

Work Posture and Musculoskeletal Complaints among Furniture Workers: A Cross Sectional Study

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Abstract

Background: Furniture manufacturing involves repetitive movements, manual handling, and sustained working postures that may contribute to musculoskeletal complaints. Ergonomic assessment may help identify work activities requiring corrective action.

Objective: To examine the associations of work posture risk assessed using the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA), age, and gender with musculoskeletal complaints among furniture workers.

Methods: This analytical cross-sectional study included 52 furniture workers in Makassar, Indonesia, from March to April 2026. Work posture was assessed using RULA or REBA according to production tasks, and musculoskeletal complaints were assessed using the Nordic Body Map. Associations between categorical variables were analyzed using Pearson chi square or Fisher exact tests, as appropriate.

Results: Thirty-one workers (59.6%) were aged >45 years, and 33 (63.5%) were male. RULA and REBA assessments were each reported for 26 workers. Overall, 37 workers (71.2%) had low and 15 (28.8%) had high musculoskeletal complaint categories. Based on the reported data, older age and higher REBA risk were significantly associated with musculoskeletal complaint categories, whereas gender was not significantly associated. The RULA finding requires interpretation according to the final verified statistical analysis.

Conclusion: Older age and higher REBA risk were associated with a greater proportion of high musculoskeletal complaints. These findings support the relevance of ergonomic assessment for identifying work activities that may require further evaluation and corrective action. Because of the cross-sectional design, the observed associations do not establish causality or temporal direction.

Keywords

ergonomics; musculoskeletal pain; occupational health; occupational exposure; furniture industry

Introduction

Furniture manufacturing is a labour-intensive activity involving wood cutting, sanding, carving, shaping, painting, assembly, packaging, and material handling.¹ These tasks may require repetitive movements, manual force, sustained standing or sitting, bending, reaching, and prolonged use of hand tools.¹ Repeated exposure to such physical demands can contribute to musculoskeletal complaints and may affect workers' comfort, functional capacity, and productivity.²

Musculoskeletal disorders are common occupational health problems, particularly in jobs characterized by repetitive movements, manual handling, awkward or static postures, and substantial physical workload. Symptoms may occur in the neck, shoulders, upper limbs, back, and lower limbs. In Indonesia, musculoskeletal disorders have also been identified as an occupational health concern, with national survey data reporting substantial variation between regions.³ The burden is relevant to physiotherapy and occupational health because prevention requires identification of modifiable workplace exposures as well as recognition of individual factors that may influence susceptibility.

Age is one individual characteristic that may influence musculoskeletal complaints. Advancing age may be accompanied by changes in muscle strength, flexibility, physical capacity, and recovery from physical workload. Occupational exposure may interact with these changes, so age should be considered when interpreting ergonomic risk. Previous studies have reported both positive and null associations between age and musculoskeletal complaints, suggesting that the relationship may vary according to occupational task, workload, and exposure pattern.^{4,5}

The furniture industry presents particular ergonomic challenges because workers may perform different production tasks under different postural demands. In the setting described in the original manuscript, cutting and sanding involved prolonged standing and repetitive movements, whereas engraving and other tasks could involve seated work with forward neck flexion and repetitive hand activity. Shaping, painting, assembly, packaging, and material handling may require bending, reaching, lifting, and sustained upper limb activity.^{1,6} These differences make task specific ergonomic assessment important.

RULA is designed to assess postural loading involving the upper limbs together with the neck and trunk, whereas REBA provides a broader whole-body assessment.⁷ The Nordic Body Map is used to document the distribution and severity of subjective musculoskeletal complaints.⁸ Combining postural observation with symptom reporting can therefore provide complementary information about workplace ergonomic risk.⁹ However, the current manuscript does not establish that RULA and REBA were applied to comparable workers, because the source data indicate that 26 workers were assessed with RULA and 26 with REBA. The distinction between these groups is important when interpreting associations and limits direct comparison between the two instruments unless the allocation procedure is clearly documented.

Previous studies have examined musculoskeletal complaints in garment, agricultural, construction, and other industrial workers, while evidence specific to furniture manufacturing remains more limited.^{10,2} Existing furniture related studies have also considered age, work posture, and duration of employment.^{11,12} The contribution of the present study is its attempt to examine postural

risk together with subjective musculoskeletal complaints in a furniture production setting in Makassar. Nevertheless, the current evidence does not permit causal conclusions, and the use of different posture instruments across production units requires careful interpretation.

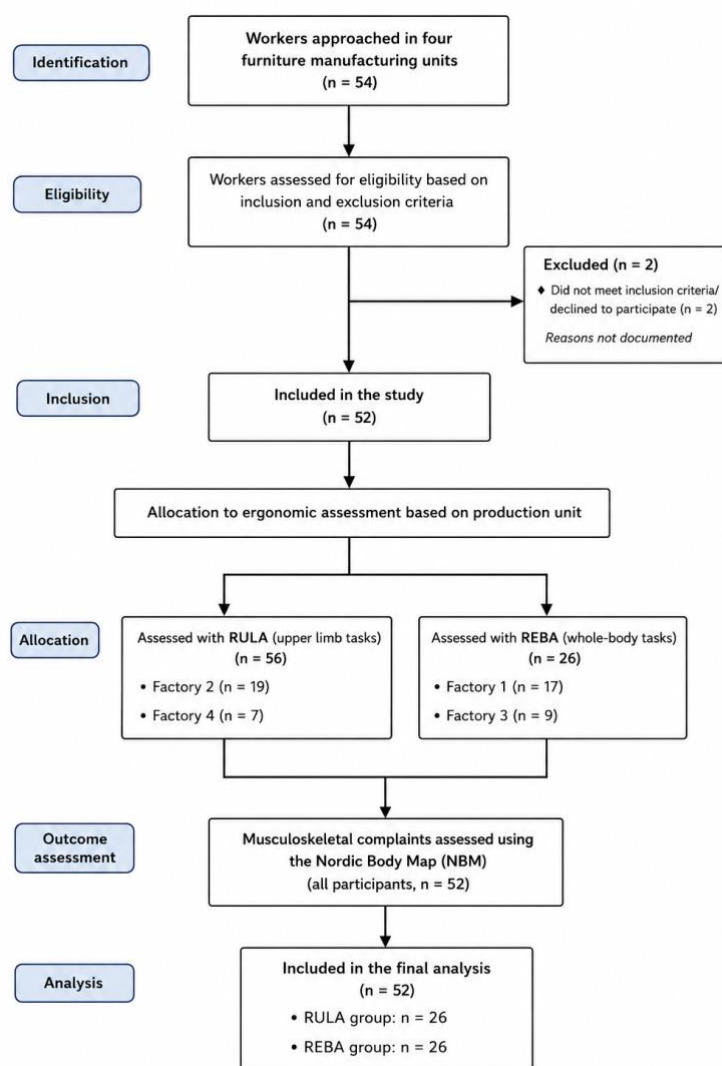
The study therefore aimed to determine the level of ergonomic postural risk and examine its association with musculoskeletal complaints among furniture industry workers in Makassar using RULA and REBA, while also assessing the associations of age and gender with musculoskeletal complaints. The hypothesis was that workers exposed to higher ergonomic postural risk would have a greater proportion of high musculoskeletal complaints.

Methods

This study used an analytical observational cross-sectional design. Data collection was conducted in a furniture manufacturing industry in Makassar, Indonesia, from March to April 2026. Exposure and outcome variables were assessed during the same study period, and no intervention was administered.

The study population consisted of workers involved in furniture production, including cutting, sanding, carving, shaping, painting, assembly, packaging, and storage. Purposive sampling was reported in the original manuscript. The inclusion criteria were active involvement in production activities, at least one year of work experience, willingness to participate, and ability to complete the assessment procedures. Workers were excluded if they declined participation, had a musculoskeletal injury resulting from a work-related accident at the time of data collection, or did not complete the assessment process. The final analytic sample reported in the manuscript was 52 workers.

The source flowchart reports 54 workers meeting the inclusion criteria and 52 participants in the final analysis. The reasons for exclusion of the two workers are not provided. Accordingly, the verified flow can currently be stated only as follows: workers meeting the stated eligibility criteria ($n = 54$); included in final analysis ($n = 52$); excluded after eligibility assessment ($n = 2$, reasons).



Note: Reasons for exclusion of two workers were not documented in the available dataset.

Figure 1. Participant flow diagram

Work posture was assessed during routine production activities using RULA or REBA. The original manuscript states that four production units were observed, with Factory 1 and Factory 3 assessed using REBA and Factory 2 and Factory 4 assessed using RULA. The current tables indicate 26 workers in the RULA categories and 26 workers in the REBA categories. Workers were photographed while performing routine tasks and the recorded postures were subsequently scored.

Musculoskeletal complaints were assessed using the Nordic Body Map questionnaire. The original manuscript describes assessment of the neck, shoulders, upper and lower limbs, back, waist, buttocks, thighs, and calves. Workers completed the questionnaire after standardized instructions, and questionnaires were checked for completeness before coding.

Researchers identified the principal production activities and selected the relevant posture assessment method for each unit. Workers were observed without modifying their normal procedures. Relevant postures were photographed and scored using RULA or REBA. Participants then completed the NBM questionnaire. Age and gender were recorded. Participant identifiers were excluded from the analysis dataset.

Age and gender were examined as individual characteristics. Other occupational factors identified in the Introduction, including duration of employment, workload, repetitive exposure, and task characteristics, were not incorporated into a multivariable model in the source manuscript. Because the sample is small and the sampling was purposive, residual confounding and selection bias are possible. The NBM is self-reported and may be affected by information or recall bias. The use of different posture instruments across production units also introduces differential exposure assessment.

Statistical analysis was reported to have been performed using SPSS. Frequencies and percentages were used for descriptive analysis. Categorical associations were assessed using Pearson chi square when assumptions were met and Fisher exact tests when expected cell frequencies were insufficient. The source table labels the displayed effect estimates as prevalence ratios; however, the numerical estimates 2.701, 7.111, and 32.000 correspond exactly to crude odds ratios calculated from the displayed 2×2 tables. Therefore, the revised table below labels these estimates as crude odds ratios pending confirmation of the intended analysis. For the displayed counts, Fisher exact testing gives $p < 0.001$ for age, $p = 0.126$ for gender, $p = 0.057$ for RULA, and $p = 0.002$ for REBA. Statistical significance was assessed at a two-sided alpha of 0.05.

Results

A total of 52 workers were included in the final analysis. Most were aged >45 years (31, 59.6%) and male (33, 63.5%). All workers were reported to work for more than four hours. The posture assessment was divided between RULA and REBA, with 26 workers represented in each instrument specific set of categories. Overall, 37 workers (71.2%) were classified as having low musculoskeletal complaints and 15 (28.8%) as having high complaints.

Participant characteristics, posture risk categories, and musculoskeletal complaint categories are summarized in Table 1.

Table 1. Participant characteristics, posture risk categories, and musculoskeletal complaint categories

Variable	Category	n	%
Age	<45 years	21	40.4
Age	>45 years	31	59.6
Gender	Male	33	63.5
Gender	Female	19	36.5
Working duration	>4 hours	52	100.0
RULA	Further investigation and possible changes	19	73.1 of 26
RULA	Immediate investigation and corrective action	7	26.9 of 26
REBA	Action required	17	65.4 of 26
REBA	Immediate action required	9	34.6 of 26
MSD complaints	Low	37	71.2
MSD complaints	High	15	28.8

Note: RULA and REBA percentages were calculated using the instrument specific denominator of 26. RULA, Rapid Upper Limb Assessment. REBA, Rapid Entire Body Assessment. MSD, musculoskeletal disorder.

Most participants were aged >45 years and male. RULA and REBA results were each reported for 26 workers. Because the instruments were applied to different production units, their categories were interpreted within their respective assessment groups.

The displayed 2×2 tables provide sufficient information to verify the direction and magnitude of several crude associations, but the statistical test must account for small expected cell frequencies. The age table contains a zero cell because none of the workers aged <45 years were classified as having high complaints. The gender table is internally consistent with the reported $p = 0.126$. For RULA, the Pearson chi square value corresponding to $p = 0.035$ is reproduced by the displayed counts, but Fisher exact testing gives $p = 0.057$. For REBA, Fisher exact testing gives $p = 0.002$. Associations between age, gender, posture risk categories, and musculoskeletal complaint categories are presented in Table 2.

Table 2. Associations between selected factors and musculoskeletal complaint categories

Factor	Comparison	Low n (%)	High n (%)	Crude OR (95% CI)	Fisher exact p
Age	>45 vs <45 years	16 (51.6)	15 (48.4)	Not estimable because of zero cell	<0.001
Gender	Female vs male	11 (57.9)	8 (42.1)	2.701 (0.785 to 9.291)	0.126
RULA	Immediate vs further investigation	3 (42.9)	4 (57.1)	7.111 (1.022 to 49.459)	0.057
RULA	Further investigation	16 (84.2)	3 (15.8)		
REBA	Immediate action vs action required	3 (33.3)	6 (66.7)	32.000 (2.761 to 370.827)	0.002
REBA	Action required	16 (94.1)	1 (5.9)		

Note: OR, odds ratio; CI, confidence interval; RULA, Rapid Upper Limb Assessment; REBA, Rapid Entire Body Assessment. Effect estimates are presented as crude ORs because the displayed numerical values correspond to odds ratios.

Age and REBA risk category were significantly associated with musculoskeletal complaint category, whereas gender was not. For RULA, the displayed Pearson chi square and Fisher exact results differed; therefore, the association was interpreted cautiously because of the small cell counts.

Discussion

This study examined the relationship between work posture and musculoskeletal complaints among furniture workers in Makassar. The verified information currently available from the manuscript indicates that 52 workers were included, with a larger proportion aged >45 years and male. RULA and REBA were applied to different subsets of workers, each comprising 26 participants according to the displayed category counts. Overall, 28.8% of workers were classified as having high musculoskeletal complaints. In the displayed cross tabulations, high complaints were more frequent among workers aged >45 years and among workers in the higher REBA risk category. The RULA comparison requires particular caution because the Pearson chi square result reported as $p = 0.035$ does not remain below 0.05 when Fisher exact testing is applied to the displayed small cell counts.

Older workers showed a higher proportion of high complaints than younger workers. No worker aged <45 years was classified in the high complaint category, whereas 15 of 31 workers aged >45 years were classified as having high complaints. The Fisher exact test based on the displayed counts was statistically significant. This pattern is compatible with the possibility that age related changes in physical capacity and recovery interact with occupational physical demands.^{4,5,13} However, the cross sectional design cannot determine whether age itself is responsible for the observed difference, and unmeasured factors such as duration of employment, task assignment, cumulative workload, and previous musculoskeletal symptoms may contribute.

Gender was not significantly associated with complaint category in the displayed data. Although the proportion of high complaints was numerically greater among women than men, the confidence interval for the crude odds ratio was wide and included the null value. The result should therefore be interpreted as a lack of evidence of association in this sample rather than evidence that gender has no relationship with musculoskeletal symptoms. Differences between occupational groups, task allocation, physical workload, and sample size may influence the observed pattern.

The displayed RULA table shows a larger proportion of high complaints among workers classified as requiring immediate investigation and corrective action. The crude odds ratio was 7.111, but the confidence interval was wide, reflecting the small number of workers in the two RULA categories. Importantly, the original $p = 0.035$ appears to derive from Pearson chi square testing, whereas Fisher exact testing of the displayed counts gives $p = 0.057$. Consequently, the revised interpretation is that the displayed data suggest a possible association but do not provide statistically significant evidence at the conventional 0.05 threshold when the small cell counts are handled conservatively. The final analysis should be confirmed from the raw dataset and prespecified statistical plan.

The REBA table shows a clear difference in the proportion of high complaints between workers in the action required category and those in the immediate action category. The crude odds ratio was 32.000, although the confidence interval was extremely wide because of the small cell counts. Fisher exact testing of the displayed table gave $p = 0.002$. This result supports an association between the REBA risk category and complaint category in the available data. It should not be interpreted as evidence that higher REBA risk causes musculoskeletal complaints because exposure and outcome were assessed at the same time.

The observed pattern is consistent with the occupational principle that awkward, sustained, or repetitive postures may increase biomechanical loading on the neck, shoulders, back, and upper limbs. In furniture production, tasks may require workers to maintain flexed neck positions, reach repeatedly, hold tools, bend the trunk, or work with equipment that is not fully adjusted to individual anthropometric characteristics. Such conditions may contribute to physical fatigue and discomfort.^{12,14,15,16} Nevertheless, the present study does not measure cumulative biomechanical exposure or establish a temporal sequence between posture and symptoms. The findings should therefore be used to identify tasks that warrant ergonomic review rather than to infer causation.

Ergonomic attention may be prioritized for tasks categorized as requiring immediate action, particularly where workers maintain bent or elevated postures for prolonged periods.⁷ Potential workplace responses include adjustment of work surface and chair dimensions, improved tool positioning, reduction of unnecessary manual handling, task rotation, appropriate recovery periods, and ergonomic education.¹⁷ These recommendations should be evaluated prospectively because the current study does not test their effectiveness.

A strength of the study is the combination of direct posture assessment with a structured symptom questionnaire in a real furniture production setting. However, several limitations affect interpretation. Purposive sampling and the small sample reduce external validity and statistical precision. The absence of an a priori sample size calculation prevents assessment of whether the study was adequately powered for the planned associations. RULA and REBA were applied to different worker groups, so their results should not be interpreted as directly comparable instrument measurements. The NBM is self-reported and may be influenced by recall or reporting bias.¹⁸ Important potential confounders identified in the Introduction were not included in a multivariable model. The cross-sectional design prevents determination of temporal direction and leaves open the possibility of reverse causation. Finally, the region level NBM data contain a denominator inconsistency that must be resolved before the findings can be considered publication ready.

Future research should use a clearly defined sampling frame, prespecified sample size justification, standardized posture assessment procedures with documented assessor training and reliability, a fully specified NBM scoring algorithm, and multivariable analysis when the sample size permits. Future studies should also distinguish task specific exposure, duration, workload, and work history and should consider prospective designs when causal relationships are the research objective.

Conclusion

Additional limitations include incomplete documentation of the reasons for exclusion, the allocation of workers to posture assessment instruments, and detailed region specific NBM reporting. These limitations should be considered when interpreting the findings and their generalizability. Among the 52 furniture workers included in the analysis, older age and higher REBA risk were associated with a greater proportion of high musculoskeletal complaints.

Author Contribution

Supartina Hakim: Conceptualization, Methodology, Validation, Investigation, Data Curation, Writing Original Draft.
Nurhikmatul Jannah: Software, Validation, Formal Analysis, Writing Review and Editing.

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Conflict of Interest Statement

The authors declare that they have no conflicts of interest related to this study or the publication of this manuscript.

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Ethics Statement

The ethical status of this study should be reported in accordance with the applicable institutional requirements. The authors should confirm whether ethical approval, an exemption, or another form of institutional authorization was required for this case report. Written informed consent for participation and publication should also be confirmed and documented as applicable before final submission.

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