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Ergonomic Risk Factors Associated with Work-Related Musculoskeletal Disorders in Iranian Workers: A Scoping Review

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Abstract

Background: Work-related musculoskeletal disorders (WMSDs) are major occupational health problems linked to various ergonomic and biomechanical exposures. This scoping review aimed to map the available evidence on ergonomic risk factors associated with WMSDs among Iranian workers, focusing on occupational groups, ergonomic exposures, musculoskeletal outcomes, and assessment methods. **Methods:** PubMed, Scopus, Web of Science, and Google Scholar were searched from database inception to August 2026. Eligible studies were those conducted in Iran that examined ergonomic or physical/biomechanical risk factors in relation to WMSDs or musculoskeletal symptoms among workers. Two reviewers independently performed study selection. Findings were synthesized descriptively and narratively without quantitative pooling. **Results:** Thirty-one studies met the inclusion criteria and covered diverse occupational settings, including industrial and manufacturing, agricultural, office, healthcare, and service jobs. All 31 included studies were conducted in Iran. The most frequently investigated ergonomic risk factors were awkward or sustained postures, repetitive movements, manual handling, physical workload, force exertion, prolonged standing or sitting, and workstation-related factors. Rapid Upper Limb Assessment (RULA), Quick Exposure Check (QEC), Rapid Entire Body Assessment (REBA), and Rapid Office Strain Assessment (ROSA) were the most commonly used assessment methods. Musculoskeletal outcomes most often involved the low back, neck, shoulders, upper extremities, and multiple body regions. Higher ergonomic exposure or risk scores were frequently associated with greater musculoskeletal symptoms. Several studies that evaluated ergonomic interventions generally reported improvements in musculoskeletal outcomes or reductions in ergonomic risk. **Conclusion:** Considerable ergonomic risks exist across diverse Iranian occupational groups, although the distribution of evidence remains uneven. Greater standardization of ergonomic and musculoskeletal assessments, inclusion of underrepresented occupations, and further evaluation of targeted workplace interventions are needed.

Keywords: Work-related musculoskeletal disorders; Ergonomic risk factors; Occupational ergonomics; Job-related risk factors; Iran; Iranian workers

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Introduction

Work-related musculoskeletal disorders (WMSDs) are among the major occupational health problems and can affect muscles, tendons, joints, nerves, and other structures of the musculoskeletal system. They commonly involve the lower back, neck, shoulders, upper limbs, and lower limbs and may impair workers' physical functioning and ability to perform occupational tasks (1). Musculoskeletal conditions more broadly affect approximately 1.71

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billion people worldwide and represent a major contributor to disability globally (1).

The development of WMSDs is multifactorial and is influenced by physical, biomechanical, organizational, psychosocial, and individual factors (2). Among occupational exposures, ergonomic and biomechanical factors are particularly important, including awkward or sustained postures, repetitive movements, manual handling, forceful exertion, prolonged sitting or standing, and other physically demanding tasks (2). Evidence indicates that biomechanical exposures can contribute to musculoskeletal disorders, while psychosocial and organizational factors may interact with physical demands and further influence musculoskeletal health (3). Identifying these occupational exposures is therefore an important component of WMSD prevention.

Ergonomic risk assessment can help identify hazardous work conditions and characterize workers' exposure to potentially harmful physical demands (4). Several observational methods, including the Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Quick Exposure Check (QEC), and Rapid Office Strain Assessment (ROSA), have been developed for assessing ergonomic risks across different occupational settings (4). The use of different assessment approaches across occupations highlights the importance of mapping not only the ergonomic risk factors investigated but also the methods used to assess them (5).

Iran has a diverse workforce employed in industrial, manufacturing, healthcare, administrative, agricultural, and other occupational settings, with substantial variation in physical and ergonomic demands. Studies among Iranian workers have investigated associations between ergonomic exposures and musculoskeletal problems across several occupational environments. For example, studies among Iranian office workers have used RULA and ROSA to assess ergonomic risks and have reported associations between ergonomic risk scores and musculoskeletal symptoms (6, 7). These findings indicate that ergonomic risk factors continue to be investigated in Iranian occupational populations using different assessment approaches.

Previous reviews have addressed musculoskeletal disorders among Iranian workers, but their objectives differ from those of the present review. A 2017 systematic review and meta-analysis synthesized 27 studies published between 2001 and 2010, primarily to estimate the prevalence of occupational musculoskeletal disorders among Iranian workers (8). More recent reviews have focused on specific occupational populations, such as Iranian military personnel, and have also emphasized prevalence and quantitative synthesis (9). Although these reviews provide valuable evidence regarding the burden of musculoskeletal disorders, a focused mapping of the ergonomic risk factors associated with WMSDs across occupational settings in Iran has not been identified. Therefore, this scoping review aimed to map and describe the available evidence on ergonomic risk factors associated with WMSDs among Iranian workers**,** with particular emphasis on the types of ergonomic exposures investigated, occupational groups studied, musculoskeletal outcomes and body regions examined, and ergonomic assessment methods used.

Materials and Methods

Study Design

This scoping review was conducted to map the available evidence on ergonomic risk factors associated with WMSDs among Iranian workers. A scoping review design was selected because the aim was to map the range and characteristics of existing evidence rather than to estimate pooled effects or prevalence.

Eligibility Criteria

Studies were eligible if they investigated workers employed in occupational settings in Iran and examined ergonomic or physical/biomechanical risk factors in relation to WMSDs or musculoskeletal symptoms. Eligible exposures

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included awkward or sustained postures, repetitive movements, manual handling, forceful exertion, prolonged sitting or standing, physical workload, and other workplace ergonomic factors. Studies from industrial, manufacturing, healthcare, office, agricultural, service, and other occupational settings were considered. Studies were excluded if they were not conducted in Iran, did not involve workers, or did not examine an ergonomic or biomechanical exposure in relation to a musculoskeletal outcome. Systematic reviews, meta-analyses, narrative reviews, editorials, letters, conference abstracts without sufficient information, and other secondary sources were also excluded. No restrictions were applied based on occupational group, body region, or study design.

Information Sources and Search Strategy

A literature search was conducted in PubMed, Scopus, Web of Science, and Google Scholar from database inception to August 2026. The reference lists of relevant studies and reviews were also screened to identify additional potentially eligible studies. The search strategy combined terms related to WMSDs, ergonomic and biomechanical risk factors, workers, and Iran/Iranian populations. Search terms included combinations of "work-related musculoskeletal disorders," "musculoskeletal symptoms," "ergonomic risk," "ergonomic factors," "biomechanical risk factors," "occupational exposure," "awkward posture," "repetitive movement," "manual handling," "Rapid Upper Limb Assessment," "Rapid Entire Body Assessment," "Quick Exposure Check," "Rapid Office Strain Assessment" "worker," "employee," "Iran," and "Iranian." The search strategy was adapted to the requirements of each database.

Study Selection

All retrieved records were imported into EndNote for reference management and removal of duplicate records. Titles and abstracts were screened according to the predefined eligibility criteria, followed by full-text assessment of potentially relevant studies. Study selection was performed independently by two reviewers, and disagreements were resolved through discussion and consensus.

Data Synthesis

The characteristics and findings of the included studies were summarized descriptively and narratively. The evidence was mapped according to publication year, occupational setting, occupational group, ergonomic risk factors, ergonomic assessment methods, musculoskeletal outcomes, and main findings. Ergonomic assessment methods and tools were identified and summarized according to their use across different occupational settings, with commonly used tools such as RULA, REBA, QEC, and ROSA highlighted. The reported relationships between ergonomic exposures and musculoskeletal outcomes were described without quantitative pooling or meta-analysis. Evidence gaps were also identified based on underrepresented occupational groups, ergonomic exposures, body regions, and assessment methods.

Results

Study Selection and Characteristics of Included Studies

A total of 31 studies met the eligibility criteria and were included in this scoping review. The included studies were published between 2004 and 2026 and represented a broad range of occupational settings in Iran, including industrial and manufacturing workplaces, agriculture, healthcare, office-based occupations, communication and assembly industries, and other physically demanding occupations. The characteristics of the included studies, including occupational groups, ergonomic exposures, assessment methods, musculoskeletal outcomes, and main findings, are presented in Table 1.

Occupational Settings and Ergonomic Risk Factors

The included studies investigated a wide range of ergonomic and physical/biomechanical exposures across different occupational groups. In industrial

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and manufacturing settings, commonly examined factors included awkward or sustained postures, manual material handling, repetitive movements, force exertion, postural loading, and workstation-related ergonomic deficiencies. Among Iranian hand-woven carpet weavers, ergonomic factors included loom type, working posture, working time, and seat type (10). Similar concerns were reported among rubber and sugar factory workers, where awkward postures, manual handling, and other physically demanding activities were examined in relation to musculoskeletal symptoms (11, 12). Studies among furniture and telecommunication assembly workers also identified manual work, workstation deficiencies, awkward postures, postural loading, repetition, and contact stress as relevant occupational exposures (13, 14). Repetitive and uncomfortable working conditions were also investigated among packing workers, while upper-extremity ergonomic strain was examined among television assembly workers (15, 16). Among hand-sewn shoe workers and sewing-machine operators, poor or prolonged working postures, prolonged working time, workstation characteristics, insufficient breaks, and work-related demands were investigated as potential ergonomic risk factors (17, 18). Pharmaceutical employees were evaluated with respect to posture and workplace ergonomic factors, whereas working posture, working time, and force exertion were examined among hand-woven shoe-sole makers (19, 20). Office-based studies primarily focused on computer workstations, working posture, ergonomic workload, and workstation design. These factors were investigated among office and computer workers, including studies addressing workstation-related ergonomic risk, anthropometric mismatch, and furniture characteristics (6, 7, 21-23). Agricultural studies examined physical workload, working posture, harvesting activities, work-rest patterns, and general working conditions. These exposures were investigated among apple harvesting laborers and agricultural workers, including farmers working in rice, vegetable, and greenhouse production (24-26). Repetitive work, awkward postures, and work-rest schedules were also investigated among dairy workers (27).

In healthcare settings, ergonomic exposures included bending over patients, lifting or moving equipment, raised-arm activities, and the ergonomic characteristics of nursing workstations (28, 29). Physical workload was also investigated among hospital clinical personnel in relation to regional musculoskeletal pain (30).

Ergonomic Assessment Methods

The included studies used a variety of observational and workplace-based methods to characterize ergonomic exposure. RULA, QEC, REBA, and ROSA were among the most frequently reported assessment tools, while other approaches included the Strain Index, LUBA, ergonomic checklists, workstation-specific assessment methods, and modified ergonomic assessment instruments. RULA was used in several occupations involving upper-limb, workstation, or postural demands, including communication-company workers, hand-sewn shoe workers, sewing-machine operators, pharmaceutical employees, hand-woven shoe-sole makers, and electronic assembly workers (17-20, 31, 32). In office workers, RULA was also combined with ROSA to assess computer workstation and postural risks (6). QEC was used to assess ergonomic exposure in several physically demanding occupations, including rubber and sugar factory workers, agricultural workers, dairy workers, and oil and gas workers (11, 12, 25, 27, 33). These assessments primarily addressed whole-body physical exposure associated with postures, manual handling, repetitive work, and other physically demanding activities.

REBA was applied in physically demanding occupational settings, including apple harvesting and quarry work (24, 34). In addition, Yazdanirad et al. used the modified REBA (MOREBA) approach among steel-factory workers to evaluate multiple physical risk factors, including posture, force, repetition, vibration, and contact stress, in relation to musculoskeletal symptoms (35).

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ROSA was predominantly used in office-based settings. Studies among office workers, bank employees, and computer-based workers applied ROSA either alone or in combination with other measures to assess workstation-related ergonomic risk (6, 7, 21-23, 36). Other assessment approaches were used for specific occupational demands. The Strain Index was used to assess upper-extremity ergonomic strain among television assembly workers (16), while LUBA and an ergonomic checklist were used to assess postural loading among telecommunication assembly workers (14). Several studies also combined ergonomic assessment tools with standardized musculoskeletal questionnaires, most commonly the Nordic Musculoskeletal Questionnaire or its modified/extended forms.

Musculoskeletal Outcomes and Affected Body Regions

The included studies examined musculoskeletal outcomes across multiple anatomical regions. The low back, neck, shoulders, upper limbs, and knees were among the most frequently investigated regions, although the distribution varied according to occupational demands.

Low-back outcomes were examined across industrial, agricultural, office, healthcare, and other physically demanding occupations (11, 19, 24-26, 30, 34, 37). Neck and shoulder symptoms were frequently assessed among office workers, sewing-machine operators, nurses, agricultural workers, and industrial workers (6, 7, 18, 19, 23, 26, 28, 36). Upper-extremity outcomes were particularly relevant in occupations involving repetitive or upper-limb-intensive tasks, including television assembly, communication and telecommunication assembly, footwear production, sewing, and electronic assembly (14, 16-18, 20, 31, 32). Several studies assessed multiple body regions simultaneously rather than focusing on a single anatomical site. This pattern was evident across manufacturing, agricultural, healthcare, office, and other occupational populations (10-15, 17, 20-23, 25-28, 30, 33, 38).

Associations Between Ergonomic Exposures and Musculoskeletal Outcomes

Overall, the observational evidence predominantly reported relationships between ergonomic exposure and musculoskeletal symptoms or discomfort. In industrial and manufacturing populations, awkward postures, manual handling, repetitive activities, postural loading, and workstation-related ergonomic deficiencies were reported in association with musculoskeletal symptoms (10-15). Among office-based workers, studies reported associations between ergonomic risk scores, workstation characteristics, ergonomic workload, and musculoskeletal outcomes, particularly involving the neck, shoulders, and low back (6, 7, 19, 21-23, 36). Agricultural studies similarly identified relationships between physical workload, working posture, ergonomic exposure, and musculoskeletal symptoms (24-26). Among quarry workers, REBA risk level was significantly related to wrist and low-back pain, while the MOREBA study reported significant contributions of multiple physical risk factors to musculoskeletal symptoms among steel-factory workers (34, 35). Recent studies extended this evidence to office, nursing, technical and vocational, and hospital settings. Ergonomic risk factors, workstation conditions, and physical workload were reported in relation to musculoskeletal symptoms, discomfort, or musculoskeletal risk among these occupational groups (7, 22, 23, 29, 30).

Ergonomic Interventions

A subset of the included studies evaluated ergonomic interventions in addition to assessing occupational exposures and musculoskeletal outcomes. The interventions included ergonomic training, workstation or task modifications,

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organizational changes, and multicomponent approaches.

Among automobile factory workers, a randomized clinical trial evaluated three ergonomics training programs and reported a reduction in one-year low-back pain following ergonomic training (37). An ergonomic intervention among television assembly workers was also associated with reduced musculoskeletal symptoms (16). Intervention studies were also conducted among electronic assembly workers, dairy workers, flour-factory workers, bank employees, and oil and gas workers (27, 32, 33, 36, 38). These studies reported improvements in ergonomic exposure measures and/or musculoskeletal outcomes following ergonomic interventions involving changes in work practices, workstation or task characteristics, training, or organizational measures.

Distribution of Evidence Across Occupational Groups

The included evidence covered a diverse range of occupational groups, with the greatest representation observed in industrial/manufacturing, agricultural, and office-based occupations. Healthcare workers, including nurses and hospital clinical personnel, were also represented, while fewer studies addressed some other occupational sectors (24-30). The studies varied considerably in occupational exposure definitions, assessment methods, sample sizes, and musculoskeletal outcome measures. This heterogeneity allowed the available evidence to be mapped across diverse occupational contexts but limited direct comparison of findings between occupational groups.

Discussion

This scoping review mapped the available evidence on ergonomic risk factors associated with WMSDs among workers in Iran. The included studies covered a diverse range of occupational settings, with evidence concentrated particularly in industrial and manufacturing, agricultural, and office-based occupations. Across these settings, awkward or sustained postures, repetitive movements, manual handling, physical workload, force exertion, prolonged working time, and workstation-related ergonomic deficiencies were among the most frequently investigated exposures. Overall, the findings indicate that ergonomic risks are present across substantially different occupational environments, although the specific exposures and assessment approaches vary according to the nature of the work.

A major finding of this review was the consistent identification of physical and biomechanical exposures across occupational groups. Industrial workers were frequently exposed to awkward postures, repetitive tasks, manual handling, and postural loading, whereas agricultural workers were exposed to physically demanding tasks, prolonged or awkward postures, and work-rest limitations (39). Office workers were primarily investigated in relation to workstation design, prolonged sitting, posture, and computer-related ergonomic risks. This pattern is consistent with broader evidence indicating that occupational musculoskeletal disorders are associated with diverse work-related physical demands across different occupational sectors (2, 3, 39). The findings also support the importance of considering the interaction of biomechanical exposures with organizational and psychosocial characteristics rather than interpreting ergonomic risk in isolation.

The distribution of ergonomic assessment methods was another important finding. RULA and ROSA were particularly common in office-based and workstation-related studies, whereas QEC and REBA were more frequently used in physically demanding occupations. The use of different tools across occupational settings is reasonable because ergonomic assessment methods differ in the tasks and body regions they are designed to characterize (4). However, this methodological heterogeneity also limits direct comparison of ergonomic risk levels between occupational groups. Previous evidence has similarly highlighted substantial

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variation in the ergonomic assessment tools used in WMSD research and the need for greater consistency in exposure assessment (5). Therefore, future studies in Iran may benefit from clearer reporting of the rationale for selecting a particular assessment tool and from combining observational assessment with standardized measures of musculoskeletal outcomes.

The mapped evidence also showed that musculoskeletal outcomes were not restricted to a single anatomical region. Low-back, neck, shoulder, upper-extremity, and knee symptoms were frequently investigated, with the affected regions varying according to occupational demands (39). This finding is important because different occupational tasks may place different mechanical demands on the musculoskeletal system. For example, repetitive upper-limb activities were particularly relevant in assembly, sewing, and footwear occupations, whereas physical workload and awkward postures were prominent in agricultural and industrial work. The overall distribution of body regions is broadly compatible with previous evidence on Iranian workers, although previous reviews have primarily focused on estimating the prevalence or burden of musculoskeletal disorders rather than mapping the ergonomic exposures associated with them (8, 9).

The findings regarding healthcare workers deserve particular attention. Nurses and other hospital personnel were exposed to patient-handling activities, awkward postures, physical workload, and workstation-related ergonomic risks. Previous systematic reviews of Iranian healthcare workers have also identified prolonged standing, repetitive movements, and other occupational risk factors as important contributors to musculoskeletal problems. A systematic review of Iranian healthcare workers reported prolonged standing and repetitive movements among the most frequently identified occupational risk factors (40). Similarly, a systematic review and meta-analysis of Iranian military personnel identified improper postures, lifting and carrying, prolonged standing, and repetitive tasks among the ergonomic risk factors associated with WMSDs (9). Although these populations differ from the broader workforce considered in the present review, their findings reinforce the observation that physical workload and task-related biomechanical demands are recurring concerns across occupational sectors.

Another important finding was the presence of ergonomic intervention studies, although these represented a smaller proportion of the mapped evidence than observational studies. Ergonomic training, workstation modifications, task modifications, and multicomponent interventions were reported across several occupational settings (41). These studies generally indicated improvements in ergonomic exposure measures and/or musculoskeletal outcomes. However, because the primary purpose of this scoping review was to map the available evidence rather than determine intervention effectiveness, these findings should be interpreted as an indication of the types of interventions investigated rather than as evidence of comparative effectiveness. The relatively smaller number of intervention studies also suggests an opportunity for future research to move beyond identification of ergonomic risks toward evaluating targeted and context-specific preventive strategies. This is consistent with broader evidence indicating that ergonomic interventions may reduce work-related musculoskeletal pain, although intervention effects vary according to the outcome, intervention components, and occupational context (41).

The findings should also be interpreted in light of the existing review literature on Iranian workers. The 2017 systematic review and meta-analysis by Parno et al. synthesized 27 studies primarily to estimate the prevalence of occupational musculoskeletal disorders in Iran (8), while more recent reviews have focused on specific occupational populations such as military personnel (9). The present review differs from these studies by emphasizing the mapping of ergonomic exposures, occupational groups, assessment methods, and associated musculoskeletal outcomes rather than estimating pooled prevalence. This distinction is important because high prevalence

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alone does not indicate which workplace exposures are most relevant or how ergonomic risks have been assessed across different occupations.

Several evidence gaps were identified. First, the available literature was unevenly distributed across occupational sectors, with substantially more evidence from manufacturing, agriculture, and office-based work than from some other service and occupational groups. Second, considerable variation existed in the assessment methods, definitions of ergonomic exposure, and outcome measures, consistent with the heterogeneity reported in the broader WMSD literature (5). Third, many studies examined several ergonomic exposures simultaneously, which makes it difficult to determine the independent contribution of individual risk factors. Finally, although ergonomic interventions have been investigated, intervention evidence remains less extensive than observational evidence. These gaps indicate a need for future Iranian studies using clearer exposure definitions, standardized outcome measures, and longitudinal or intervention-based designs where appropriate.

Overall, this scoping review indicates that ergonomic risk factors are widespread across Iranian occupational settings and are consistently linked with musculoskeletal symptoms or risk. The evidence is characterized by considerable occupational and methodological diversity, which provides a broad picture of ergonomic challenges but limits direct comparison across workplaces. Future research should therefore focus not only on identifying ergonomic risks but also on improving the consistency of exposure assessment and developing and evaluating targeted interventions for occupational groups that remain underrepresented in the current evidence base.

Conclusion

This scoping review mapped the available evidence on ergonomic risk factors associated with work-related musculoskeletal disorders among Iranian workers across diverse occupational settings. Awkward and sustained postures, repetitive movements, manual handling, physical workload, force exertion, and workstation-related factors were among the most commonly investigated risks, with RULA, QEC, REBA, and ROSA frequently used for ergonomic assessment. The evidence was concentrated mainly in industrial, agricultural, and office-based occupations, while some occupational groups remained underrepresented. Overall, the findings highlight the need for more standardized ergonomic and musculoskeletal assessment methods, broader coverage of occupational groups, and further evaluation of targeted ergonomic interventions in Iranian workplaces.

Data availability statement

No new data were generated or analyzed in this study. All data supporting the findings of this scoping review are derived from previously published literature and publicly available sources, which are cited within the article.

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Conflict of interests

None.

Author's contribution

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All authors contributed equally to preparing this article.

Table 1. Characteristics of the included studies

Authors	Year	Occupational group / Sample	Ergonomic exposure/risk factors	Assessment method	Main musculoskeletal outcomes	Main findings
Choobineh et al. (10)	2004	Hand-woven carpet weavers, n=1,439	Loom type, working posture, working time, seat type	Ergonomic assessment + questionnaire	Neck, back, large joints	Loom type, posture, working time and seat type were associated with MSD symptoms.
Choobineh et al. (11)	2007	Rubber factory workers, n=454	Awkward posture, manual material handling	QEC + NMQ	Low back, knees, upper back	High/very-high QEC exposure was common and significantly associated with MSD symptoms.
Choobineh et al. (12)	2009	Sugar factory workers, n=116	Awkward posture, manual handling, prolonged standing	QEC + NMQ	Knees, lower back, upper back	High occupational exposure and high MSD prevalence were reported.
Ghasemkhani et al. (15)	2008	Packing workers, n=75	Repetitive movements, uncomfortable postures	Modified NMQ + ergonomic assessment	Low back, shoulders, neck	Repetitive and uncomfortable working conditions were associated with musculoskeletal symptoms.

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Motamedzadeh et al. (16)	2011	TV assembly workers, n=80	Upper-extremity ergonomic strain	Strain Index + NMQ	Upper extremities	Strain Index was correlated with MSD symptoms; symptoms decreased following intervention.
Choobineh et al. (31)	2011	Communication company workers, n=85	Awkward postures and assembly-line work	RULA + NMQ	Low back and other regions	High RULA risk was prevalent and associated with musculoskeletal symptoms.
Aghakhani et al. (28)	2011	Nurses, n=400	Bending over patients, lifting/moving equipment, raised-arm activities	Questionnaire/task-based ergonomic assessment	Low back, knees, neck, shoulders, wrists	Patient-handling and awkward working tasks were associated with MSDs.
Nejad et al. (13)	2013	Furniture workers, n=410	Manual work, poor workstation design, awkward postures	Ergonomic checklist + NMQ	Neck, shoulders, elbows, wrists/hands, upper back, lower back, thighs, knees, legs/feet	Ergonomic deficiencies were associated with musculoskeletal symptoms.
Kamalinia et al. (14)	2013	Telecommunication assembly workers, n=193	Postural loading, repetition, contact stress	LUBA + ergonomic checklist + NMQ	Neck, shoulders, elbows, wrists/hands, upper back, lower back, thighs, knees, legs/feet	High postural loading and workplace factors were associated with symptoms.
Aghilinejad et al. (37)	2014	Automobile factory workers, n=503 randomized	Ergonomic work practices	Ergonomic training + NMQ	Low back	Workshop-based ergonomic training reduced

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						one-year low-back pain.
Dianat & Salimi (17)	2014	Hand-sewn shoe workers, n=180	Poor posture, prolonged work, insufficient breaks, work pressure	RULA + questionnaire	Multiple body regions (including neck, shoulders, elbows, wrists/hands, back, hips/thighs, knees, and ankles/feet)	RULA scores and work-related factors were associated with MSD symptoms.
Dianat et al. (18)	2015	Sewing-machine operators, n=251	Poor workstation, prolonged sitting, prolonged work, posture	RULA + questionnaire	Neck/shoulders, back, hands/wrists	High RULA scores and several work-related factors were associated with symptoms.
Labbafinejad et al. (19)	2016	Pharmaceutical employees, n=396	Posture and ergonomic workplace factors	RULA + NMQ	Low back, neck	RULA-related exposure was associated with low-back pain; posture-related factors were associated with neck pain.
Veisi et al. (20)	2016	Hand-woven shoe-sole makers, n=240	Posture, working time, force exertion	RULA + NMQ	Neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs/buttocks, knees, ankles/feet	Working time, posture and force exertion were associated with MSD symptoms.
Besharati et al. (21)	2020	Office workers, n=359	Computer workstation, ergonomic workload	ROSA + NMQ + NASA-TLX	Shoulders, elbows, wrists/hands, thighs, and ankles/feet	Ergonomic risk and workload were associated with musculoskeletal problems.

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Mohammadipour et al. (6)	2018	Office workers, n=250	Computer workstation and posture	RULA + ROSA + NMQ	Low back, neck	Ergonomic risk scores were associated with selected MSD outcomes.
Daneshmandi et al. (32)	2019	Electronic assembly workers, n=53	Awkward/prolonged postures	RULA + questionnaire	Low back, wrists/hands, neck	Most assessed postures were at high/very-high action levels.
Houshyar & Kim (24)	2018	Apple harvesting laborers, n=30	Awkward harvesting posture, workload, work-rest pattern	REBA + NMQ + stopwatch study	Lumbar, knees, neck, shoulders	Corrected posture and appropriate rest periods reduced musculoskeletal problems.
Momeni et al. (25)	2020	Agricultural workers, n=1,501	Physical workload, posture, ergonomic working conditions	QEC + ergonomic checklist + NMQ	Low back, knees, upper back	High/very-high ergonomic exposure was common and associated with MSDs.
Dianat et al. (26)	2020	Rice, vegetable and greenhouse farmers, n=377	Agricultural working postures and physical demands	RULA + questionnaire	Low back, knees, upper back, neck	Musculoskeletal symptoms were highly prevalent and associated with physical/work factors.
Karimi et al. (27)	2020	Dairy/milking workers, n=48	Repetitive work, awkward posture, work-rest schedule	QEC + CMDQ	Neck, shoulders, lower back, forearms, knees	Multicomponent ergonomic intervention improved exposure risks and musculoskeletal outcomes.

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Hemati et al. (38)	2020	Flour factory workers, n=85	Repetitive movements, manual handling, awkward posture	Ergonomic intervention + MSD questionnaire	Neck, shoulders, low back, lower limbs	Engineering and management interventions reduced ergonomic risk and MSDs.
Fouladi-Dehaghi et al. (34)	2021	Quarry workers, n=78	Physical workload and awkward working postures	REBA + NMQ	Waist/low back, wrist	REBA risk level was significantly related to wrist and low-back pain.
Motamedzade et al. (36)	2021	Bank employees, n=277	Computer workstation/postural exposure	ROSA + NMQ	Neck, shoulders, lumbar region	Ergonomic intervention reduced ROSA scores and musculoskeletal symptoms.
Khoshakhlagh et al. (33)	2022	Oil and gas workers, n=1,243	Physical/ergonomic exposure	QEC + NMQ	Low back, knees, wrists/hands	Educational ergonomic intervention reduced both QEC scores and MSD symptoms.
Yazdanirad et al. (35)	2022	Steel-factory workers, n=300	Posture, force, repetition, vibration, contact stress	REBA/MOREBA + CMDQ	Low back, knees, neck, shoulders	Physical risk factors significantly contributed to musculoskeletal symptoms.
Mohammadian et al. (7)	2025	Office workers, n=99	Ergonomic and psychosocial workplace factors	ROSA + NMQ-E	Neck, lower back, shoulders, upper back, knees	Ergonomic risk factors were associated with MSDs.

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Khademi et al. (22)	2025	Computer/office workers, n=196	Workstation–anthropometric mismatch, furniture design	ROSA + anthropometric assessment	Neck, low back, shoulders	Workstation mismatch and inappropriate furniture dimensions were associated with musculoskeletal symptoms.
Tabrizi et al. (29)	2025	Nurses, n=76; 32 workstations	Nursing workstation ergonomic conditions	ESPT + NSEA	Work-related MSD risk	Nursing workstation conditions were associated with measurable ergonomic risk.
Ebrahimi et al. (23)	2026	Technical/vocational organization staff, n=214	Office ergonomics/workstation conditions	ROSA + CMDQ	Upper extremities, neck/back, lower extremities	ROSA scores were strongly correlated with musculoskeletal discomfort.
Sarmadi et al. (30)	2026	Hospital clinical personnel, n=508	Physical workload	PWQ + Extended NMQ	Neck, upper back, lower back, shoulders, elbows, wrists/hands, hips/thighs, knees, ankles/feet	Higher physical workload was significantly associated with higher odds of regional musculoskeletal pain.

CMDQ: Cornell Musculoskeletal Discomfort Questionnaire, ESPT: Ergonomic Screening and Posture Tool, LUBA: Loading on the Upper Body Assessment, MSD: Musculoskeletal Disorders Questionnaire, MOREBA: Modified Rapid Entire Body Assessment, NMQ: Nordic Musculoskeletal Questionnaire, NMQ-E: Extended Nordic Musculoskeletal Questionnaire, NSEA: Ergonomic Screening and Prioritization Tool, QEC: Quick Exposure Check, RULA: Rapid Upper Limb Assessment, ROSA: Rapid Office Strain Assessment, REBA: Rapid Entire Body Assessment

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