Comfort and Discomfort While Smart Phoning in Bed

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Abstract The number of smartphone users worldwide from 2014 to 2020 was increased from 1.57 to 2.87 billion, respectively. Moreover, the internet of Things (IoT) connected devices trend predicts to increase to 75.44 billion in 2025. People can continuous do more by the smartphone. However, people use smartphone continuously for long times, which could contribute to discomfort or muscle pain as it could result in awkward postures. The areas for using the smartphone could be the bed and on the sofa. The awkward postures in test areas could affect the comfort and discomfort using the smartphone. To study the comfort and discomfort of a smartphone in bed and how the posture is influenced by smartphone use 52 participants were asked to use the smartphone in the bed with a backrest, that can be adjusted in 6 steps 177, 162, 142, 120, 99, 75 degrees respectively. 26 subjects started from 3-105 degrees, and 26 subjects started from 105 to 3 degrees. The results of this study were analysed by Independent-Sample Kruskal-Wallis Test to see if comfort of participants differed for different back support angles. The results showed that the distribution of comfort is significantly different across categories of backrest angles. The participants prefer an angle of back support of 142, 120 (these were not significantly different) followed by 162, 177, 99 (which also did not differ), followed by 75 degrees. The best of the six positions were asked again, and subjects had to report in which body part they feel most discomfort and most comfort. The body discomfort showed that 53.84%, 32.69 %, 11.53%, and 11.53% of the participants had discomfort at lower back, neck, shoulder and lower arm respectively when using the smartphone in bed. The comfort of body region was mentioned most in the legs (34.6%). , 26.92%, and 19.23% felt comfort at upper back and shoulders when using the smartphone in bed. The size and weight of smartphones and the duration of the test could influence the comfort and discomfort, which is of interest for a follow up study.

Keywords: Comfort, Discomfort, Posture, Smart phone, Bed

1 Introduction

Observing passengers in a train showed that 40-50% of the passengers use their smartphone at the moment of observing (Kilincsoy & Vink, 2018). Among others, it could be texting, listening to music, reading, or web browsing. Much effort is devoted to optimizing the systems and mechanisms of smartphones to increase productivity (e.g., Jewell, 2011; Lee and Lee, 2011). New versions of smartphones are often introduced in the market. The number of iPhones sold from Q3 2014-Q3 2018 is 40 million each quarter of the year (https://www.textrequest.com/media/2320/iphone-sales-2007-2018.png). Assumably, the new version probably has much more features, which probably stimulates to use the smart phone more. However, the relationship between smartphone comfort and body posture is seldom mentioned, while this might be more important taking into account what the newer versions of the smartphone can offer. Also, in the bed, the smartphone is used. Fifty percent reports to frequently use the smartphone in bed in the study of Honan (2015). Some beds are adjustable and can be inclined. The semi-Fowler position is used in hospitals, in which the upper part of the bed is raised, resulting in a position with the head and trunk raised to 30 degrees. This semi-Fowler's position was more effective than supine position in hemodynamic stability of patients with head injury (Kim et al., 2015). The question is, however, what position is best for smart phoning in the bed. A flat position might give too much strain in the neck for bending the neck, and a fully upright position might result in too much stretching of the back or hamstring muscles. This paper was aimed to identify the back position that is appropriate when people using a smartphone in bed.

2 Materials and Methods

To answer the research question “what is the best angle of the backrest for using the smartphone in the bed” an experiment was performed.

2.1 Participants

30 men and 22 women of different nationalities (European, American, and Asian) all of higher education participated in the study. The lengths of participants varied from 153 to 197 cm. an average stature was 175 cm.

2.2 Protocol

The research started with the introduction of the experiment and signing an informed consent. The participants were separated into 13 groups of 4 persons. In the first 15 minutes, the 1st person of the group settled on the bed and takes 6 positions (different back rest angles). In each position, which took a few minutes, a message is sent to the manager group, and the comfort is scored. The comfort score is asked by the 2nd of the four others and written in an electronic questionnaire. In the questionnaire the area of discomfort is marked as well. The 3rd person takes a lateral picture of each person. The 4th of each group is managing the whole process. The subjects take a position on a reclining sunbed and adjust the reclining mechanism in the following angles 177, 162, 142, 120, 99 and 75 degrees. 26 participants were asked to start with the flat position (177degrees), and others were asked to start in the upright position (75 degrees).

2.3 Questionnaire

A questionnaire was used to evaluate each position having a different angle of back support. Each participant was asked to rate comfort on a scale from 1-7. A 7 points Likert scale was used to assess discomfort (1 = No no comfort at all and 7 =extreme comfort). After scoring each position the participant had to take the most comfortable position and score on a body map the discomfort on each body area. In this case the LPD-method

(Localized Postural Discomfort) (Grinten, 1992) was used for scoring the discomfort for the neck, shoulder, upper back, lower back, upper arm, lower arm, wrist, and leg.

2.4 Analysis

The analysis consisted of calculating the mean, standard deviation of the comfort and discomfort score and were plotted in a graph for each angle 177, 162, 142, 120, 99, 75 degrees respectively. Statistics consisted of applying the Independent-Sample Kruskal-Wallis test were used to compared comfort of participants when using the smartphone in each angle for answer the research question "what is the best angle of the backrest for using the smartphone in the bed." For the local postural discomfort percentage of the total were calculated to get an impressin where comfort and discomfort is experienced.

3 Results

The body length of the participants (22 females and 30 males) varied from 1530 cm to 1970 cm, the age was between 22 and 30 years and all had higher education.

3.1 The results of back support angle.

The comfort results show that the participants prefer an angle of back support of 142, 120 (these were not significantly different) followed by 162, 177, 99 (which also did not differ), followed by 75 degrees (see figure 1 and table 1)) with average comfort levels rated at 4.8,4.8,4.4,3.3,3.2 and 1.8 respectively (an extremely high comfort level is 7, and no comfort at all is 1). The answer to the research question which is the best angle of backrest that the users prefer to use was 142 and, 120 degrees. The data are shown in figure 1.

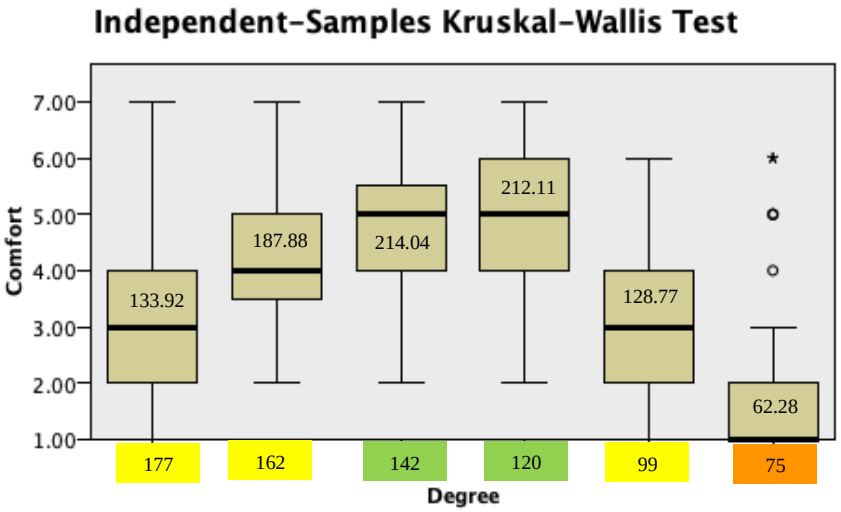

Figure 1. The results of comfort levels separated by an angle of back support

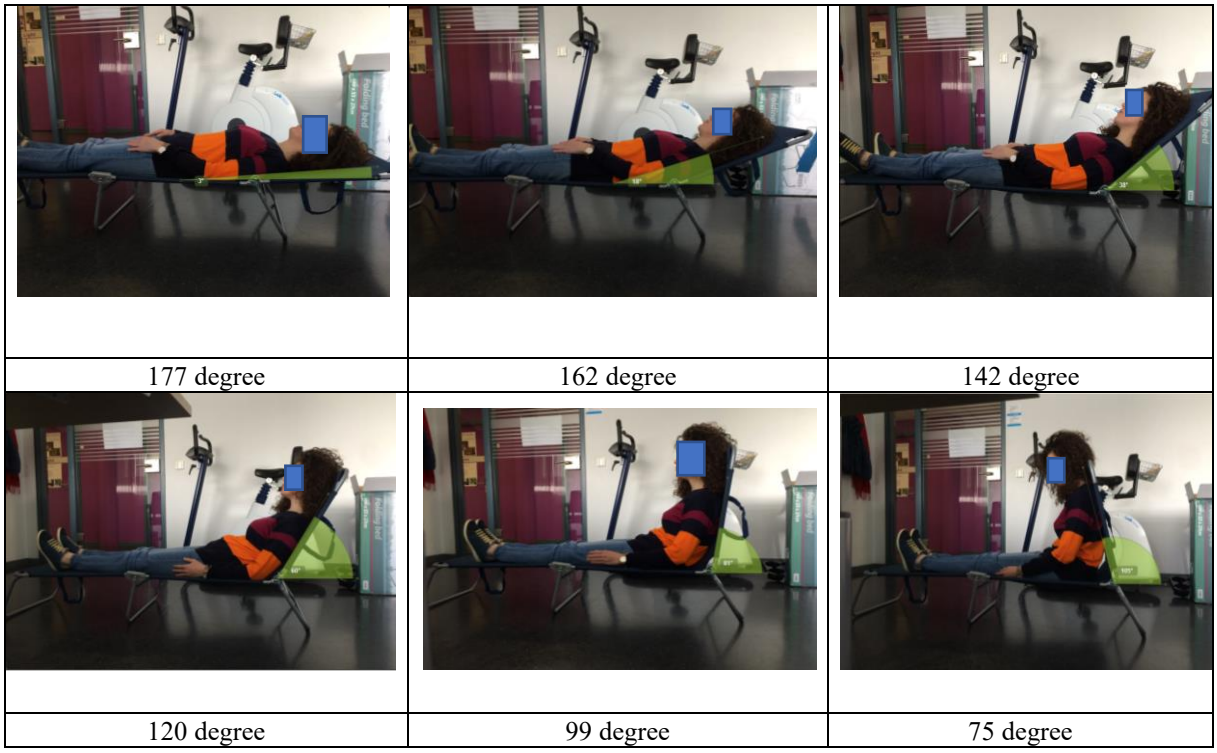

Figure 2. The different angles in which the participants had to use the smart phone

The Independent-Sample Kruskal-Wallis Test showed that the comfort values at 142 and 120 did not differ significantly, but these were different from 162, 177 and 99. These again did not differ from each other, but they did differ significantly from the75 degrees.

Table 1. The results of mean range separated by the degree of backrest

Part of body	*Degree of an ankle*					
	177	*162*	*142*	*120*	*99*	*75*
Mean range	133.92	187.88	214.04	212.11	128.77	62.28

The results of Pairwise Comparisons node Degree each node shows the sample average rank of degree. The 75 degree was showed the fell comfort of participants that significant difference with all other degrees. The 99 degrees reported significant difference with 120, 142, and 162 degrees while no significant difference between 99 and 177 degrees. Besides, the results found that the comfort feel of the subjects was a significant difference between 177 degrees and 120,142 and 162 degrees respectively. Moreover, 162 degree was a difference from 120 and 142 degrees but not significant level. Finally, the participants were rated the comfort level between 120 and 142 was not a significant difference.

3.2 The results of comfort and discomfort by body region.

For the best of the six positions, which was taken again by the participants LPD was rated as well as comfort. . The body discomfort experience shows that 53.8%, 32.7 %, 11.5%, and 11.3% of the participants reported discomfort in the lower back, neck, shoulder, and lower arm, respectively (see table 2). While, the

comfort was high by 34.6% in the legs. 26.9%, and 19.2% felt comfort in the upper back and shoulders respectively when using the smartphone in bed.

Table 2. The percentage of the participants mentioning comfort and discomfort for the different regions.

The part of body	*Feel of participants*	
	Comfort (%)	*Discomfort (%)*
Neck	7.69	32.96
Shoulders	19.23	11.53
Upper arms	15.38	5.76
Lower arms	3.85	11.53
Wrist	0.00	1.92
Upper back	26.92	1.92
Lower back	7.69	53.84
Legs	34.61	5.76
Totally	**	**

** Remark : some people prefer more than one angle.
Moreover, 63.5% used two fingers and 30.8 used one finger and 5.8 used other method for typing.

4 Discussions

In answering the research question "what is the best angle of the backrest for using the smartphone in the bed" it is clear that there is not one preferred angle, but a range of angles in which the comfort is better . The participants experienced a high comfort when using the smartphone in bed at a 142 to 120 degree backrest angle. Groenesteijn et al. (2009) mentions that the adjustable backrest was better for adapting to the human and the task. She found a back rest angle of 132 degrees while reading in an office chair in a relaxed position. Of course this is not laying in bed, but the results show similarities. Probably the position of the arms and neck play a large role in determining the most comfortable back rest angle. This certainly needs further research. Of all participants, 34.61% mentions the comfort legs in this position and, 26.92%, and 19.23%, felt comfort at upper back and shoulders. The dis-comfort recordings showed that 53.84%, 32.69 %, 11.53% and 11.53% of participants felt discomfort at lower back, neck, shoulder and lower arm respectively when using the smartphone in bed. .

A disadvantage of the study is that the participants only use the smart phone a few minutes. It could be that longer use leads to other preferences. Smulders et al. (2016) and Sammonds et al. (2017) showed that sitting longer in one position does lead to higher discomfort ratings.

5 Conclusions

Regarding the research question "what is the best angle of the backrest for use the smartphone in the bed" the 52 participants showed a preference for two angles, which did not differ significantly. The participants experienced a high comfort when using the smartphone in bed at a 142 to 120 degree backrest angle. The participants prefer these angles, but still have discomfort. a 53.8%, 32.7 %, 11.5% and 11.5% of participants mention discomfort at the prefered backrests angle at lower back, neck, shoulder and lower arm respectively. While, the comfort when using the smartphone in bed at the prefered backrests angle was mentioned by 34.6% regarding the legs and 26.9%, and 19.2% regarding upper back and shoulders respectively.

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