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Risk factors associated with low back pain among adults: A population based case control study

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Abstract

Background:

Although numerous studies have explored factors associated with LBP, evidence from large population based case control studies in low and middle income countries remains limited. This study aimed to investigate demographic, lifestyle, occupational, psychological and clinical factors associated with chronic low back pain among adults.

Methods:

This population based case control study utilized data extracted from the SINA Electronic Health Record system, a nationwide health surveillance registry in Iran. Adults aged 18 years and older with complete data on low back pain status and key covariates were included. Cases were defined as individuals reporting chronic low back pain, while controls reported no low back pain at the time of assessment. Multivariable logistic regression models were applied to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Model 1 adjusted for demographic variables and Model 2 further included lifestyle, occupational, psychological and clinical factors. Interaction terms between sex and hard physical job and between sex and body mass index (BMI), were evaluated, followed by sex stratified analyses.

Results:

We managed to get 139,499 adults to take part in this study. When we looked at all the data, it turned out that being male (OR = 2.61, 95% CI: 2.53–2.70, $p < 0.001$), getting older (especially between 48 and 57 years, or 58 and above), underweight (OR = 1.42, $p < 0.001$), overweight (OR = 1.49, $p < 0.001$), and obese individuals (OR = 1.78, $p < 0.001$), Smoking (OR = 1.18, $p < 0.001$), hypertension (OR = 1.20, $p < 0.001$), diabetes (OR = 1.95, $p < 0.001$), musculoskeletal diseases (OR = 8.02, $p < 0.001$), anxiety (OR = 1.68, $p < 0.001$) depression (OR = 1.64, $p < 0.001$)and Hard physical work (OR = 2.34, $p < 0.001$) were independently associated with low back pain. Significant interactions were observed between sex and hard physical work ($p < 0.001$) and between sex and BMI ($p < 0.001$), with stronger associations observed among women.

Conclusions:

It seems low back pain is the result of a whole heap of different factors - demographic, lifestyle, work-related, psychological and clinical all interacting in a complicated way to produce its effects on each individual. And it's clear that girls are different from boys in this respect. We reckon that looking at how some of these factors affect certain groups of people, like women, is really important when studying low

back pain. It also suggests that if we can get people to change some of the things that are putting them at risk, like working too hard or being obese, then that might help reduce the burden of low back pain.

1. Introduction

Low back pain (LBP) is one of the leading causes of disability worldwide and represents a major public health concern due to its high prevalence, recurrent nature, and substantial socioeconomic burden(1). The prevalence is ranged from 20 – 33% in all patients with musculoskeletal pain complaints worldwide. LBP is a complaint that is not only experienced by elderly people but also be found in all age categories including productive adults(2). Research in the United States indicates that LBP affects one to three adults under 65 annually, suggesting that middle-aged adults (30–60 years) are prone to developing LBP (3). In China, the population of individuals afflicted with LBP increased to 67.3 million from 1990 to 2016, with YLDs due to LBP reaching 7.7 million(4). LBP has emerged as the second major factor that affects the burden of YLDs among the population in China(4).According to global estimates, LBP affects individuals across all age groups, with a particularly high impact among working age adults, resulting in reduced productivity, increased healthcare utilization, and impaired quality of life(5, 6). The Global Burden of Disease (GBD) studies consistently rank LBP as the top cause of years lived with disability globally, highlighting its persistent and growing burden across regions and populations(6, 7).

Most times, low back pain is called nonspecific, which means there's no clear medical reason that can be found. Because of this, people are paying more attention to finding things that can be changed that help cause and keep long-term low back pain going. Studies and long-term research suggest that things like age and gender, along with how people live, such as being overweight, not active, smoking, and using drugs, are big factors in whether low back pain happens(8–11). In particular, being overweight or obese has been shown to put more stress on the lower back and cause low-level swelling throughout the body, making people more likely to have long-term pain problems(12–14). What people do for work is also known to contribute to low back pain.. Jobs involving heavy physical workload, prolonged standing or sitting, repetitive movements, and awkward postures have been consistently associated with a higher risk of LBP across diverse occupational settings(7, 8). These occupational factors often interact with individual characteristics such as sex and body mass index (BMI), further modifying the risk of developing chronic low back pain.

In addition to physical and occupational determinants, psychosocial and mental health factors have gained increasing recognition as important contributors to LBP. Depression and anxiety are frequently reported among individuals with chronic low back pain and may exacerbate pain perception, reduce coping capacity, and contribute to pain chronicity(9, 10). Moreover, metabolic and chronic conditions such as diabetes and hypertension have been associated with LBP, potentially through mechanisms involving vascular dysfunction, inflammation, and neuropathy(11–13).

Currently, epidemiological studies on low back pain among the Iranian population are still incomplete, with small sample sizes and limited research scope. Furthermore, there are no national data that

systematically report the epidemiological characteristics and factors affecting low back pain. In addition, back pain can cause economic losses and reduce patient productivity. Therefore, the present population based case control study aims to investigate demographic, lifestyle, occupational, psychosocial and clinical factors associated with chronic low back pain among adults, with particular attention to modifiable risk factors that may inform evidence-based prevention and management strategies.

2. Methods

Participants and study design:

This population based case control study was conducted using data extracted from the SINA Electronic Health Record (SINAEHR) system, a nationwide health surveillance platform implemented in Iran to support routine health monitoring of adult populations across both urban and rural settings. The SINA system systematically records comprehensive information on demographic characteristics, socioeconomic status, lifestyle behaviors, occupational factors, clinical conditions, and mental health status during standardized health assessments performed at primary healthcare centers. All data within the SINA system are entered by trained healthcare professionals, including physicians and health care providers, following standardized national protocols. The system incorporates automated validation rules and periodic quality control audits to ensure data completeness, internal consistency, and accuracy. The structure and data collection procedures of the SINA system are comparable to other large scale population based health registries that have been widely used in epidemiological research.

Study population

Adults aged 18 years and older who were registered in the SINA electronic health record system and had complete information on low back pain status and key covariates were eligible for inclusion in this study. Participants were recruited from 256 primary healthcare centers affiliated with Mashhad University of Medical Sciences, covering a wide geographical area and representing both urban and rural populations. The study period extended from March 1, 2017 to May 11, 2025. Individuals were classified as cases if they reported a history of chronic low back pain, based on self-report during routine health assessments. Controls were defined as individuals who did not report low back pain at the time of evaluation. Participants with missing or incomplete data on major exposure variables or outcome status were excluded from the analysis to ensure the validity of statistical modeling. After applying inclusion and exclusion criteria, a total of 139499 individuals were included in the final analytical sample, comprising 36983 cases and 102516 controls.

Data collection and Covariates

All data were extracted from SINA in deidentified format. The registry automatically performs internal consistency checks, range validation, and duplicate detection at the time of entry. Potential confounders were selected a priori based on literature and data availability. Age was categorized into five groups (18–27, 28–37, 38–47, 48–57, and ≥ 58 years). Sex was recorded as female or male. Marital status was

categorized as single or married. Educational attainment was classified into primary education, high school, diploma, and college education. Place of residence was grouped as rural, cities with fewer than one million inhabitants, suburban areas, and metropolitan cities. Body mass index (BMI) was calculated based on measured height and weight and categorized according to standard definitions as underweight, normal weight, overweight, and obese. BMI was included due to its established mechanical and metabolic role in the development of musculoskeletal disorders. Smoking status was assessed as a binary variable (yes/no) based on self-reported history of cigarette smoking. History of drug abuse was Individuals were registered based on diagnostic tests and blood tests. Physical activity status was defined as engagement in regular physical activity and categorized as yes or no. Physical activity was included as a potentially protective factor against chronic low back pain. Hard physical job was defined as employment involving heavy physical workload, frequent lifting, prolonged standing, or repetitive trunk movements. This variable was coded as yes or no and included due to strong evidence linking occupational physical strain with low back pain. Hyperlipidemia (E78), Diabetes (E10- E11), Hypertension (I10-I15), Depression (F32, F33), anxiety disorders (F40, F41, F43), were diagnosed by icd10 codes in the database. These variables were included to account for potential metabolic and vascular mechanisms associated with chronic pain conditions. In addition, history of other musculoskeletal diseases was recorded (M 54 icd10 code), capturing comorbid conditions that may predispose individuals to low back pain. These variables were included given their established role in pain perception, pain chronicity, and disability.

Outcome definition

The primary outcome was low back pain, defined based on self-reported physician-diagnosed low back pain or persistent pain localized to the lumbar region lasting for an extended period, as recorded in the SINA database. This definition is consistent with epidemiological studies using large health databases and self-reported pain assessments.

Ethics Statement

This research was carried out following all applicable guidelines and regulations. Ethical approval was obtained from Mashhad University of Medical Sciences (Approval Code: IR.MUMS.FHMPM.REC.1404.183). Due to the retrospective nature of the research and the use of anonymized medical records, the waived the requirement for obtaining informed consent from the participants.

Statistical analysis

Data were coded and entered into Excel version 7.2.0.1 and analyzed using Stata version 14. Descriptive statistics were used to summarize participant characteristics. Categorical variables were presented as frequencies and percentages, and comparisons between cases and controls were performed using the chi-square test. Multivariable logistic regression analyses were conducted to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for factors associated with low back pain. Two hierarchical models

were constructed. Model 1 was adjusted for demographic variables including age, sex, marital status, education level, and place of residence. Model 2 further adjusted for lifestyle factors, occupational exposure, BMI, smoking, drug abuse, physical activity, clinical conditions (diabetes, hypertension, musculoskeletal diseases), and mental health variables (depression and anxiety). To assess potential effect modification, interaction terms between sex and hard physical job and between sex and BMI were included in the fully adjusted model. A statistically significant interaction was observed between sex and hard physical job (OR for interaction = 0.80, 95% CI: 0.74–0.87; p < 0.001), indicating that the association between hard physical job and chronic low back pain differed by sex. Additionally, a significant interaction was identified between sex and BMI (OR for interaction = 0.82, 95% CI: 0.80–0.84; p < 0.001). Based on these findings, sex-stratified logistic regression analyses were conducted to estimate sex-specific associations between hard physical job, BMI categories, and chronic low back pain. Statistical significance was defined as a two sided p-value < 0.05.

3. Results

A total of 139499 adults were included in this population based case control study, comprising 36983 cases with chronic low back pain and 102516 controls without LBP. The baseline characteristics of the study participants are presented in Table 1. Significant differences were observed between cases and controls across all examined variables ($p < 0.001$). Participants with LBP were generally older, with the highest proportion of cases observed among individuals aged ≥58 years (39.4% in cases vs. 60.6% in controls). Men constituted a significantly higher proportion of cases compared with controls (41.4% vs. 58.6%, $p < 0.001$). Married individuals were more frequently observed among cases than among controls (24.5% vs. 75.5%, $p < 0.001$). Lower educational attainment was associated with a higher prevalence of LBP, with individuals having primary education showing the highest proportion of cases ($p < 0.001$). Participants residing in rural areas and cities with fewer than one million inhabitants exhibited a higher prevalence of LBP compared with those living in metropolitan areas ($p < 0.001$). Overweight and obese participants had a markedly higher prevalence of LBP compared with those with normal or underweight BMI ($p < 0.001$). Smoking and history of drug abuse were significantly more common among cases than controls ($p < 0.001$). Clinical conditions including hypertension, diabetes, hyperlipidemia, and other musculoskeletal diseases were significantly more prevalent among cases ($p < 0.001$). Psychological disorders, including anxiety and depression, were also significantly more frequent among individuals with LBP ($p < 0.001$). Engagement in hard physical work was substantially more common among cases (65.6% vs. 34.4%, $p < 0.001$), whereas regular physical activity was less frequent, suggesting a protective role. (Table1)

Table1: Characteristics of participants by low back pain

Variables	**Categories**	**Case**(n=36983) **Freq(%)**	**Control**(n=102516) **Freq(%)**	**P value***
Age	18-27	2061(19.0)	8777(81.0)	<0.001
	28-37	5092(15.1)	28732(84.9)	
	38-47	8530(22.2)	29959(77.8)	
	48-57	7564(35.2)	13946(64.8)	
	+58	13736(39.4)	21102(60.6)	
Gender	Female	24026(22.2)	84140(77.8)	<0.001
	Male	12957(41.4)	18376(58.6)	
Marital status	Single	6499(43.6)	8411(56.4)	<0.001
	Married	30484(24.5)	94105(75.5)	
Level of Education	Primary	9812(41.2)	14001(58.8)	<0.001
	High school	22577(26.0)	64307(74.0)	
	Diploma	3584(15.4)	19727(84.6)	
	College graduate	1010(18.4)	4481(81.6)	
Place of Residence	Rural	26642(32.6)	55024(67.4)	<0.001
	Under 1 million inhabitants	8056(34.0)	15661(66.0)	
	Suburb	1533(5.8)	24874(94.2)	
	Metropolis	752(9.8)	6957(90.2)	
Body Mass Index (BMI)	Normal	8346(21.0)	31353(79.0)	<0.001
	Under weight	2424(20.2)	9588(79.8)	
	Overweight	14188(28.0)	36469(72.0)	
	Obese	12025(32.4)	25106(67.6)	
History of Smoking	No	34793(26.3)	97589(73.7)	<0.001
	Yes	2190(30.8)	4927(69.2)	
History of Drug abuse	No	36714(26.5)	102079(73.5)	<0.001
	Yes	269(38.1)	437(61.9)	
History of Hypertension	No	33599(24.9)	101593(75.1)	<0.001

	Yes	3384(78.6)	923(21.4)	
History of Hyperlipidemia	No	33717(24.9)	101500(75.1)	<0.001
	Yes	3266(76.3)	1016(23.7)	
Musculoskeletal diseases	No	29014(22.4)	100315(77.6)	<0.001
	Yes	7969(78.4)	2201(21.6)	
History of Anxiety	No	35694(25.9)	101951(74.1)	<0.001
	Yes	1289(69.5)	565(30.5)	
History of Depression	No	35104(25.6)	101868(74.4)	<0.001
	Yes	1879(74.4)	648(25.6)	
History of Diabetes	No	34516(25.4)	101486(74.6)	<0.001
	Yes	2467(70.5)	1030(29.5)	
Hard physical job	No	25454(24.0)	80549(76.0)	<0.001
	Yes	21967(65.6)	11529(34.4)	
Physical activity	No	24437(28.5)	61446(71.5)	<0.001
	Yes	12546(23.4)	41070(76.6)	

* chi-square test

In Model 1 after adjustment for demographic factors age showed a significant association with LBP. Compared with individuals aged 18–27 years, those aged 38–47 years (OR = 1.24, 95% CI: 1.17–1.32, $p < 0.001$), 48–57 years (OR = 1.87, 95% CI: 1.76 –1.98, $p < 0.001$), and ≥58 years (OR = 1.72, 95% CI: 1.62–1.83, $p < 0.001$) had higher odds of LBP. Male sex was significantly associated with increased odds of LBP (OR = 2.10, 95% CI: 2.04 –2.16, $p < 0.001$). Married participants had lower odds compared with single individuals (OR = 0.50, 95% CI: 0.48– 0.52, $p < 0.001$). Higher educational levels were inversely associated with LBP (all $p < 0.001$). Living in cities with fewer than one million inhabitants was associated with higher odds of LBP (OR = 1.22, 95% CI: 1.18 –1.26, $p < 0.001$), whereas living in suburban (OR = 0.16, 95% CI: 0.15 – 0.17, $p < 0.001$) or metropolitan areas (OR = 0.30, 95% CI: 0.27–0.32, $p < 0.001$) was associated with lower odds. (Table2)

In Model 2 after further adjustment for lifestyle, occupational, psychological and clinical variables, male sex remained strongly associated with LBP (OR = 2.61, 95% CI: 2.53–2.70, $p < 0.001$). BMI showed a dose response relationship with LBP. Compared with normal BMI, underweight (OR = 1.42, 95% CI: 1.34 –1.50, $p < 0.001$), overweight (OR = 1.49, 95% CI: 1.44 –1.55, $p < 0.001$), and obese individuals (OR = 1.78, 95% CI: 1.72–1.85, $p < 0.001$) had significantly higher odds of LBP. Smoking was independently associated with LBP (OR = 1.18, 95% CI: 1.11–1.26, $p < 0.001$), whereas history of drug abuse was not

statistically significant (OR = 1.13, 95% CI: 0.95–1.35, p = 0.163). Hypertension (OR = 1.20, 95% CI: 1.09 –1.32, p < 0.001), diabetes (OR = 1.95, 95% CI: 1.77–2.14, p < 0.001), and musculoskeletal diseases (OR = 8.02, 95% CI: 7.56 –8.51, p < 0.001) were significantly associated with increased odds of LBP. Anxiety (OR = 1.68, 95% CI: 1.48–1.91, p < 0.001) and depression (OR = 1.64, 95% CI: 1.46 –1.84, p < 0.001) were also independently associated with LBP. Hard physical work was one of the strongest risk factors for LBP (OR = 2.34, 95% CI: 2.26 –2.42, p < 0.001), while physical activity was inversely associated with LBP (OR = 0.88, 95% CI: 0.85– 0.91, p < 0.001). (Table2)

Table 2. Multivariable logistic regression models for Risk factors of low back pain

Variables	Categories	Model 1		Model 2	
		OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	18-27	1	-	1	-
	28-37	0.83(0.78-0.89)	<0.001	0.78(0.73-0.83)	<0.001
	38-47	1.24(1.17-1.32)	<0.001	1.08(1.01-1.15)	0.011
	48-57	1.87(1.76-1.98)	<0.001	1.53(1.43-1.64)	<0.001
	+58	1.72(1.62-1.83)	<0.001	1.38(1.29-1.47)	<0.001
Gender	Female	1	-	1	-
	Male	2.10(2.04-2.16)	<0.001	2.61(2.53-2.70)	<0.001
Marital status	Single	1	-	1	-
	Married	0.50(0.48-0.52)	<0.001	0.47(0.45-0.49)	<0.001
Level of Education	Primary	1	-	1	-
	High school	0.76(0.73-0.79)	<0.001	0.72(0.69-0.75)	<0.001
	Diploma	0.64(0.60-0.67)	<0.001	0.62(0.58-0.66)	<0.001
	College graduate	0.72(0.67-0.79)	<0.001	0.77(0.71-0.85)	<0.001
Place of Residence	Rural	1	-	1	-
	Under 1 million inhabitants	1.22(1.18-1.26)	<0.001	1.21(1.16-1.25)	<0.001
	Suburb	0.16(0.15-0.17)	<0.001	0.14(0.13-0.15)	<0.001
	Metropolis	0.30(0.27-0.32)	<0.001	0.27(0.25-0.30)	<0.001
Body Mass Index (BMI)	Normal	-	-	1	-
	Under weight	-	-	1.42(1.34-1.50)	<0.001

	Overweight	-	-	1.49(1.44-1.55)	<0.001
	Obese	-	-	1.78(1.72-1.85)	<0.001
History of Smoking	No	-	-	1	-
	Yes	-	-	1.18(1.11-1.26)	<0.001
History of Drug abuse	No	-	-	1	-
	Yes	-	-	1.13(0.95-1.35)	0.163
History of Hypertension	No	-	-	1	-
	Yes	-	-	1.20(1.09-1.32)	<0.001
Musculoskeletal diseases	No	-	-	1	-
	Yes	-	-	8.02(7.56-8.51)	<0.001
History of Anxiety	No	-	-	1	-
	Yes	-	-	1.68(1.48-1.91)	<0.001
History of Depression	No	-	-	1	-
	Yes	-	-	1.64(1.46-1.84)	<0.001
History of Diabetes	No	-	-	1	-
	Yes	-	-	1.95(1.77-2.14)	<0.001
Hard physical job	No	-	-	1	-
	Yes	-	-	2.34(2.26-2.42)	<0.001
Physical activity	No	-	-	1	-
	Yes	-	-	0.88(0.85-0.91)	<0.001

Model 1 was adjusted for age, gender, education level, place of Residence, and marital status.
Model 2 was adjusted for age, gender, education level, place of Residence, marital status, physical activity, hard physical job, body mass index, history of smoking status, history of drug abuse, history of depression, history of anxiety, history of diabetes, history of hypertension, and musculoskeletal diseases.

A significant interaction was observed between sex and hard physical work (OR for interaction = 0.80, 95% CI: 0.74 – 0.87, $p < 0.001$). In sex stratified analyses, hard physical work increased the odds of LBP in both women (OR = 2.60, 95% CI: 2.51–2.70, $p < 0.001$) and men (OR = 2.12, 95% CI: 1.98–2.27, $p < 0.001$), with a stronger association observed among women. A statistically significant interaction between sex and BMI was identified (OR for interaction = 0.82, 95% CI: 0.80 – 0.84, $p < 0.001$). Sex stratified analyses demonstrated that increasing BMI was associated with higher odds of LBP in both women and men. Among women, underweight (OR = 1.71, 95% CI: 1.60 –1.83, $p < 0.001$), overweight (OR = 1.78, 95% CI: 1.70 –1.87, $p < 0.001$), and obese status (OR = 2.00, 95% CI: 1.91–2.11, $p < 0.001$) were associated with progressively higher odds of LBP. Among men, although BMI was also positively associated with LBP, the magnitude of associations was smaller compared with women across all BMI categories ($p < 0.001$). (Table3) (Table4) (Figure 1)

Table 3. Association between hard physical job and low back pain stratified by Gender

Gender	Hard job	OR (95% CI)	P value
Female	No	1.00	-
	Yes	2.60(2.51-2.70)	<0.001
Male	No	1.00	-
	Yes	2.12(1.98-2.27)	<0.001

Table 4. Association between BMI and low back pain stratified by Gender

BMI category	OR (95% CI) – Women	P value	OR (95% CI) – Men	P value
Normal	1	-	1	-
Under weight	1.71(1.60-1.83)	<0.001	1.62(1.42-1.84)	<0.001
Overweight	1.78(1.70-1.87)	<0.001	1.15-1.09-1.22)	<0.001
Obese	2.00(1.91-2.11)	<0.001	1.54-1.43-1.65-	<0.001

4. Discussion

We found several demographic, lifestyle, occupational, psychological and clinical characteristics to be independently associated with LBP among adults in this population based case control study. Older age and male sex were significantly associated with increased odds of low back pain, underlining the substantial burden of this condition among elderly and working age groups. Marital status, education and place of residence as well were significant predictors indicating a possible effect of social contextual factors on the occurrence of low back pain. Both lifestyle and clinical factors had a large contribution to the risk of low back pain. In terms of low back pain, there was a straightforward dose–response trend with higher body mass index: the more obese an individual, the higher the odds for

developing low back pain. Low back pain was independently related to smoking but not to the practice of exercise. Furthermore, diseases such as hypertension and diabetes but specially other musculoskeletal disorders were strongly linked with Low Back Pain occurrences, suggesting the influence of metabolic and structural factors on pain vulnerability. The psychological correlates were also identified as major correlates where both anxiety and depression had significantly higher odds of low back pain reporting. Occupational exposures were found to be dominant, and heavy physical work was established as one of the most important risk factors for LED. Interesting interaction effects with sex was found for hard physical work, and BMI, and results in stratified analysis indicated stronger associations for women.

Our study discovered a link between gender and LBP. In line with previous research, we discovered that the LBP was higher in females than in males(14–17). Females have a lower pain threshold than men, so they are more likely to report LBP symptoms than men(18, 19). Additional studies have shown that women face an increased risk of LBP because of hormonal fluctuations. The hormonal changes that take place during pregnancy lead to the loosening of spinal ligaments, which weakens the lower back muscles and heightens the likelihood of LBP. Females tend to have a lower pain threshold than men, therefore they often report the symptoms of LBP than men(20, 21). Based on the multivariate analysis, this study showed that increasing age was a significant predictor of LBP. This is consisting with the findings of other studies(22–25). Unlike our study Morris Kahere et all showed that increasing age was not a significant predictor of LBP(26).In line with previous findings(17, 26, 27), our findings indicated that BMI was a significant risk factor for LBP. Also this is consistent with the findings of Iizula et al(22). Possible explanations include (1) increasing mechanical compression in the lumbar spine during movements in obese people possibly enhances mechanical burden, (2) the chance of experiencing an accident may therefore enhance the risk of LBP, and (3) adipose tissues generate certain proinflammatory cytokines (e.g., tumor necrosis factor-α, interleukin-6) that initiate the release of C-reactive protein (CRP), and this statement was supported by the fact that females with normal waist circumference and high CRP have tendency to report LBP than females with low CRP(28, 29).This study showed that lack of regular physical activity was a significant predictor of LBP. Similar results have been observed in previous studies(28, 30). Physical activity is recognized for its ability to lower all-cause mortality and the risk factors associated with various chronic conditions, including cardiovascular and respiratory diseases, diabetes, obesity, and musculoskeletal disorders(31, 32).Higher smoking rates were identified as a notable predictor of LBP. These findings align with the outcomes of comparable research(33–36). Multiple potential explanations have been employed to elucidate this connection. Smoking diminishes bone mineral content, heightening the likelihood of osteoporosis and micro injuries to the vertebral body, leading to a faster degenerative spinal process(37, 38). Secondly, smoking heightens coughing, leading to increased intradiscal and intraabdominal pressures, which raises the likelihood of disc herniation(26, 39). Finally, smoking diminishes blood circulation to the disc, which ultimately impacts the metabolic equilibrium of the disc, leading to disc degeneration(26, 39). Nonetheless, research on this subject employing prospective approaches is necessary.

Psychosocial elements have a significant influence on the development of LBP. LBP is regarded as a longterm primary pain influenced by multiple factors and linked to significant emotional disorders or impairments(40). Psychological elements were the main factor influencing LBP triggers(41). Research indicates that adverse emotions, like depression, may forecast unfavorable pain and functional results(42, 43). In the present research, depression and anxiety emerged as a significant predictor, both in the subgroups and overall. A different cross-sectional study found a prevalence of 41.8% for LBP alongside depressive symptoms(44). These studies indicate that the high-risk group requires increased focus and prioritization for the prompt detection and intervention of LBP. In line with previous findings(45–47) our findings indicated that hard physical job was a significant risk factor for LBP. Engaging in tasks that require lifting, carrying, or other physically demanding activities during youth is linked to an increased severity of lower back pain (LBP) in older employees who currently have sedentary jobs. These findings suggest that early working life may have an impact on later working years and underscore the necessity for careful introduction and instruction to the working environment for retaining musculoskeletal health and prolonging working life(45).

Musculoskeletal disorders are public health problems in several countries. In our study we find musculoskeletal disorders significant high influence on the low back pain. Karahan et al. found the highest prevalence of musculoskeletal disorders (77.1%) in a sample health care worker in Turkey(48). In Europe one multicenter study showed a prevalence of 16% of LBP and increased to 32% in the middle of the lumbar area(49). In Italy the prevalence was higher ranging from 36% to 86%(50).In our study diabetes was significantly associated with increased odds of LBP. Both type 1 and type 2 diabetes lead to neuropathy in around 90% of the patients within 25 years of their diagnosis with signs and symptoms that include muscle weakness, lack of coordination, and pain gradually spreading from the lower side of the body to the back and neck(51, 52). Diabetes and low back pain are somehow connected, and pain is one of the leading symptoms of diabetic neuropathy(53).

We observed a statistically significant interaction between sex and hard physical job, indicating that the strength of the association between physically demanding work and chronic low back pain (LBP) varied by gender. In line with recent demographic investigations, occupational groups with higher physical demands tend to exhibit different patterns of LBP prevalence between women and men. Socio-demographic analyses have demonstrated that the prevalence of LBP is higher in women compared to men across varied work environments, and that the relative importance of predictors such as atypical work hours and occupational category differs by sex, suggesting gender-specific vulnerability to occupational stressors(54). Mechanistically, this may reflect sex related differences in musculoskeletal function and pain experiences reported in experimental studies on chronic LBP patients: males and females show distinct patterns of movement quality and pain sensitivity, which are likely to influence how physically demanding jobs affect LBP risk(55). This interaction highlights the importance of considering sex as an effect modifier rather than a simple confounder in occupational LBP research, as the same level of physical workload may confer differential risk in women versus men due to biomechanical and pain processing differences. A significant interaction between sex and body mass index (BMI) was also identified, indicating that BMI's association with chronic LBP differs by gender.

Recent population-level evidence shows that obesity increases the odds of chronic LBP, after adjusting for sex, age, and physical demands; importantly, women in the general adult population have both higher LBP prevalence and higher odds ratios associated with obesity than men(56). Moreover, global burden projections underscore that high BMI related LBP is increasing worldwide and that disability rates are persistently higher among females across age strata, reinforcing the notion of sex-specific risk trajectories linked to adiposity(57).

This study has several important strengths that should be acknowledged. First, the large sample size derived from a nationwide electronic health record system provided substantial statistical power to detect associations and enabled detailed subgroup and interaction analyses. The population based case control design, including participants from both urban and rural settings, enhances the generalizability of the findings to the adult population. Second, the availability of comprehensive demographic, lifestyle, occupational, clinical, and mental health data allowed for adjustment of a wide range of potential confounders, reducing the likelihood of residual confounding. Third, the use of standardized data collection procedures, trained healthcare personnel, and built in validation and quality control mechanisms within the SINA system strengthens the reliability and internal validity of the data. Finally, the assessment of effect modification by sex, through interaction and stratified analyses, provides novel insight into gender-specific risk patterns that are often overlooked in epidemiological studies of low back pain. Despite these strengths, several limitations should be considered when interpreting the results. Due to the observational case control design, causal inferences cannot be definitively established, and reverse causation remains possible for some associations, particularly for lifestyle and psychological factors. Low back pain status was based on self report and routine clinical records rather than standardized clinical examinations, which may have led to misclassification. Additionally, information on pain severity, duration, imaging findings, ergonomic factors, and detailed occupational exposures was not available in the database, limiting more granular analyses. Some lifestyle variables, such as physical activity and smoking, were self-reported and therefore subject to recall and reporting bias. Finally, although extensive adjustments were performed, unmeasured confounders cannot be entirely ruled out.

5. Conclusions

In this community based study, chronic low back pain in adults was associated with many demographic, lifestyle, occupational and psychological factors. Older age, male sex, high BMI, smoking, heavy physical work, metabolic and musculoskeletal comorbidity as well as psychological conditions were the most relevant risk factors whereas regular sports activities had a protective association. Differences in the effects on low back pain between heavy physical work and BMI were found by sex, with stronger associations among women. These results emphasize that chronic low back pain is multifactorial and that sex-specific and occupation-targeted measures should be preventive lines. Modifiable risk factors can be targeted and intervention strategies applied to reduce the burden of LBP in adult populations.

Declarations

Acknowledgements

Not Applicable.

Authors' contributions

AM is the principal investigator and research leader. MN and EM designed the Study and drafted the manuscript and analyzed the data. SA contributed to the conception, design, data interpretation, and revising the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

Ethical approval was obtained from Mashhad University of Medical Sciences (Approval Code: IR.MUMS.FHMPM.REC.1404.183). The study utilized secondary data that were anonymized.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number: not applicable

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Figures

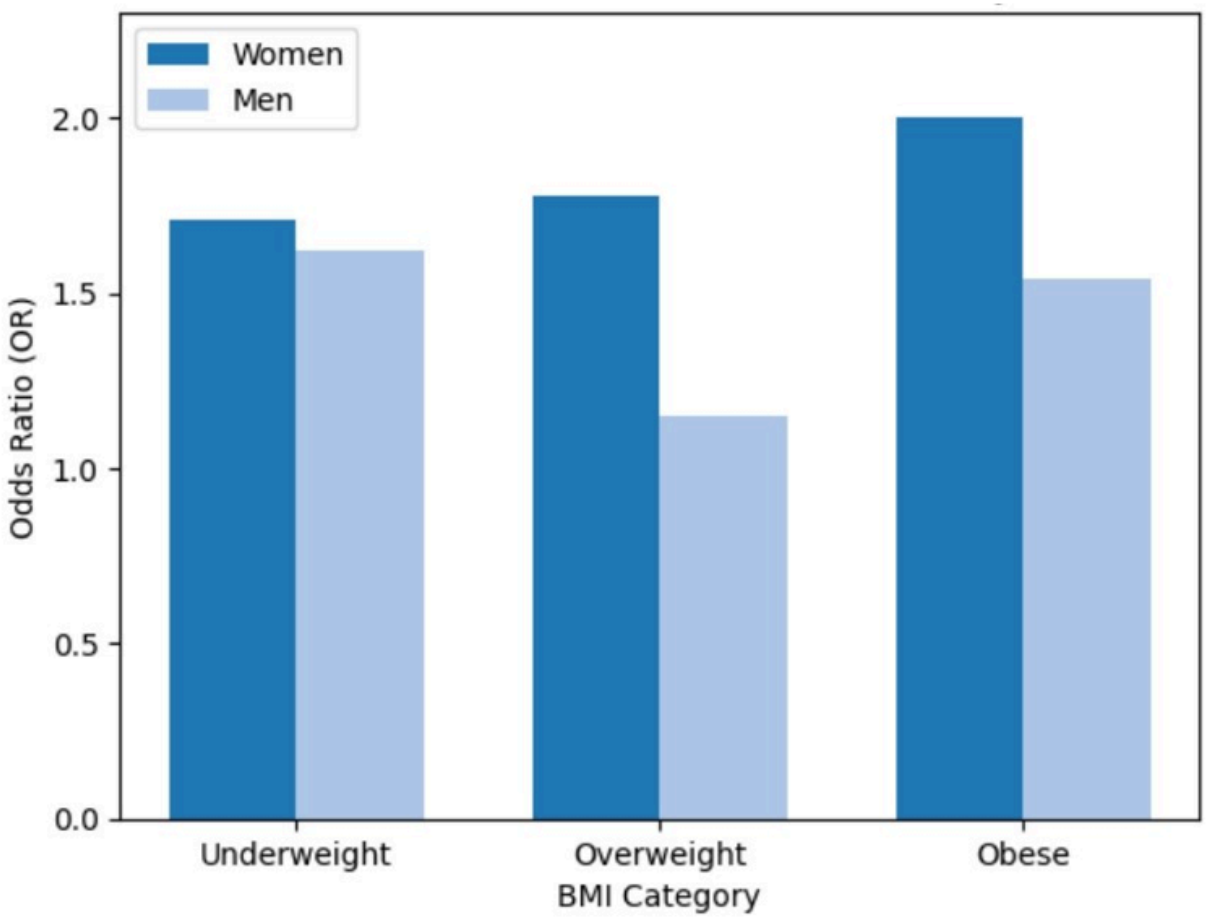

Figure 1

Adjusted odds ratio of Association between BMI and low back pain stratified by Gender