses of the Neck While Texting on a Touchscreen Smartphone. Saf Health Work, 9(3), 319–325. https://doi.org/10.1016/j.shaw.2017.07.004.
11. Vasavada, A. N., Nevins, D. D., Monda, S. M., Hughes, E., & Lin, D. C. (2015). Gravitational demand on the neck musculature during tablet computer use. Ergonomics, 58(6), 990–1004.

https://doi.org/10.1080/00140139.2015.1005166.

12. Xie, Y., Szeto, G. P. Y., Dai, J., & Madeleine, P. (2015). A comparison of muscle activity in using touchscreen smartphone among young people with and without chronic neck–shoulder pain. Ergonomics, (October), 1–12. https://doi.org/10.1080/00140139.2015.1056237.
13. Ning, X., Huang, Y., Hu, B., & Nimbarte, A. D. (2015). Neck kinematics and muscle activity during mobile device operations. Int J Ind Ergon, 48(July), 10–15. https://doi.org/10.1016/j.ergon.2015.03.003
14. Kim, J. H., Aulck, L., Bartha, M. C., Harper, C. a., & Johnson, P. W. (2014). Differences in typing forces, muscle activity, comfort, and typing performance among virtual, notebook, and desktop keyboards. Appl Ergon, 45(6), 1406–1413. https://doi.org/10.1016/j.apergo.2014.04.001
15. Young, J. G., Trudeau, M. B., Odell, D., Marinelli, K., & Dennerlein, J. T. (2013). Wrist and shoulder posture and muscle activity during touch-screen tablet use: Effects of usage configuration, tablet type, and interacting hand. Work, 45(1), 59–71. https://doi.org/10.3233/WOR-131604
16. Shin, J. J., Kim, J. S., Hon, J. H., Yu, J. H., & Lee, D. Y. (2015). The effect of table height on the thickness of neck muscle during computer work. Indian Journal of Science and Technology, 8(26). https://doi.org/10.17485/ijst/2015/v8i26/80279
17. Straker, L., Pollock, C., Burgess-Limerick, R., Skoss, R., & Coleman, J. (2008). The impact of computer display height and desk design on muscle activity during information technology work by young adults. J Electromyogr Kinesiol, 18(4), 606–617. https://doi.org/10.1016/j.jelekin.2006.09.015