ORIGINAL RESEARCH PAPER
Volume-9 | Issue-5 | May-2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ERGONOMIC RISK ASSESSMENT USING RULA IN RELATION TO MOBILE GAMING.

Physiotherapy

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ABSTRACT

Introduction : The rising use of smartphones has concurrently led to an increased risk of musculoskeletal problems. The study aimed to assess the level of ergonomic risk in smartphone gamers in relation to any self-reported musculoskeletal disorders.

Methodology: An online survey was conducted on 70 subjects comprising of 4 sections. The musculoskeletal disorders were identified through Standardized Nordic Questionnaire. Participants were given a gaming task and their postures were photographed. The photographs were evaluated using the Rapid Upper Limb Assessment tool.

Result: The correlation between musculoskeletal disorders and the ergonomic risk among smartphone users was determined using the Chi-Square test; $p<0.05$ was considered statistically significant.

Conclusion: The RULA results identified the high ergonomics risk of smartphone users. The neck, trunk and leg postures had a combined effect on neck musculoskeletal disorders. Future investigations should consider these factors when designing ergonomic interventions for smartphone gamers

KEYWORDS

Ergonomic risk factors, RULA, Musculoskeletal disorders, Gaming Addiction Scale.

Ergonomics enables an individual to understand his/her abilities as well as limitations and ensures safe, efficient, and comfortable task performance with respect to the same. Worldwide, 3.4 billion people of varying age groups use smart phones.[1]The rising use of smartphones has concurrently led to an increased risk of musculoskeletal problems. Approximately 18.8% of people who used smartphones complained of having musculoskeletal problems in at least one of their body part.[2,3]Smartphones are not ergonomically supported and their intensive use increases tension on muscles. It further causes eye tension, fatigue and sometimes insomnia.[4]Awkward postures are one of the leading physical risk factors associated with MSD and are further encouraged by the use of smartphones.[5]The smartphone users assume awkward postures including flexed neck, upper and lower back, protracted shoulder, flexed elbow, wrist and hand during keying, and supinated wrist and hand to support the device .[6,7]

RULA, an observational screening tool assess the risk factors the person is exposed to in the light of the postures assumed (by the neck, upper limb and trunk), the use of muscles and other external loads/forces experienced by the body.[8] The Standard Nordic Questionnaire is a simple and standardized questionnaire that acknowledges MSDs in the neck, shoulder, elbow, wrist & hand, upper and lower back, hip & thigh, knee, ankle & foot.[9,10]Gaming addiction, defined as excessive, obsessive, compulsive and problematic use of gaming has lately become one of the most common psychosocial problem. Gaming addiction scale aims at assessing the extent of addiction based on 7 criteria. If the person meets the given criteria during a period of 6 months, addiction is present. [11] This study aims to assess ergonomic risk associated with mobile phone games and musculoskeletal disorders concerning the playing of such mobile games.

METHODOLOGY

The inclusion criteria required the participants to be smartphone gamers between 18-25 years of age with at least 3 months of smartphone gaming experience, for duration of ≥1 hour on daily basis. The exclusion criteria accounted for any history of accident or surgery of relevant regions within the last 1 year; pathological medical conditions negatively affecting the spine and upper extremities; chronic diseases affecting the musculoskeletal system and orthopedic disorders; neurological and sensory deficits; visual problems (not correctable by glasses); dizziness or vertigo; and finally, consumption of any sedative drug or alcohol within the past 48 hours.

An online survey was conducted on 130 subjects comprising of 4 sections: participant history, smartphone use pattern, smartphone gaming pattern (involving preferred place and position for gaming) and, participant complaints. Only 70 responses were selected based on the inclusion and exclusion criteria. 30 participants were chosen through convenience sampling. Once the purpose and procedure of the research was explained to them, and consent form was collected, they were made to fill a questionnaire, tailored specifically for smartphone gamers, to determine the extent of gaming addiction (using 7- item Gaming addiction Scale) and any musculoskeletal disorders encountered by them in different body parts along with its duration (using Standardized Nordic Questionnaire). Participants were told to play their favorite game on their smartphones for at least 20 minutes at their preferred place for gaming (home/college), and their most sustained postures were photographed from anterior and lateral views. The participants were told to sit in the same location throughout the game as they usually do. The photographs were evaluated to determine the level of ergonomic risk using the RULA tool.

RESULTS

The Chi-Square test was used to establish the relationship between musculoskeletal discomfort faced in past 12 months and ergonomics risk level amongst smart phone gamers. Out of the total of 70 participants, 24 (34.3%) were female and 46 (65.7%) were male smartphone gamers. While 64 (91.4%) participants had right hand dominance only 6 (8.6%) participants had left. The average age of the participants was 21.04±2.25 years, with 65.71±14.24 kg being the average weight and 1.71±0.1 m being the average height. The reported average sleep duration amongst participants was 7.13±1.28 hours per day. 75.71% of the participants were students while the remaining 24.29% comprised of the working class.

Maximum number of participants (45.71%) stated they use smartphones for 3-6 hours per day followed by those who used it for more than 6 hours per day (28.57%) and only 1-3 hours per day (25.71%). All the 70 participants were mobile gamers, most of them had been playing their favourite game since the past 6-12 months (50%), followed by 3-6 months (28.5%) and more than 12 months (21.5%). Majority of the participants preferred playing game at night (80%) at home (92.9%) for 1-3 hours per day (87.1%). The most preferred position was sitting in bed(64.3%) followed by lying in bed (52.9%). 65.7% participants used both hands equally, followed by those who used right hand more (22.9%) and left hand more (11.4%) while gaming.

The Standard Nordic questionnaire results showed that in the past 12 months the neck musculoskeletal disorders were the most prevalent (80%), followed by upper back (73.3%), wrist/ hands (66.7%), lower back (60%), shoulders (50%), hip/thighs/buttocks (16.7%), Elbow (13.3%), ankle/foot (13.3%) and knees (10%). Most commonly faced other symptoms included eye tension (47.1%), headache (37.1%), fatigue (21.4%) and distraction (18.6%). 21 (70%) participants were classified as addicted to gaming while 9 (30%) were not addicted. The average score of 7-item Gaming Addiction Scale was 4.67±2.56. Most

of the participants scored 7 (49%) implying they were severely addicted to gaming.

Table 1: Results of 7 – Item Gaming Addiction Scale

GAS SCORE	n (%)
0	4(13.33)
1	1(3.33)
2	2(6.67)
3	2(6.67)
4	2(6.67)
5	5(16.67)
6	2(6.67)
7	12(49)

The Final RULA Grand score ranged from 4 to 7 for both, right and left side with an average of 5.85±0.92 and 5.9±0.96 and respectively. The mode score for both, right and left side was 6. Since majority of the smartphone gamers had a Grand Score of 6 on both the sides, they were at Action Level 3 which suggested that they soon required further investigation and changes. None of the participants had acceptable RULA scores

This study found that neck MSDs significantly correlated with the RULA Action Level and Grand Score for both, right and left sides. Upper back score too, were very significantly correlated with the RULA Action Level and Grand Score for both right and left sides. Further, RULA Score A of left side correlated with the wrist MSDs and RULA Score C of left side correlated with the shoulder MSDs . RULA Score B did not show significant correlation with any MSD, however, RULA Score D was highly correlated with neck and upper back musculoskeletal problems.

Table 2: RULA Score

RULA	Musculoskeletal Disorders	Chi-square (*p* value)	
		Lt.	Rt.
Score A	Shoulder	1.84 (0.39)	1.38 (0.58)
	Elbow	2.34 (0.31)	0.30 (0.86)
	Wrist and Hand	**7.95 (0.018)**	2.08 (0.35)
Score B	Neck	4.62 (0.09)	
	Upper Back	3.32 (0.189)	
	Lower Back	0.21 (0.89)	
	Hip and Thigh	0.53 (0.76)	
	Knee	0.80 (0.69)	
	Ankle and Foot	0.72 (0.96)	
Score C	Shoulder	**6.093 (0.047)**	4.71 (0.09)
	Elbow	1.17 (0.55)	1.45 (0.48)
	Wrist and Hand	2.27 (0.32)	2.82 (0.24)
Score D	Neck	**5.40 (0.05)**	
	Upper Back	**9.27 (0.0097)**	
	Lower Back	0.141 (0.9)	
	Hip and Thigh	0.35 (0.83)	
	Knee	0.93 (0.62)	
	Ankle and Foot	0.69 (0.70)	
Grand Score	Shoulder	5.37 (0.06)	2.46 (0.29)
	Elbow	1.01 (0.60)	0.78 (0.67)
	Wrist and Hand	2.0 (0.36)	2.02 (0.355)
	Neck	**7.87 (0.019)**	**6.15 (0.046)**
	Upper Back	**32.805 (0.001)**	**14.26 (0.0008)**
	Lower Back	1.763 (0.414)	0.321 (0.851)
	Hip and Thigh	1.519 (0.46)	1.31 (0.51)
	Knee	0.488 (0.78)	1.30 (0.521)
	Ankle and Foot	1.95 (0.377)	0.56 (0.75)
Action Level	Shoulder	0.98 (0.61)	
	Elbow	0.26 (0.98)	
	Wrist and Hand	2.81 (0.244)	
	Neck	**6.29 (0.04)**	
	Upper Back	**12.56 (0.0019)**	
	Lower Back	2.50 (0.28)	
	Hip and Thigh	2.141 (0.34)	
	Knee	1.039 (0.59)	
	Ankle and Foot	0.50 (0.77)	

DISCUSSION

There were multiple reasons behind smartphone gamers being exposed to such high levels of ergonomic risk. Observation of the posture revealed that while playing games on their smartphones, most participants flexed both their upper arm up to 20°, but some also took it beyond (20°- 45°). Lower arm postures of majority of participants were in flexion beyond 100° for both the arms. Both the wrists were postured in extension either between 0-15° or beyond with a bend away from the midline (ulnar deviation) and a mid-range twist (hand-shake position). The participants held their necks in flexion of more than 20° along with slight rotation or side flexion. Such postures are the leading causes of neck pain.[12,13] Even a slight flexion of the head gravely raises the load on the supporting soft tissue structures and activates the muscles in the cervical region.[14,15]

Trunk posture of a major proportion of participants was between 20-60° or beyond with some also demonstrating mild rotation or lateral bending. The slouched trunk posture especially with respect to the upper back was a major risk factor for causing neck and upper back pain. Neck, trunk and shoulder posture further changes with respect to the users' arms and where they are looking. Lastly, most of the participants sat with their legs well supported. Those who did not, consequently had increased level of ergonomic risk.[16,17] Smartphone gamers clearly adopted awkward postures while playing on their phones. As a joint move away from its neutral posture and towards its end range, its gets increasingly awkward, consequently putting more strain on the muscles, tendons, ligaments around the joint and even compressing the nerves sometimes.[18,19,20]

Other than the musculoskeletal problems (pain, discomfort, tingling, and numbness), participants also complained about other symptoms namely: eye tension, headache, fatigue, distraction, inattention and insomnia. These could be attributed to constantly staring at the bright screen while gaming and the reduced frequency of eye blinking. Few participants even reported fighting with family and friends due to the lack of attention and distraction during intensive gaming. Fatigue is most likely to occur as a consequence of headache, eye tension and mental exhaustion associated with prolonged gaming.

CONCLUSION

Direct measurement methods such as EMG can be used in the future to investigate the muscle use and activation for varying postures in the affected regions. Future studies may investigate for the various probable awkward postures or possibly an ideal posture for mobile phone gaming which would pose minimal ergonomic risks.Educational intervention regarding appropriate posture and muscle use could prove helpful in prevention or treatment of musculoskeletal disorders in the smartphone gamers.

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