

Ergonomic risk factors and their association with musculoskeletal disorders among Indian dentist: A preliminary study using Rapid Upper Limb Assessment

Vineet Golchha, Pooja Sharma¹, Jitesh Wadhwa, Deepti Yadav, Rahul Paul

Department of Orthodontics,
IP Dental College, Sahibabad,
¹Amity Institute of
Physiotherapy, Amity University,
Noida, Uttar Pradesh, India

ABSTRACT

Context: Ergonomics is the scientific study of people and their work. The manufacturers typically do not design to accommodate the dimensions of the individual user. Work-related musculoskeletal disorders (MSDs) have emerged as major health problem among workers in both industrialized and industrially developing countries. Rapid Upper Limb Assessment (RULA) was developed to investigate the exposure of the individual workers to risk factors associated with work-related upper limb disorders.

Aims: The assessment of the posture using RULA, which is quick reliable tool to determine the posture, has not been done in the Indian dentist population, indicating the need for the same.

Settings and Design: A total of 104 subjects were included from New Delhi/NCR.

Subjects and Methods: The procedure was explained, and the questionnaire was distributed and assessment was done using RULA. The MSDs can be recorded using the standard Nordic questionnaire.

Statistical Analysis Used: The data were collected from 104 subjects out of the 192 evaluated and was statistically analyzed using SPSS software.

Results: The study sample included 70 male and 34 female dentists. The posture of the subjects and the MSDs are not associated with a significant difference as according to Pearson's Chi-square test (0.231).

Conclusions: RULA can be used as a screening tool for postural risks following a short training session regardless of the assessor's experience in postural risk assessments.

Key words: Musculoskeletal disorders in dentist, posture, Rapid Upper Limb Assessment

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The term ergonomics is derived from “Greek” words “ergon” meaning work and “nomos” meaning natural laws. Ergonomics is the scientific study of people and their work. Ergonomics is highly relevant to preventive and occupational medicine, management of musculoskeletal injuries and rehabilitation. It helps people understand their abilities and limitations and teaches them how to perform safely, effectively, and comfortably within the environment.^[1]

Address for correspondence:

Dr. Vineet Golchha
E-mail: orthovineet@gmail.com

The manufacturers typically do not design to accommodate the dimensions of the individual user. While manufacturing inventory costs are an important concern, there are also costs involved in products that are designed based on properly selected anthropometric data and ergonomics. Without proper design, sitting will require greater muscular force and control to maintain stability and equilibrium which in turn lead to greater fatigue and discomfort and is likely to lead to poor postural habits as well as neck and back complaints.

The posture of an individual is usually assessed in the current literature by photographic method or frame grabbing. Similarly, Rapid Upper Limb Assessment (RULA) is a survey method developed for use in ergonomics investigations of workplaces where work-related upper limb disorders are reported. This tool requires no special equipment in providing a quick assessment of postures of the neck, trunk, and upper limbs along with muscle function and the external loads experienced by the body. A coding system is used to generate an action list which indicates the level of

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intervention required to reduce the risks of injury due to physical loading on the operator. RULA was developed to investigate the exposure of the individual workers to risk factors associated with work-related upper limb disorders. The method uses diagrams of body postures and three scoring tables to provide evaluation of exposure to risk factors.^[2] The musculoskeletal disorders (MSDs) can be recorded using the standard Nordic questionnaire (SNQ). It is one of the most popular survey tools for detecting the severity and duration MSDs.^[3]

Work-related MSDs have emerged as major health problem among workers in both industrialized and industrially developing countries.^[4] Most people experience pain in the back, neck, and shoulder at some time, although few have pain over long periods.^[5] Chronic nonspecific musculoskeletal pain is a common in adolescents and adults, and the prevalence appears to be increasing.^[6] Spinal pain is a well-recognized condition associated with significant personal and community burdens. The most common spinal regions studied are the lumbar and cervical spine, probably because of their strong and well-established associations with pain conditions, work related injuries, intervertebral disc degenerative conditions, headaches, and psychological disturbances.^[7]

Many researchers have linked the musculoskeletal symptoms with exposure time to the work involving body segments.^[3] Main concern is that equipment should be designed according to principles of anthropometry, biomechanics, and hygiene.^[8] The seat alone is insufficient for stabilization, and the use of the legs, feet, and back in contact with other surfaces, as well as muscular forces are necessary to produce equilibrium. The examination of the match between dental chair dimensions and dentist's anthropometry revealed a substantial frequency of mismatch especially for seat height and seat depth. Deviations from the defined accepted limits varied among groups and between genders signifying their special requirements and their different potential problems.^[8]

Although various studies have been performed to assess the ergonomic risk factors faced by the dental professionals, but there are no studies in current literature which study the effect of duration of these ergonomic factors on the MSD's in them. Furthermore, methods used in the current studies are either by observation, videotape, optical or frame grabbing. The assessment of the posture using RULA, which is quick reliable tool to determine the posture, has not been done in the Indian dentist population, indicating the need for the same.^[9]

SUBJECTS AND METHODS

A total of 104 subjects with a mean age of 36 years and mean body mass index of 34.4 were included from New Delhi/NCR.

Those with any history of major accidental injuries in the past 1-year affecting the posture or any deformities affecting the posture of the subject were excluded from the study. The cognitive ability of the subject should not be low as according to the mini-mental state examination. Prior information was given to the subjects about the purpose of the study, and an informal consent was taken in their own understandable language from each subject. This was in accordance with the ethical standards of the responsible committee on human experimentation. The procedure was explained, and the questionnaire was distributed and assessment was done using RULA. Assessment was done by the first two authors, one of them being a physical therapist with expertise in posture evaluation. A small pilot study was conducted in order to check the reliability of data collection by both the authors following which they were blinded to the results of each other for the rest of the study. RULA is an observational method of assessing postural health among human workers.^[9] It is a survey method developed for use in ergonomics investigations of workplaces where work-related upper limb disorders are reported.^[2] The RULA method uses diagrams of body postures and three scoring tables to provide evaluation of exposure to risk factors by providing a risk score. The range of movement for each body part is divided into segments and recorded appropriately.^[10] The general evaluation of subjects history, particulars about the environment, and psychological factors were followed by standardized Nordic questionnaire to assess MSDs.^[11] The posture of the upper arm, lower arm, wrist, cervical, trunk, and lower limb was scored from the observation and calculation from the photographs of the subjects. Static loading or repetition and force load source were then estimated. Combination of these scores produced a grand score that was used to determine an action level indicating whether the posture was acceptable or required investigation and change [Figure 1].^[12]

RESULTS

The data were collected from 104 subjects out of the 192 evaluated and were statistically analyzed using SPSS software (IBM corporation). The study sample included 70 male and 34 female dentists. The rest 88 of the subjects could not be assessed due to reasons like not meeting the inclusion criteria completely, lack of time available at dentists end, lack of motivation [Table 1].

The males had higher pain levels in the neck as compared to the females. The data were significant at 0.05 [Figure 2 and Table 2].

This table provides the information that out of 104 subjects which were assessed and RULA score was defined had pain in different regions of the body. The posture of the subjects and the MSDs are not associated with a significant difference [Figure 3].

RULA SCORING SHEET

ANALYSES DATE: _____ LOCATION: _____

ANALYST: _____ JOB/TASK: _____

UPPER ARM _____ GROUP A

L / R

LOWER ARM _____ TABLE A + MUSCLE + FORCE = SCORE C

L / R L / R L / R L / R

WRIST _____

L / R

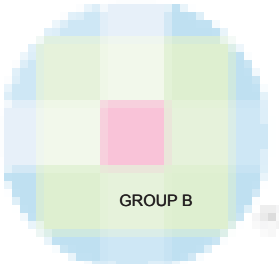
WRIST TWIST _____

L / R

NECK _____

TRUNK _____ TABLE B + MUSCLE + FORCE = SCORE D

LEGS _____



GRAND SCORE (TABLE C) L / R

RESULTS :

SCORE	ACTION LEVEL	DESCRIPTION
1-2	1	ACCEPTABLE
3-4	2	FURTHER INVESTIGATION NEEDED
5-6	3	INVESTIGATION AND CHANGES REQUIRED
7	4	INVESTIGATE AND CHANGE REQUIRED IMMEDIATELY

Figure 1: Rapid Upper Limb Assessment scoring sheet

DISCUSSION

Every individual is of different height, shape, and size and has a different level of strength. Without any application of ergonomic principles, tools, machines, and equipment the workstations are designed. It is important to consider these factors for the comfort of the subjects.^[13] An overall height adjustment and chairs of different sizes are available, but individual adjustment for the seat, arm, and back is not offered. A one – size – fits – all philosophy has been adopted in the industry because lessens the inventory problems for manufacturers, making it less costly to manufacture and easier to sell at a lower price.^[14] The RULA score gives the information about the posture and the angulations of the spine in relation to the stresses faced. Forces acting on the spine in forward incline posture are the cervical extensor muscle force and lumbar extensor muscle force. The proportion of neck strength in respect of neck angle shows that we have average neck strength at 30° neck inclination. It is also seen that when work surface is too low, a person not only lean forward but also may lower and rotate the shoulders forward causing fatigue and pain in the levator scapulae muscles.^[13,15]

Many forces act on the spine while performing work from the surrounding muscles, such as the weight of the body and

Table 1: The association between gender difference and MSD's

Gender/MSD	Neck	Shoulder	Upper back	Lower back
Pearson's Chi-square	4.573	1.879	1.275	0.267

MSD=Musculoskeletal disorder

Table 2: The association between RULA score and MSD's

RULA/MSD	Neck	Shoulder	Upper back	Lower back
Action level 1	1	-	1	-
Action level 2	12	7	5	7
Action level 3	17	11	20	7
Action level 4	5	4	8	1

RULA=Rapid Upper Limb Assessment, MSD=Musculoskeletal disorder

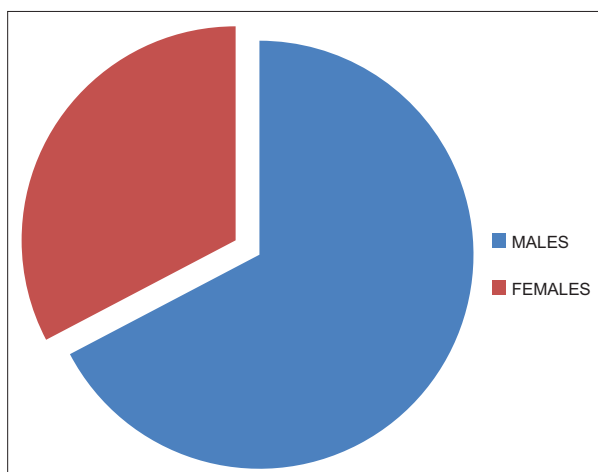


Figure 2: Prevalence of musculoskeletal disorders in males and females

gravity. The spine is in its natural curved position (S shape) while standing, enabling the body's line of gravity to pass through the trunk and feet, so requiring minimal muscular activity to maintain the posture and to hold the trunk erect. Callaghan and McGill found that standing produced a uniquely different spine posture compared with sitting, and standing spine postures did not overlap with flexion postures adopted in sitting.^[16] Sitting with a 90° angle between the trunk and the thighs causes the pelvis to rotate backward shifting the spine away from the line of gravity. This in turn reduces the lumbar lordosis, causing the spine to slump and increasing the loads placed on the spine.^[17] The movement of the lumbar spine influences the movement of the cervical spine and the slumped sitting posture (posterior pelvic tilt) is a poor posture for the spine. The forces experienced by the joints of the lumbar spine during sitting and standing activities were found to fall well below any traditional single exposure tissue tolerance value. However, prolonged static loads can still present a fatigue injury mechanism either due to low but prolonged muscle contraction and or prolonged flexed postures of the spine leading to accumulated damage to the posterior component of the annulus.^[16] The posture of the subjects on an average was predominated by neck flexion and neck twisting, shoulder abduction, and excessive forward trunk bending. These are given high score in RULA and hence leading to the action levels of RULA to be in the moderate to high-risk values. The action level 2 and 3 signify that the posture needs to be assessed properly, and changes may be required, and the action level 4 suggests that immediately changes would be required after in depth assessment.^[2,10,13] RULA proved to be a suitable method for evaluating posture. A relationship was seen between increasing action level and increasing frequency of reported discomfort in the back and neck area and the shoulders. It is in accordance with an another study done on dental students where RULA method allowed a rapid evaluation of their posture during simulated dental treatment.^[10]

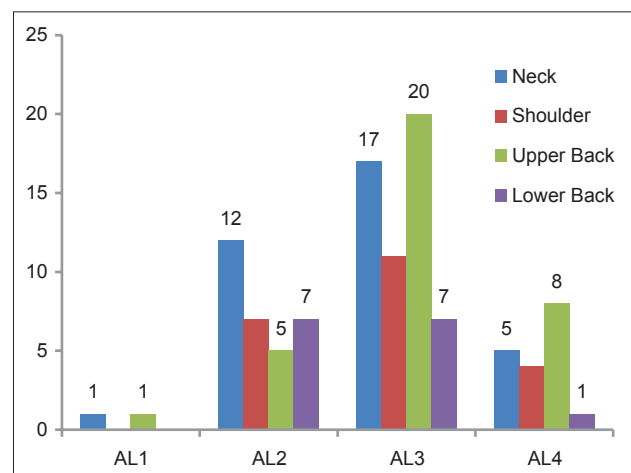


Figure 3: Association between action levels of Rapid Upper Limb Assessment and the musculoskeletal disorders in different regions of the body

The posture assessed by RULA score and MSD's recorded using the SNQ did not have any significant association in the present study. The result was in accordance to Syazwan *et al.* who also found no significant association between MSD and increment in RULA score. In contrast to the study available in the current literature that concludes that there is a relationship between the increasing action level of RULA and the increasing frequency of reported discomfort in the back/neck area and shoulder. Hence, our study suggests that bad posture directly does not lead to MSD's. Instead, bad posture and various ergonomic factors faced by a subject for a longer duration leads to MSDs. 56.2% of dentist had pain tenderness in the upper trapezius and 42.6% in area cervical. Lateral movements in the cervical found pain in 25.8%, with the bending cervical 32.1% related to all these factors.

Studies in current literature also suggest that the prevalence of MSD's was higher in women than men in areas like neck, shoulder, upper back, and lower back pain. The previous cross-sectional studies that showed a greater female predisposition to MSD, suggested that pain prevalence may indeed be higher in both the genders, but it is possible that it may be more acceptable for women to complain about pain than men.^[18] The result of the present study was not in accordance with the previous studies where male subjects had a higher prevalence of MSD's in comparison to females. After analyses, this association was no longer significant in the present study. The difference was only significant in the neck region with men having a higher prevalence of pain in the neck as compared to the women. The reasons for this remain speculative and further studies on larger study sample may be conclusive. The onset of muscle pain in this population is influenced by multiple variables, most of them, related to dental practice which can trigger symptoms at neck and back.^[10] Previous studies results indicated that the dentist using the conventional seat recorded significantly higher risk scores.^[19-21] New technologies and changes in dental care, aimed at providing dentists with greater comfort and better health.

CONCLUSION

The framework suggested that ergonomic risk evaluation techniques, self-reported body part questionnaires, and physical measurement of physiological/biomechanical transients may have a relationship and can be used for the evaluation of work-related MSDs. The proposed integrative approach will help in developing stage wise intervention strategies for work-related MSDs. RULA can be used as a screening tool for postural risks following a short training session regardless of the assessor's experience in postural risk assessments.

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REFERENCES

1. Khalil TM, Moby SM, Rosomoff RS, Rosomoff HI. Ergonomics in Back Pain: A Guide to Prevention and Rehabilitation. Spine (Phila Pa 1976) 1992;17:311-7.
2. McAtamney L, Nigel Corlett E. RULA: A survey method for the investigation of work-related upper limb disorders. Appl Ergon 1993;24:91-9.
3. Kaewboonchoo O, Yamamoto H, Miyai N, Mirbood SM, Morkiokai I, Miyashita K. The standardized Nordic questionnaire applied to workers exposed to hand-arm vibration. J Occup Health 1998;40:218-22.
4. Nagi A, Vyasi H, Nagi PK. Gender differences, work stressors and musculoskeletal disorders in weaving industries. Industrial Health 2010;1:339-48.
5. Hakala P, Rimpelä A, Salminen JJ, Virtanen SM, Rimpelä M. Back, neck, and shoulder pain in Finnish adolescents: National cross sectional surveys. BMJ 2002;325:743.
6. O'Sullivan P, Beales D, Jensen L, Murray K, Myers T. Characteristics of chronic non-specific musculoskeletal pain in children and adolescents attending a rheumatology outpatients clinic: A cross-sectional study. Pediatr Rheumatol Online J 2011;9:3.
7. Briggs AM, Smith AJ, Straker LM, Bragge P. Thoracic spine pain in the general population: Prevalence, incidence and associated factors in children, adolescents and adults. A systematic review. BMC Musculoskelet Disord 2009;10:77.
8. Gouvali MK, Boudolos K. Match between school furniture dimensions and children's anthropometry. Appl Ergon 2006;37:765-73.
9. Ismail AS, Tamrin SB. The association between ergonomics risk factors, RULA score, and musculoskeletal pain, among school children: A preliminary result. Glob J Health Sci 2009;1:2.
10. Gandavadi A, Ramsay JR, Burke FJ. Assessment of dental student posture in two seating conditions using RULA methodology – A pilot study. Br Dent J 2007;203:601-5.
11. Trevelyan FC, Legg SJ. Back pain in school children-where to from here? Appl Ergon 2006;37:45-54.
12. Bruijnzeels MA, Foets M, van der Wouden JC, van den Heuvel WJ, Prins A. Everyday symptoms in childhood: Occurrence and general practitioner consultation rates. Br J Gen Pract 1998;48:880-4.
13. Ghosh T, Das B, Gangopadhyay S. Work-related musculoskeletal disorder: An occupational disorder of the goldsmiths in India. Indian J Community Med 2010;35:321-5.
14. Parcels C, Stommel M, Hubbard RP. Mismatch of classroom furniture and student body dimension. J Adolesc Health 1999;24:262-73.
15. Newell TM, Kumar S. Comparison of instantaneous and cumulative loads on the low back and neck in orthodontists.; Clin Biomech (Bristol, Avon). 2005;20:130-7.
16. Callaghan JP, McGill SM. Low back joint loading and kinematics during standing and unsupported sitting. Ergonomics 2001;44:280-94.
17. Tissot F, Messing K, Stock S. Studying the relationship between low back pain and working postures among those who stand and those who sit most of the working day. Ergonomics 2009;52:1402-18.
18. Diepenmaat AC, van der Wal MF, de Vet HC, Hirasig RA. Neck/shoulder, low back, and arm pain in relation to computer use, physical activity, stress, and depression among Dutch adolescents. Pediatrics 2006;117:412-6.
19. Chaikumarn M. Differences in dentists' working postures when adopting proprioceptive derivation vs. conventional concept. Int J Occup Saf Ergon 2005;11:441-9.
20. Chen JD, Falkmer T, Parsons R, Buzzard J, Ciccarelli M. Impact of experience when using the Rapid Upper Limb Assessment to assess postural risk in children using information and communication technologies. Appl Ergon 2014;45:398-405.
21. Fals Martínez J, González Martínez F, Orozco Páez J, Correal Castillo SP, Pernett Gómez CV. Musculoskeletal alterations associated factors physical and environmental in dental students. Rev Bras Epidemiol 2012;15:884-95.

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