

Review Article

Work-related musculoskeletal disorders and related risk factors among bakers: A systematic review

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Abstract.

BACKGROUND: Work-related musculoskeletal disorders (WRMSDs) and ergonomic risk factors are very common in bakery workers.

OBJECTIVE: The purpose of this study is to (1) assess the prevalence of musculoskeletal disorders among bakers because they use automated machines or traditional baking, and (2) to determine the strategies to prevent musculoskeletal disorders in bakers.

METHODS: A systematic review of PubMed, Scopus, and Web of Science was conducted from the beginning to February 4, 2022, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Mesh keywords and phrases were used to execute the search strategy. Information on MSDs and ergonomic risk factors in bakery workers was collected. Two reviewers worked independently on study selection, data extraction, and paper quality ranking.

RESULTS: This study identified 14 papers from seven countries. Although the prevalence of MSDs in bakery workers has been studied, only a handful of them have been studied ergonomic risk factors, and the findings have been very limited. The association between different risk factors and MSDs seemed significant compared to many other occupational diseases. The traditional bread-baking system and lack of mechanization may increase the risk of MSDs in bakery workers.

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CONCLUSION: WRMSDs for bakery workers have been less studied than other occupational diseases. Our systematic review found several significant relations between the factors influencing the prevalence of MSDs. This study also showed the comparison of traditional and modern cooking systems with diseases of the upper limbs, shoulders, and back pain as possible fields for future research.

Keywords: Occupational disease, ergonomics, food industry, bakery workers, disease, back pain

1. Introduction

The daily increase in occupational accidents and diseases is rooted in the lack of attention to ergonomics in the workplace. One of the key goals of ergonomics and the ergonomic process is to conform people's work methods and activities within the framework of abilities and limits. The main purpose of ergonomics in the workplace is to create fit and adapt environmental conditions for humans [1]. If repetitive work activities are conditions of the profession that exceed the abilities of the worker, such activities cause harm. Repetitive trauma to the limbs is a cumulative effect that progresses over time and ultimately manifests itself as musculoskeletal disorders.

According to the National Institute for Occupational Safety and Health (NIOSH), work-related musculoskeletal disorders (WRMSDs) are disorders or injuries that affect a part of the body's musculoskeletal system, which includes bones, nerves, tendons, ligaments, joints, cartilage, and blood vessels in the arms, legs, head, neck, or back. Their symptoms include soft tissue discomfort, insensitivity, stiffness, edema, tiredness, impatience, and a lack of control [2]. WRMSDs are common in many occupations, including office workers [3], industry workers [4], and healthcare workers [5] worldwide. WRMSDs are one of the most common and costly occupational disorders in the world [6]. These multifactorial disorders [7] can be exacerbated in the workplace as a result of acute trauma [8]. Disorders caused by occupational risk factors can cause symptoms such as chronic pain, discomfort, injury, tingling, persistent pain in the limbs, and general disability of body structures [9, 10]. Upper limb stabilization exercises such as neck stabilization can have significant effects in reducing pain and relieving chronic non-specific neck pain [11].

Ergonomists consider repetitive motion injuries (RMIs) to be one of the most important factors in increasing the risk of MSDs [12]. MSDs account for 44% of work-related compensation and cost about \$45 million to \$54 million a year, according to a

recent U.S. Census Bureau report [13]. In the United Kingdom, the average prevalence of WRMSDs in all industries was 1,130 per 100,000 workers in the period 2018-2021. This includes 212,000 (45%) cases in which the upper limbs or neck were affected between 2020 and 2021 [14]. The most common types of WMSDs among workers in 28 European Union countries (EU-28) included low back pain and muscle pain in the upper limbs (43% and 41%, respectively) in 2015 [15]. Ergonomists can identify the points of failure by direct observation and by studying statistics and documents or inquiries, and by applying an experimental design and evaluating them, new decisions can be made to improve the situation [16].

According to the USDA report in Fig. 1, China, the European Union, and India are the largest consumers of wheat in the world in 2021-2022. Most of this wheat consumption includes baking bread in the food industry. The baking of bread is done according to the traditions of different ethnic groups and special nutritional patterns, and a large number of bakers work in this industry.

Bread is considered a very important food in countries and its daily consumption is impressive. In Iran, Egypt, India, Lebanon, Indonesia, Taiwan, Ecuador, and other countries around the world, traditional bakeries make bread in various methods (Fig. 2).

Among the food industry, the highest rate of WMSDs worldwide has been consistently reported among small-scale bakers [17, 18]. A bakery is one of the occupations in which workers do a lot of physical activity and repetitive movements during their work shifts. Job fatigue during manual handling of cargo is also known as another risk factor for musculoskeletal disorders in bakers. A manual training program in material handling should be used in this profession [19].

Bakery workers face a variety of occupational diseases, including respiratory illnesses [20, 22], heat illnesses [23, 24], and sometimes incurable diseases, and are constantly exposed to extreme stress. Musculoskeletal disorders are common in bakers and similar occupations such as flour production workers in the

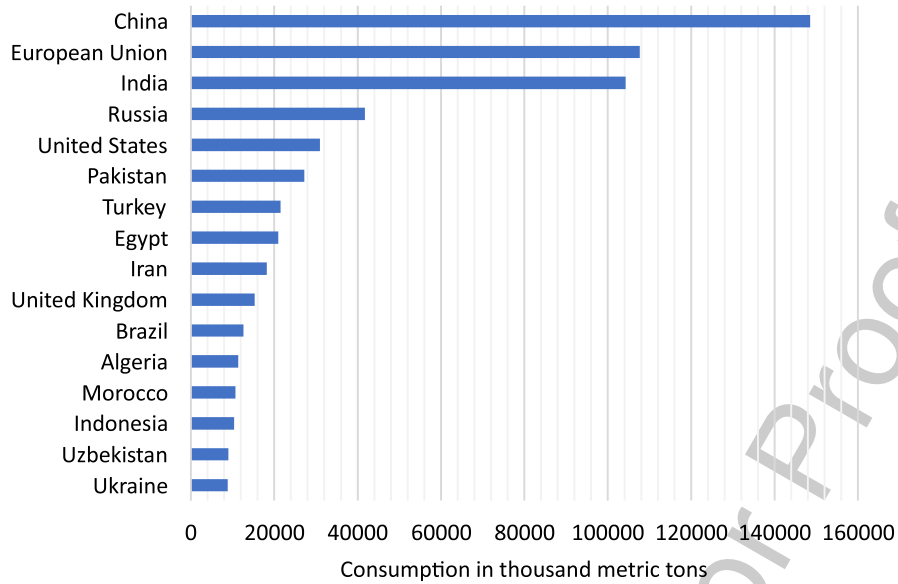


Fig. 1. Wheat consumption worldwide in 2021/2022, by country (in 1,000 metric tons) [16].



Fig. 2. Traditional bakeries in several countries.

120 waist, arms, and shoulders [25]. Lifestyle [26] and
 121 workplace conditions such as organizational factors,
 122 psychological stress [27], and shift work [28] can
 123 threaten the health and well-being of workers and
 124 lead to WRMSDs.

125 By reviewing the bakery WRMSD literature and
 126 background studies, it is possible to assess the preva-
 127 lence and ergonomic risk factors in this profession.
 128 This research is significant in two ways: 1. It provides
 129 comprehensive information about musculoskeletal

disorders in bakers. 2. Expresses new solutions for
 the bakery profession to prevent and reduce muscu-
 loskeletal disorders. The main question of the study
 is, based on the type of bread, and the use of auto-
 mated machines or traditional baking, what is the
 prevalence of musculoskeletal disorders in bakers?
 We are also seeking strategies to prevent muscu-
 loskeletal disorders in bakers. The dimensions and
 factors revealed in this study can be used as a guide
 in future studies.

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A systematic review of the prevalence of musculoskeletal disorders has been performed in many occupations, including drivers [29], nurses [30], school teachers, dental professionals [31], and farmers [32]. Therefore, musculoskeletal disorders in bakers must be also evaluated. In this regard, the present study was conducted to investigate the prevalence of WRMSDs among bakers and identify ergonomic risk factors affecting the occurrence of these disorders.

2. Methods

2.1. Search strategy

This is a systematic review of the prevalence of WRMSDs in bakers based on papers published in domestic and foreign journals without a time limit (from the beginning February 4, 2022). All papers were collected in journals in international databases including Web of Science, PubMed, and Scopus as well as the Google Scholar search engine and other indexes. The current study was conducted in several stages, including accurate determination of the problem, collection, analysis, and interpretation of the findings. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed [33]. Papers were searched with appropriate Persian keywords and English equivalents (MeSH term) using a combination of AND and OR operators. The search process keywords are given in Table 1.

2.2. Entry and exit criteria

The main criterion for including papers in this study was MSDs in bakers. Exclusion criteria were

also studies that only had abstracts, letters to the editor or conference, and papers in local languages of each country and without a full English text, with the exception of the Persian language.

For papers whose full text was not available, authors were contacted by e-mail to receive the full text. To prevent bias, research, selection of studies, quality evaluation, and data extraction were performed by two researchers independently.

2.3. Data extraction

After determining the relevant reviews, the selected papers were evaluated by the researchers using the PRISMA checklist. A datasheet was prepared to include the names of the authors, year of publication, place of the study, sample size, and most important findings. After evaluating the quality of the papers using a checklist and criteria considered by the researcher, which included the availability of variables examined by the checklist in the papers, 14 suitable papers were included in the study. Figure 3 shows the number of papers searched and reviewed.

3. Results

178 articles were found in the databases. 104 articles were excluded due to duplication and 14 articles due to non-relevance. After the full review of the articles, 14 articles related to the study topic that was selected for the final review were included in the research. Their results are explained in Table 2, focusing on several topics, description of risk factors found in each article, report pain areas and pain prevalence, intervention and intervention results. The final selected articles were all research articles. Regarding

Table 1
Search process information from databases

Number of searches	Search term	Google Scholar Combined search terms	PubMed Combined search terms
S1	musculoskeletal disorder* OR musculoskeletal injury* OR musculoskeletal discomfort*	ALL FIELDS: (musculoskeletal disorders) AND ALL FIELDS: (bakery workers) AND ALL FIELDS: (food industry) AND ALL FIELDS: (risk factors)	work-related musculoskeletal disorders AND baker AND food industry AND bakery workers AND risk factors
S2	bakery* OR bakery* workers* OR food industry*		
S3	food-baking OR small-sized industry OR bakery business		
S4	risk factors* OR prevent* OR interventions		
S5	# S1 AND # S2 AND # S3 AND # S4		

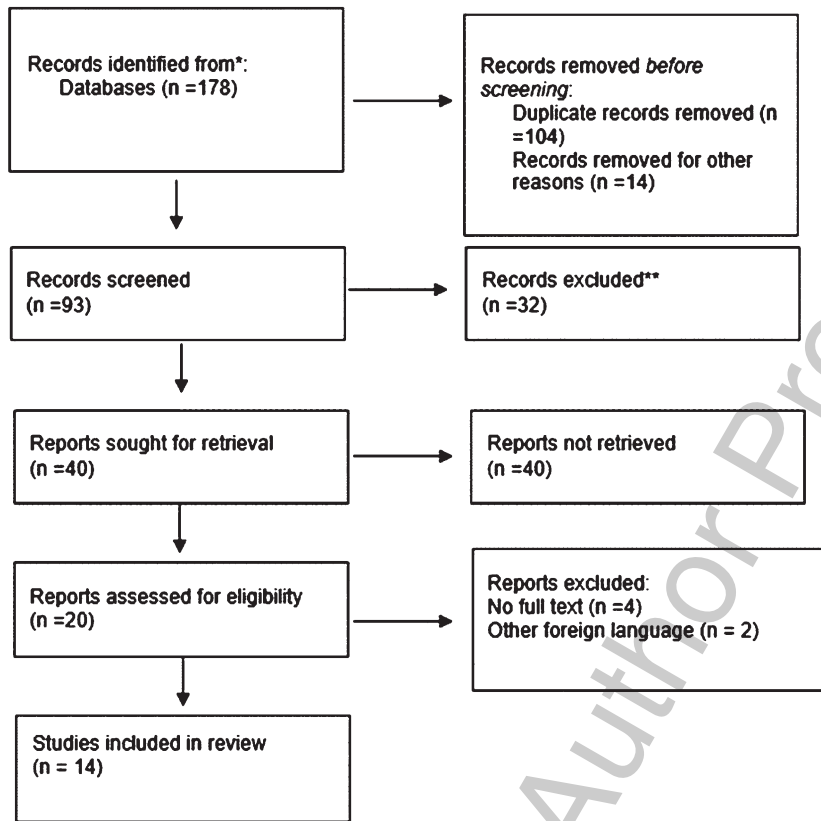


Fig. 3. Strategy flow chart of systematically reviewed studies.

204 the year of publication, most articles were printed and
 205 published between 2009 and 2021. Bakery workers
 206 in different job tasks (rolling out dough, kneading
 207 dough, rounding dough, selling) were included in
 208 the study sample size. Lavash traditional bread bak-
 209 ing workers have the largest number of participants
 210 in the studies (413, 24.49%), followed by Sangak
 211 bread baking (275, 16.31%), and the lowest number
 212 includes Taftoon bread baking workers (79, 4.68%).
 213 The total number of statistical samples in all studies
 214 was 1686 people with an average of 121 people. The
 215 largest number of samples was 504 people (29.89%)
 216 and the smallest number of studied samples was 15
 217 people (0.88%). 8 studies (57.14%) focused on pain
 218 and musculoskeletal disease and 3 studies (21.42%)
 219 focused on a specific type of pain and disease (such
 220 as carpal tunnel syndrome, arthritis and back pain).
 221 In order to measure the results of epidemiological
 222 studies in the field of musculoskeletal injuries, the
 223 most used tool was the Nordic questionnaire (6,
 224 42.85%). Also, analysis of body posture using posture
 225 assessment methods in occupational ergonomics
 226 (9, 64.28%) was the most studied.

227 Working in a bakery is associated with exposure
 228 to physical loads during the production process of
 229 bakery products, which affects the risk of WMSDs.
 230 Bakers are prone to musculoskeletal disorders due
 231 to their daily tasks, which involve a lot of repetitive
 232 movements [8]. These risk factors are due to some
 233 organizational characteristics such as incorrect work-
 234 rest cycle, high speed of work (or tasks, the speed
 235 of which is determined by the machine), long dura-
 236 tion of work, unknown jobs, lack of variety in work,
 237 receiving wages based on the number of breads pro-
 238 duced, and Other related factors are exacerbated. The
 239 most common types of diseases and adverse effects of
 240 the work environment in bakers are heat stress [23],
 241 respiratory diseases [34], mental workload [35], and
 242 most importantly MSDs that lead to reduced pro-
 243 ductivity, efficiency, and disability. While WMSDs
 244 are common among workers, bakers are more likely
 245 to develop a work-related musculoskeletal disorder
 246 than workers in other occupations because their jobs
 247 are often physically arduous. Baker-related MSDs
 248 include back pain, shoulder pain, recurrent compres-
 249 sion injuries, and joint pain that impedes movement.

Table 2
General information on selected studies in the present study

Author and year	Country	Type of study	Number of samples	Intervention or measurement method	Pain areas (prevalence)	Risk factors	Evaluation	Results
Joudakinia et al. (2021)	Iran	Cross-sectional	20	No intervention	The neck and the back	Improper position of neck and back of bakers while baking bread	Working postures and movements of the back and neck during work were continuously recorded with inclinometry measurements during three hours	Physical workload in bakers was characterized by awkward postures and the percentage of time spent with the neck flexed more than 20°. Besides, low angular velocity and lack of postural variation during baking shows that bakers' back is in the static position and bakers have to work with constrained back for a long time.
Beheshti et al. (2021)	Iran	Cross-sectional	Not reported	No intervention	The shoulder/arm, wrist, the hand, head/neck, and the back	Biomechanical risk factors (force, posture, repetition, duration) and additional factors during bread baking	ART (assessment of repetitive tasks) and OCRA Index (Occupational Repetitive Actions)	The correlation between the results of the OCRA index (Occupational Repetitive Actions) and the ART method (assessment of repetitive tasks) in determining the ergonomic status of workers was statistically significant.
Lakshmi et al. (2021)	India	Cross-sectional	15	No intervention	The shoulder (40%), the neck, and the arm (33.3%)	Improper posture in standing and bent positions	Interview and Checklist	most musculoskeletal disorders were in the tasks of mixing, cooking, and packaging.

(continued)

Table 2
(continued)

Author and year	Country	Type of study	Number of samples	Intervention or measurement method	Pain areas (prevalence)	Risk factors	Evaluation	Results
Nourollahi et al. (2020)	Iran	Cross-sectional	57	No intervention	The right shoulder (66%) and the left shoulder (64%)	Work in long time	The Nordic Musculoskeletal Questionnaire (NMQ) and Visual analogue scales (VAS)	Organizational factors in bakery work such as increased work speed and insufficient rest in combination with biomechanical factors for arms and their significant effect on muscle tension in the shoulder area.
Chen et al. (2020)	Taiwan	Cross-sectional	87	No intervention	The right hand/wrist (66.3%), left hand/wrist (51.8%), right shoulder (50.6%), left shoulder (45.8%) and lower back (48.2%)	The use of a rolling pin Non-matching of anthropometric dimensions of bakers with tools, age, and moving the load.	The Nordic Musculoskeletal Questionnaire (NMQ) and Electro goniometer	Frequent turning of the hand/wrist causes symptoms of skeletal-muscular disorders in bakery workers.
Habib et al. (2019)	Lebanon	Cross-sectional	504	No intervention	The upper regions (23%)	High physical workload, psycho-social factors	The Nordic Musculoskeletal Questionnaire (NMQ)	Somatization was positively associated with upper extremity musculoskeletal pain (OR = 1.51; 95% CI = 1.22–1.86).
Carrera et al. (2019)	Ecuador	Cross-sectional	119	No intervention	The upper body areas	Improper workstation design in 3 tasks: kneading, cooking, and packing	The Rapid Entire Body Assessment (REBA) and repetitive OCRA (Occupational Repetitive Actions) Checklist	The high-risk level in terms of percentage with forced postures according to the REBA method was equal to 11.1% and according to the OCRA method (Occupational Repetitive Actions), it was equal to 39% in the areas affected by trunk, neck, arms, and wrists.
Bidiawati et al. (2018)	Ecuador	Cross-sectional	*	No intervention	The right arm, shoulders, and upper body	Lots of repetitive movements	REBA and Occupational Repetitive Actions (OCRA)	Designing and making a tool that is in the form of a trolley rack. This trolley made of iron uses the anthropometric data of the worker's body and conforms to the ergonomic rules.

Motamedzade et al. (2017)	Indonesia	Cross-sectional	30	No intervention	The back (92.68%), knee (80.49%), shoulder (30.95%), forearm (19.26%), and wrist (26.19%)	Improper posture, hand carrying loads, twisting and bending of the body	Nordic Body Map (NBM questionnaire) and Occupational Repetitive Actions (OCRA)	The prevalence of skeletal disorders is significantly related to BMI and work history ($P \leq 0.05$).
Beheshti (2015)	Iran	Cross-sectional	129	No intervention	The right and left hand	The intensity and duration of applying force and the high speed of work during bread baking	The Nordic Musculoskeletal Questionnaire (NMQ), Visual Analogue Scale and ACGIH-HAL	The risk of musculoskeletal disorders was in the high category.
Khamirchi et al. (2015)	Iran	Cross-sectional	*	No intervention	The shoulder 58.6% and wrist 45.45%	Standing position, repetitive posture of sticking bread into the oven	Occupational Repetitive Actions (OCRA)	The prevalence of skeletal disorders was significantly related to age and work experience ($P < 0.05$).
Beheshti (2014)	Iran	Cross-sectional	70	No intervention	Pain in the neck, back, and hands	Non-compliance of bakery worker's workstations with ergonomic principles	Rapid Upper Limb Assessment (RULA) and the Nordic Musculoskeletal Questionnaire (NMQ)	83.33% of workers in Taftoon bakeries, 100% of workers in Sangak bakeries, and 91.66% of workers in Lavash bakeries had musculoskeletal disorders.
Mehrizi et al. (2014)	Iran	Cross-sectional	423	No intervention	Back, knee, and hand/wrist	Long working time and lack of suitable work tools that conform to ergonomic principles	Occupational Repetitive Actions (OCRA) and the The Nordic Musculoskeletal Questionnaire (NMQ)	The results of the OCRA index (Occupational Repetitive Action) showed that the risk of musculoskeletal disorders when bakers work while baking bread in the high-risk range in the machine Taftoon system is 5.6%, in traditional Taftoon bread baking 67.4%, Sangak bread baking is 3.77% and baguette baking is 75%.
Ghamari (2009)	Iran	Cross-sectional	232	No intervention	The knee, 62.2%), back (58.8%), and legs (53.9%)	Bending, turning, and combined positions with longer duration during bread baking	The Open Web Application Security Project (OWASP) and the Nordic Musculoskeletal Questionnaire (NMQ)	There was a significant relationship between the Pain in the neck, shoulder, elbow, and knee area with work experience ($P < 0.05$).

*Not reported.

250 The bread-baking system in the included stud- 298
251 ies includes the countries of Iran, India, Ecuador, 299
252 Lebanon, Indonesia, and Taiwan. In Iran, the most 300
253 common types of bread include Lavash, Barbari, San- 301
254 gak, Taftoon, and types of fancy bread, which are 302
255 baked in both traditional and semi-mechanized ways. 303
256 The method of baking Sangak bread is that after mak- 304
257 ing the sourdough, the workers spread the dough 305
258 inside the oven with a special paddle. The oven of 306
259 the Sangak bread baking system is a dome-shaped 307
260 space of 5x4 meters, the floor of which is covered with 308
261 pebbles. In the oven bread baking method, workers 309
262 knead the dough and bake it in the oven. In the case 310
263 of Lavash and Taftoon cooking systems, the oven is 311
264 almost semi-mechanized and consists of a plate that is 312
265 rotated by a conventional rotary device. In this device, 313
266 the heat required for cooking is provided by two burn- 314
267 ers with the direct and indirect flame from below and 315
268 above the cooking surface. In the Taftoon cooking 316
269 system, the oven is made of clay with a tile surface 317
270 and is available in two ways: buried in the ground 318
271 and installed at a height. The type of bread consumed 319
272 in India is millet. By roasting and grinding millet, 320
273 workers mix flour with salt, yeast, spices, sugar, and 321
274 other ingredients to prepare the dough and bake in the 322
275 oven, which is finally made into bread, cakes, rolls, 323
276 etc. In Taiwan, it is a type of oven bread, and bak- 324
277 ery workers bake it in the oven after three stages of 325
278 kneading, rolling, and rounding the dough. Also, in 326
279 Lebanon, it is a type of oven bread, and bakery work- 327
280 ers bake it in the oven after kneading the dough. In 328
281 Ecuador, the daily diet consists mainly of bread, the 329
282 staple food that is part of the traditional diet, usu- 330
283 ally cooked with a paste made of flour, salt, water, 331
284 and additives. Table 3 shows the tools used in baking 332
285 bread, the specific problems of traditional bread bak- 333
286 ing, and the ergonomic situation of bakers in forced 334
287 labor at different heights. 335

288 4. Discussion 336

289 4.1. Bread baking system 337



290 In today's world, foods related to nutrition 340
291 patterns are produced with a combination of high- 341
292 consumption grains such as wheat, rice and millet. 342
293 These products are not only valuable food but also 343
294 are very important in maintaining people's health. In 344
295 many countries, bread is baked in small industrial 345
296 units with semi-mechanized machines or traditional 346
297 methods. In Iran, the bread industry is very extensive, 347

and different types of bread are baked in a tradi- 298
299 tional and machine way. Bakers and bakery workers 300
301 perform tasks such as mixing flour, making dough, 302
303 adding yeast, processing, and baking. In general, dif- 304
305 ferent methods of baking common bread are offered 306
307 and consumed according to the customs and tra- 308
309 ditions of each community. India has the highest 310
311 demand for millet grain food and is, therefore, the 312
313 largest producer of millet in the world. In Iran, tradi- 314
315 tional bread has different types due to the variety of 316
317 baking methods (table 3). Among them are Taftoon 318
319 bread with a rotating machine and a tandoor oven, 320
321 Sangak bread, and baguette bread, but the way of bak- 322
323 ing bread is different from each other. In the study 324
325 by Nourollahi-Darabad et al. [39], types of bakers 326
327 were classified including Lavash tandoor oven, San- 328
329 gak and Taftoon. It is estimated that about 90,000 330
331 traditional bakeries and about 1.5 million full-time 332
333 and part-time workers work in traditional bakeries in 334
335 Iran. Bread production has a long history in Iran. Due 336
337 to the inseparable connection of the Iranian people 338
339 with bread, an increasing variety of this healthy and 340
341 nutritious food is prepared and consumed throughout 342
343 the country [40]. 344
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322 4.2. Ergonomic risk factors 323

324 In the study by Nourollahi-Darabad et al. [39], the 325
326 highest prevalence of musculoskeletal symptoms was 327
328 reported among bakers in the right and left shoul- 329
330 ders (66% and 64%, respectively). In the process of 331
332 baking bread, bakers use their right hands to lift and 333
334 place the dough in a traditional oven using a bread 335
336 paddle. In such situations, bakers are exposed to a 337
338 combination of physical risk factors such as poor 339
340 posture, excessive force, and repetitive movements 341
342 in the shoulder area. The results showed that San- 343
344 gak bakery workers were exposed to higher levels of 344
345 extreme conditions and angular rotation speed com- 345
346 pared to Taftoon and Tandoor oven bread bakery 346
347 workers. In the study by Joudakinia [17], the MSDs 347

Table 3
The tools used in baking bread, the specific problems, and Forced work at different heights



Type of bread	Country	Bread baking system	Tools used	Special difficulties in manual work	Forced work at different heights	Picture
Millet	India	Traditional	Mixers, ovens, dough maker	Exposure to heat stress, burning eyes, pain in the neck and hands	Neck and hand	
Sangak	Iran	Traditional	Measure cup, scales, mixers, ovens, dough and dough spreader	Exposure to heat stress, burning eyes, slipping and discomfort, sneezing, pain in the neck, hips, upper leg, lower leg, ankle and foot.	Neck, hips, upper leg, lower leg, ankle and foot	
Tanoori	Iran	Traditional	Measuring cup, scale, mixer, oven, and surface for spreading bread	Exposure to heat stress, burning eyes, pain in the neck, and legs	Neck and legs	

From Nourollahi et al. [39]

From Nourollahi et al. [39]

(continued)

Table 3
(continued)

Type of bread	Country	Bread baking system	Tools used	Special difficulties in manual work	Forced work at different heights	Picture
Lavash and Taftoon	Iran	Semi-mechanized	Measuring cup, rolling pin, leveler, mixer, oven, dough spreader	Exposure to heat stress, eye irritation, pain in the neck, hands and feet	Neck, hands and feet	 <p>From Joudakinia [17]</p>
Taftoon	Taiwan	Traditional	Rolling pin, measuring cup, scale, mixer, oven, kneader and dough spreader	Exposure to heat stress, burning eyes, pain in the neck, hips, hands, legs, ankles and feet	Neck, hips, hands, legs, ankles and feet	 <p>From Chen [41]</p>
Tanoori	Lebanon	Traditional	Measuring cup, scale, mixer	Exposure to heat stress, pain in the neck, hands and feet	Neck, hands and feet	
Tanoori	Ecuador	Traditional	Measuring cup, mixer, oven	Exposure to heat stress, pain in the neck, hands and feet	Neck, hands and feet	

348 traditional bread-baking system are the most impor- 398
 349 tant ergonomic risk factors. In the study by Chen [41], 399
 350 the overall prevalence of MSDs in any part of the body 400
 351 during the year was 93.0% among 81 bakers in Tai- 401
 352 wan, with the highest prevalence in the wrist (66.3% 402
 353 on the right and 51.8% on left), and shoulders (50.6% 403
 354 on the right and 45.8% on the left). Repetitive move- 404
 355 ment in the wrist (changes in wrist movement and 405
 356 maximum range of motion during kneading, rolling, 406
 357 and rounding of dough) has been reported as one of 407
 358 the most important ergonomic risk factors in bakers. 408
 359 The findings of Chen et al.'s study can also be used 409
 360 to explain why bakers report a high proportion of wrist 410
 361 and shoulder disorders and can be used as a reference 411
 362 for rescheduling and redesign [41]. In the study by 412
 363 Tajvar et al., MSDs are more common among bak- 413
 364 ery employees than in the general population of the 414
 365 country. Based on the results of this study, the type of 415
 366 bakery, type of work, and work experience have a sig- 416
 367 nificant effect on the prevalence of cumulative trauma 417
 368 disorders in the four regions of the neck, shoulders, 418
 369 hands/wrists, and waist [42]. In the study by Ghamari 419
 370 et al., MSDs of the neck, shoulders, elbows, and knees 420
 371 showed a significant relationship with work experi- 421
 372 ence [38]. In the study by Carrera et al., poor posture 422
 373 and poor job design ergonomic risk factors were men- 423
 374 tioned and could be considered potential risks for 424
 375 MSDs in the upper extremities [43]. 425

376 4.3. *Solutions and recommendations*

377 Traditional baking of bread can cause chronic and 426
 378 uncomfortable pain in the upper limbs, back, and 427
 379 shoulders. The bakery is one of those jobs that require 428
 380 a stand for a long time, so these jobs are also prone 429
 381 to MSDs. Repetitive hand activities combined with 430
 382 force, inappropriate posture, high mobility, and repeti- 431
 383 tion of tasks during the baking process can increase 432
 384 the likelihood of upper extremity disorders in bakers. 433
 385 Therefore, it can be said that the baking profession is 434
 386 one of the professions in which the risk of cumulative 435
 387 disorders due to trauma is high, especially in the three 436
 388 areas of the back, shoulders, and hands/wrists. 437

389 All activities that affect and burden these areas 438
 390 need to be identified and modified. Therefore, the 439
 391 prevention of these disorders in the workplace and 440
 392 the elimination of risk factors associated with them 441
 393 should be considered. Therefore, to improve the sta- 442
 394 tus quo, it is best to use ergonomic control methods, 443
 395 which are considered to be the most important part of 444
 396 the ergonomics program, and the effect of lowering 445
 397 the WRMSDs rate has been proven so far. The first 446

447 and best way to reduce or even eliminate WRMSDs 448
 449 is to redesign the entire baking system and how to 449
 450 bake bread in a traditional oven. 450

451 The results of the current review showed that work- 451
 452 ers in the traditional and semi-mechanized systems 452
 453 of bread baking in developing countries are exposed 453
 454 to more biomechanical risk factors compared to the 454
 455 mechanized system. 455

456 In the mechanized system, the pressure of physical 456
 457 activities of the person has been reduced. However, 457
 458 the prevalence of skeletal-muscular injuries due to the 458
 459 inappropriate physical condition of bakery workers, 459
 460 who traditionally perform several frequent activities 460
 461 in the bread baking system, has been reported in the 461
 462 four areas of the neck, shoulder, waist, and hand at a 462
 463 higher rate than in other areas. 463

464 Some suggested strategies to reduce musculoskele- 464
 465 tal disorders in bakery workers are considering rest 465
 466 time during working hours, adjusting the height of 466
 467 the oven to prevent excessive bending of the baker, 467
 468 redesigning the entire traditional bread baking sys- 468
 469 tem, considering the work table suitable for the work 469
 470 needs and physical dimensions of the bakers, and 470
 471 using anti-slip flooring. Use of anti-fatigue floor- 471
 472 ing, using proper and ergonomic tools such as an 472
 473 ergonomic cutter when cutting the dough, and train- 473
 474 ing bakers about skeletal-muscular disorders and 474
 475 their prevention methods. Considering a suitable 475
 476 work desk with the work needs and body dimensions 476
 477 of the baker, using anti-fatigue flooring, using an elec- 477
 478 tric shutter machine, using suitable and ergonomic 478
 479 tools such as using an ergonomic spatula when cut- 479
 480 ting the dough in a baguette bakery, training bakers 480
 481 (on MSDs and methods to prevent) and using man- 481
 482 agement methods such as taking into account work 482
 483 rotation or placing short breaks between long work 483
 484 meals. 484

485 With the advancement of technology and the 485
 486 expansion of the bread-baking machine industry in 486
 487 industrialized countries, the prevalence of MSDs in 487
 488 bakers is expected to decrease significantly. How- 488
 489 ever, traditional bread baking is still widespread in 489
 490 developing countries, and being in poor working con- 490
 491 ditions is an ergonomic risk factor that is an important 491
 492 reason for accelerating the development of these dis- 492
 493 orders. 493

444 4.1. *Limitations*

445 In the present systematic review, several limi- 445
 446 tations must be considered when interpreting the 446
 447 findings. One of them is not including written studies 447

448 in languages other than English and Persian. This may
 449 indicate bias, and it is always possible that some stud-
 450 ies have been missed, even if extensive text searches
 451 have been performed. Second, there is insufficient
 452 data to make definitive conclusions about ergonomic
 453 risk factors and musculoskeletal disorders in bak-
 454 ers, as there can be many other factors, including
 455 psychosocial factors that negatively affect the muscu-
 456 loskeletal system. The third was the lack of valid and
 457 reliable assessment tools in most studies. No studies
 458 have been found in other countries that have mecha-
 459 nized the baking system, and it is not possible to say
 460 how widespread WRMSDs are among these bakers.
 461 Another methodological limitation was that 4 stud-
 462 ies were not included because the full text was not
 463 available online.

464 5. Conclusion

465 Several tasks and activities are performed man-
 466 ually using the physical force of the worker in
 467 traditional systems. In the traditional system, workers
 468 are exposed to biomechanical risk factors and other
 469 contributing factors to the occurrence of WRMSDs,
 470 and it is natural that under such conditions, these dis-
 471 orders are more prevalent and incident. The results
 472 showed that the several tasks and activities of bak-
 473 ers during the day can be a factor in the prevalence
 474 of MSDs. Musculoskeletal disorders in bakeries are
 475 associated with different parts of the body, including
 476 shoulders, hands, wrists, elbows, neck, upper back,
 477 and hips. However, the evidence is somewhat lim-
 478 ited, as these data are generally from low-quality
 479 cross-sectional and interventional studies. A better
 480 explanation of risk factors unrelated to the prevalence
 481 of WRMSDs in bakeries requires a lower risk bias and
 482 higher-quality prospective studies.

483 Ethics statement

484 No ethical issues, including plagiarism, miscon-
 485 duct, data fabrication and/or falsification, double
 486 publication and/or submission and redundancy, have
 487 been reported by the authors. Due to the nature of the
 488 study, informed consent and ethical approval were
 not necessary and thus not obtained.

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Conflicts of interest

The authors declare that there is no conflict of
 interest.

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