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SYSTEMATIC REVIEW

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# Prevalence of and risk factors for low back pain among professional drivers: a systematic review and meta-analysis

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## Abstract

**Purpose** A growing body of research indicates a correlation between occupational exposure, particularly among individuals in driving-related occupations, and the incidence of low back pain (LBP).

**Methods** Databases were systematically searched, including PubMed, Embase, Web of Science, Cochrane Library, and SinoMed, from their inception through December 2023 for relevant studies of the prevalence and risk factors of LBP among professional drivers. Subsequent meta-analyses were performed utilizing Stata 17.0 and RevMan 5.4 software, while risk factor indicators were assessed using the Grading of Recommendations, Assessment, Development and Evaluation evidence quality grading system.

**Results** A systematic review and meta-analysis comprising 19 studies involving 7,723 patients indicated that the incidence of LBP among drivers was 39% (95% confidence interval [CI] 0.20–0.57) in the past 7 days and 53% (95% CI 0.43–0.63) in the past 12 months. A subgroup analysis revealed a prevalence of 48% (95% CI 0.33–0.64) in 2005–2015 and 56% (95% CI 0.42–0.70) in 2016–2023. Among the identified factors, robust evidence highlighted age ≥ 41 years (odds ratio [OR] = 2.10; 95% CI 1.36–3.24; P = 0.0008), alcohol consumption (OR = 1.75; 95% CI 1.31–2.34; P = 0.0001), sleeping < 6 h/night (OR = 1.60; 95% CI 1.13–2.24; P = 0.007), uncomfortable seating (OR = 1.71; 95% CI 1.23–2.36; P = 0.001), improper driving posture (OR = 2.37; 95% CI 1.91–2.94; P < 0.00001), and manual handling (OR = 2.23; 95% CI 1.72–2.88; P < 0.00001) as significant risk factors for LBP. There was moderate evidence of a lack of exercise (OR = 1.78; 95% CI 1.37–2.31; P < 0.0001), working > 10 h/day (OR = 2.49; 95% CI 1.89–3.28; P < 0.00001), > 5 years' driving experience (OR = 2.12; 95% CI 1.66–2.69; P < 0.00001), a lack of back support (OR = 1.81; 95% CI 1.25–2.62; P = 0.002), high work-related pressure (OR = 2.04; 95% CI 1.59–2.61; P < 0.00001), and job dissatisfaction (OR = 1.57; 95% CI 1.23–2.01; P = 0.0003) as moderate risk factors. There was no evidence of body mass index or smoking as risk factors for LBP among professional drivers.

**Conclusion** The current evidence indicates an increasing annual trend in the prevalence of LBP among professional drivers. Factors including age ≥ 41 years, alcohol consumption, and sleeping < 6 h/night were among the 12 influential factors contributing to LBP in professional drivers. Enhancing awareness of these factors and formulating targeted preventive strategies may be beneficial.

**Keywords** Low back pain, Professional drivers, Risk factors, Incidence, Meta-analysis

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## Introduction

Low back pain (LBP) is an exceedingly prevalent ailment affecting more than 540 million individuals worldwide annually. Research assessing 194 countries/regions revealed LBP as a primary contributor to global productivity decline and a significant disability-related factor across 126 countries/regions, resulting in substantial economic and healthcare burdens [1, 2]. LBP has various pathogenic mechanisms and is a popular research topic in the academic community. Examples include inflammatory stimulation, mechanical injury, and nutritional deficiency. Moreover, improper lifestyle as well as psychological and social factors are closely related to its occurrence [3–6].

Exposure to physically demanding work is reportedly associated with a higher likelihood of LBP, particularly in professions that require heavy lifting and frequently involve nonergonomic postures [7–9]. Drivers constitute a high-risk group for occupational LBP owing to their exposure to various potential pathogenic factors, including whole-body vibration (WBV), prolonged periods of sitting, the lifting of heavy objects, and extended working hours [10]. Research on driver populations in the United States and Sweden revealed that approximately 80% of American drivers versus 50% of Swedish bus drivers reported experiencing LBP, a notably higher proportion than the general worker population [11].

No definitive conclusions have been reached to date regarding the risk factors of LBP in the driving population. Recent studies suggest that multiple factors could potentially be linked to LBP onset among drivers; according to Abere et al., among 265 drivers working over 10 h daily, 245 had LBP [12]. In contrast, Rufa'i et al. reported no substantial correlation between daily working hours and LBP prevalence among drivers [13]. While some studies indicated that drivers who completed insufficient exercise have an elevated occurrence of LBP, Bayana presented a contrasting perspective [12, 14–18]. Debate persists regarding the association between age, body mass index (BMI), smoking, alcohol intake, sleep duration, manual handling, driving experience, seat comfort, back support, driving posture, work-related pressure, and job satisfaction with LBP among professional drivers.

Hence, to ensure timely diagnosis and treatment, it is essential that clinicians understand the pertinent factors that lead to LBP among drivers. This meta-analysis aimed to identify the prevalence and risk factors associated with LBP in the driving community and offer insights and guidance for early intervention among affected groups and healthcare practitioners.

## Methods

### Literature search strategy

Two researchers independently conducted a rigorous search of five databases, namely PubMed, Embase, Web of Science, Cochrane Library, and China Biology Medicine, covering their records until December 2023. To ensure a thorough search, they combined controlled and free terms and meticulously tracked and retrieved references. The key search terms included intervertebral disk degeneration, lower back pain, automobile driving, driver population, risk factors, and incidence. A comprehensive overview of the search strategy is provided in the appendix.

### Inclusion and exclusion criteria

The inclusion criteria were (1) study population; drivers aged ≥ 18 years experiencing LBP, (2) study content; examination of factors potentially causing LBP and determination of the incidence or prevalence of LBP in drivers, (3) outcome measures; findings directly extracted or converted into odds ratios (OR) and 95% confidence intervals (CI), (4) study design; using cohort, cross-sectional, and case–control study methodologies, and (5) language; studies published in Chinese and English languages. The exclusion criteria were (1) duplicate studies, conference abstracts, and other redundant materials, (2) requirement for clear and consistent diagnostic criteria for the identification of LBP, (3) studies with inaccessible full texts or missing data, (4) evaluation based on suboptimal quality assessments, and (5) research merging with other arbitrary diseases.

### Quality assessment

The Newcastle–Ottawa Scale (NOS; maximum score, 9 points) was used to evaluate the quality of the incorporated cohort and case–control studies. Studies scoring 0–4, 5–6, or 7–9 points were categorized as low, moderate, and high quality, respectively [19]. This cross-sectional study used the quality assessment tool recommended by the Agency for Healthcare Research and Quality (AHRQ) in the United States, which includes 11 evaluation indicators. Each indicator was scored as "yes" (1 point), "no" (0 points), or "unclear" (0.5 points). Ultimately, scores of 0–3 indicate low quality, 4–7 indicate moderate quality, and 8–11 indicate high quality [20]. This study incorporated both high- and moderate-quality literature. The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) Scale was used to assess the strength of the recommendations. The quality assessments were performed independently by two assessors.

Any discrepancies were addressed through discussion or consultation with a third researcher to reach consensus.

### Data extraction

Two researchers independently conducted the literature screening and data extraction processes, cross-referenced the findings, and resolved any discrepancies through discussion. After eliminating duplicate publications using EndNote version 20, they conducted a preliminary title and abstract screening before progressing to a full-text review. The extracted data included primary author, publication year, country of origin, study design, population source, total sample size, number of occurrences, and assessment tools used.

### Statistical analysis

The occurrence rate of LBP, along with the OR and 95% CI of risk factors among drivers, were synthesized for the effect size using Stata 17.0 and RevMan 5.4. Using the $I^2$ statistic and Cochran's Q test to assess heterogeneity among the included studies, if $I^2>50\%$ and $p \leq 0.1$, significant heterogeneity among the studies is indicated, prompting the use of a random-effects model, whereas if $I^2<50\%$ and $p>0.1$, minor heterogeneity among the studies is suggested, warranting the use of a fixed-effects model. Further exploration of the sources of heterogeneity was conducted through subgroup and sensitivity analyses to verify the stability of the combined occurrence rates and risk factor results. Studies with ≥ 10 publications undergo Egger's test and funnel plots are used to evaluate publication bias.

## Results

### Literature search

A total of 2,328 articles were retrieved, of which 770 duplicates were eliminated. The subsequent title and abstract screening led to the exclusion of 1,402 articles. The full-text evaluation of the remaining 156 articles led to the exclusion of 137, resulting in the final inclusion of 19 articles, representing a total of 7,723 patients (Fig. 1).

### Characteristics of included studies

The 19 included publications (7723 patients) consisted of 17 cross-sectional studies, one case–control study, and one cohort study. The studies were conducted across different continents: seven studies in Africa (seven in Ethiopia [12, 15, 17, 18, 21, 22], one in Nigeria [13]), six in Asia (two in China [16, 23]; one each in Malaysia [24], Singapore [25], India [26], and Bangladesh [27]), three in Europe (two in Italy [28, 29], one in Turkey [14]), and three in North America (two in the United States [30, 31], one in Mexico [32]). Based on the NOS and AHRQ scores, 18 studies were rated as high-quality and one as moderate-quality. Fourteen risk factors were identified: six received a high recommendation based on GRADE score and the rest were moderately recommended. Study characteristics are presented in Table 1.

### Occurrence of LBP in professional drivers

Utilizing a random-effects model, the incidence of LBP within 7 days among the professional drivers was 39% (95% CI 0.20–0.57), demonstrating substantial heterogeneity ($I^2=97.2\%$; $P<0.000$) (Fig. 2). Applying the random-effects model, the prevalence of LBP within 12 months in the driver population was 53% (95% CI 0.43–0.63), further indicating significant interstudy heterogeneity ($I^2=98.6\%$; $P<0.001$) (Fig. 3).

Subsequent to the additional subgroup analysis, the annual prevalence of lower back pain in drivers was investigated. If stratified by publication year, the prevalence rates were 48% and 56% (95% CI 0.33–0.64 and 0.42–0.70) from 2005 to 2015 and 2016 to 2023, respectively (Fig. 4). Based on the state of national development, the prevalence was 46% and 57% (95% CI 0.31–0.60 and 0.43–0.71) in developed and underdeveloped countries, respectively (Fig. 5). For vehicle classification, the prevalence rates stood at 22% (95% CI 0.13–0.31) for tricycle drivers, 56% (95% CI 0.43–0.70) for car drivers, and 61% (95% CI 0.47–0.74) for drivers of larger vehicles (Fig. 6).

Provided the pronounced heterogeneity in the pooled findings regarding the prevalence of LBP among drivers over the previous week and year, sensitivity analyses were performed using Stata17 to systematically eliminate studies on the prevalence rates of LBP among drivers over these timeframes. Following the meticulous exclusion of each study, the final aggregated outcomes did not display any notable variance, underscoring the robustness of the results (Fig. 7 and 8).

### Risk factors

In more than two studies, the following 14 risk factors of LBP were identified: age ≥ 41Y, alcohol consumption, lack of sleep, lack of exercise, high BMI, smoking, seat discomfort, poor driving posture, handling heavy objects, extended daily working hours, extended years of driving, lack of back support, high job stress, and low job satisfaction. According to GRADE score, six risk factors were highly recommended, whereas the rest were moderately recommended (Table 2).

### Patient-related factors

**Age:** Four studies examined the relationship between age and the occurrence of LBP in the driver population [18, 27, 28, 30]. Significant heterogeneity was observed among the studies ($I^2=74\%$; $P=0.01$) (Fig. 9A). Following

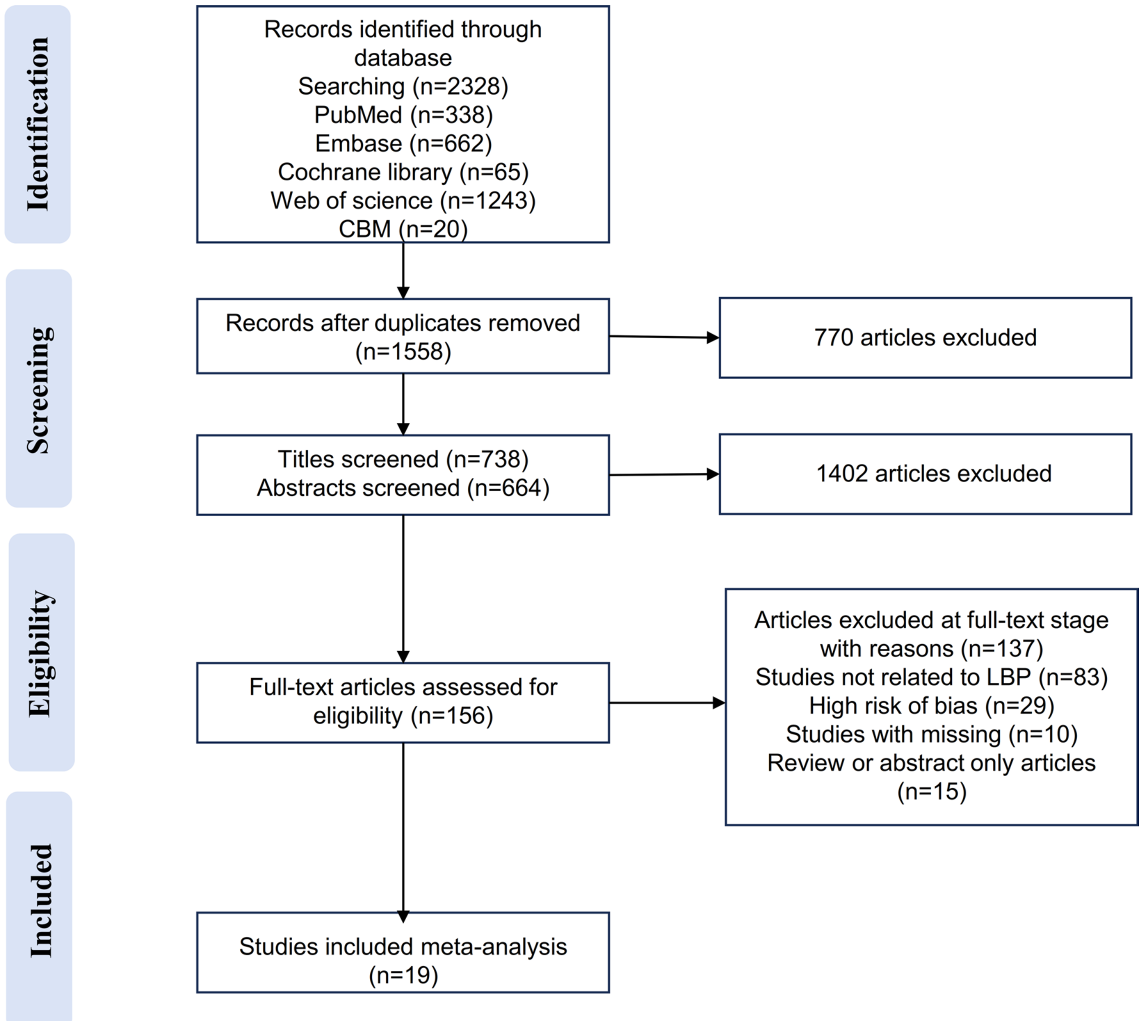


**Fig. 1** Literature search results

the sensitivity analysis, Buegel's study was identified as the primary source of the heterogeneity [30]. Upon the exclusion of this study, no heterogeneity was observed among studies ($I^2 = 0\%$; $P = 0.89$) (Fig. 9B). The use of a fixed-effects model provided substantial evidence that age ≥ 41 years was a risk factor for LBP among professional drivers (OR = 2.10; 95% CI 1.36–3.24; P = 0.0008).

**Alcohol:** Four studies examined the association between alcohol consumption and LBP incidence of LBP in drivers [12, 15, 18, 28]. A heterogeneity test ($I^2 = 0\%$, $P = 0.43$) performed using a fixed-effects model provided robust evidence that alcohol consumption was a significant risk factor for LBP among the drivers (OR = 1.75; 95% CI 1.31–2.34; P = 0.0001) (Fig. 10).

**Sleep:** Three studies explored the correlation between sleep patterns and LBP incidence among the drivers [16, 17, 27]. A heterogeneity test ($I^2 = 0\%$; $P = 0.38$) performed using a fixed-effects model provided compelling evidence that sleeping < 6 h/night was a risk factor for LBP in this population (OR = 1.60; 95% CI 1.13–2.24; P = 0.007) (Fig. 11).

**Exercise:** Five studies examined the relationship between a lack of exercise and the incidence of LBP in the driving population [12, 15–18]. Substantial heterogeneity was noted across studies ($I^2 = 73\%$; $P = 0.002$) (Fig. 12A). Through a sensitivity analysis, the Bayana study was identified as the primary contributor to this heterogeneity [18]. Upon the exclusion of this study, no significant heterogeneity was observed among studies ($I^2 = 0\%$; $P = 0.90$) (Fig. 12B). A fixed-effects model revealed moderate evidence supporting the association between a lack of exercise and an increased risk of LBP in drivers (OR = 1.78; 95% CI 1.37–2.31; P < 0.0001).

**BMI and smoking:** Five studies examined the correlation between BMI and LBP among drivers [12, 14, 16, 28, 30]. The findings indicated that a high BMI (≥ 28 $kg/m^2$)

**Table 1** Characteristics of included studies

| Author (Year) | Country | Study type | population | Age(mean ± sd) | No. of total cases | Prevalence of LBP | | Quality assessment tool | Quality score |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | The last 7 days | The past 12 months | | |
| Abere et al. [12] | Ethiopia | Cross-sectional study | Taxi driver | – | 371 | 53.4% | 85.7% | AHRQ | 7 |
| Awang Lukman et al. [24] | Malaysia | Cross-sectional study | Commercial vehicle driver | 40.5 ± 7.6 | 110 | 35.6% | – | AHRQ | 8 |
| Bayana et al. [18] | Ethiopia | Cross-sectional study | Pedicab driver | 27.9 ± 5.5 | 396 | – | – | AHRQ | 7 |
| Bovenzi et al. [29] | Italy | Cross-sectional study | Professional driver | – | 598 | 26.8% | 62.2% | AHRQ | 9 |
| Bovenzi (28) | Italy | Cohort study | Professional driver | – | 537 | – | 36.3% | NOS | 8 |
| Burgel and Elshatarat (30) | USA | Cross-sectional study | Taxi driver | 45.3 ± 10.8 | 129 | – | 62.8% | AHRQ | 8 |
| Chen et al. [31] | USA | Cross-sectional study | Taxi driver | 44.5 ± 8.7 | 1242 | – | 51.0% | AHRQ | 7 |
| Jadhav [26] | India | Cross-sectional study | Bus driver | – | 178 | – | 67.4% | AHRQ | 7 |
| Kurtul and Güngördü [14] | Turkey | Cross-sectional study | Taxi driver | 43.6 ± 11.9 | 447 | – | 49.7% | AHRQ | 8 |
| Nabi et al. [27] | Bangladesh | Cross-sectional study | Bus driver | 41.1 ± 7.8 | 368 | – | – | AHRQ | 8 |
| Noda et al. [25] | Singapore | Cross-sectional study | Pedicab driver | 38.6 ± 10.7 | 200 | – | 17.5% | AHRQ | 8 |
| Prado-León et al. [32] | Mexico | Case–control study | Professional driver | / | 231 | – | – | AHRQ | 7 |
| Rufa'i et al. [13] | Nigeria | Cross-sectional study | Long-distance driver | 42.5 ± 11.6 | 200 | – | 73.5% | AHRQ | 7 |
| Terfa et al. [21] | Ethiopia | Cross-sectional study | Pedicab driver | 27.9 ± 5.5 | 396 | – | 26.3% | AHRQ | 8 |
| Wanamo et al. [15] | Ethiopia | Cross-sectional study | Taxi driver | 35.3 ± 10.1 | 422 | – | 64.2% | AHRQ | 8 |
| Wang et al. [23] | China | Cross-sectional study | Taxi driver | 40.1 ± 5.8 | 719 | – | 54.0% | AHRQ | 9 |
| Wu et al. 2019 [16] | China | Case–control study | Taxi driver | 36.9 ± 4.9 | 465 | – | – | NOS | 7 |
| Yitayal et al. [22] | Ethiopia | Cross-sectional study | Taxi driver | 39.6 ± 10.7 | 294 | – | 27.9% | AHRQ | 9 |
| Yosef et al. [17] | Ethiopia | Cross-sectional study | Long-distance driver | 37.7 ± 9.1 | 400 | – | 65.0% | AHRQ | 7 |

was not a significant determinant of LBP in this population (OR = 1.18; 95% CI 0.64–2.19; P = 0.59), showcasing notable heterogeneity ($I^2 = 75\%$; P = 0.003) (Fig. 13A).

Six studies investigated the association between smoking and LBP in drivers [12, 16, 17, 26–28]. The results revealed that smoking did not display a significant relationship with LBP in drivers (OR = 1.46; 95% CI 0.77–2.76; P = 0.24), with considerable heterogeneity observed ($I^2 = 73\%$; P = 0.002) (Fig. 13B).

Employing the one-by-one exclusion method for the sensitivity analysis of smoking and BMI revealed that the combined effect values remained stable, with no significant changes after excluding each article. This indicates the reliability and consistency of the meta-analysis results.

### *Work-related factors*

**Seat comfort:** Three studies investigated the association between car seat comfort and the incidence of LBP among drivers [15, 21, 27]. The heterogeneity test ($I^2 = 0\%$; P = 0.84) using a fixed-effects model revealed compelling evidence supporting the notion that an

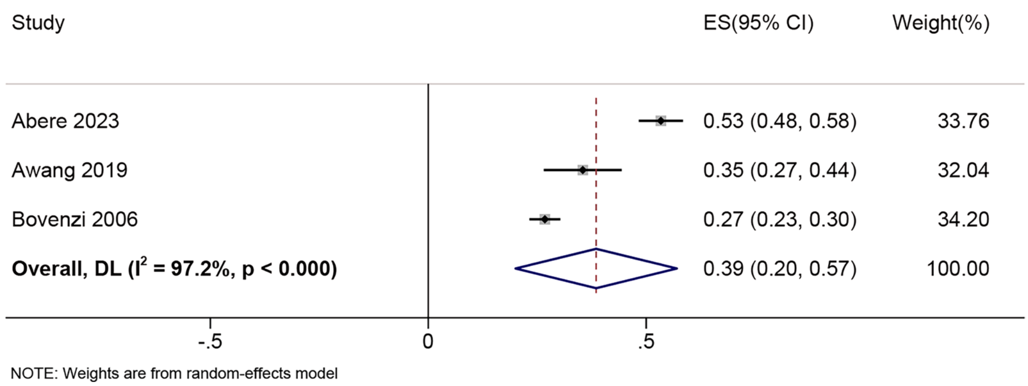


**Fig. 2** Occurrence of LBP within 7 days among the professional drivers

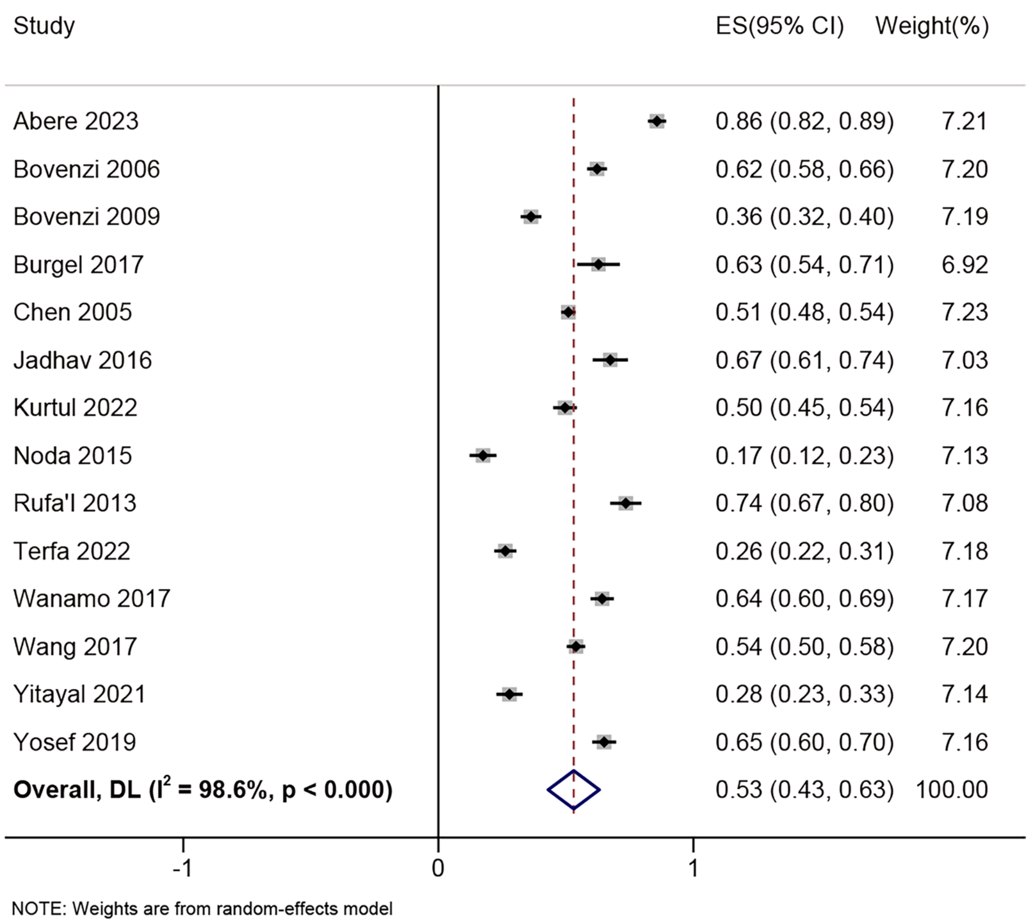


**Fig. 3** Occurrence of LBP within 12 months among the professional drivers

uncomfortable car seat was a risk factor for LBP in drivers (OR = 1.71; 95% CI 1.23–2.36; P = 0.001) (Fig. 14).

**Driving posture:** Five studies examined the correlation between driving posture and the prevalence of LBP among drivers [17, 21, 28, 29, 31]. The heterogeneity test ($I^2 = 0\%$; P = 0.68) conducted with a fixed-effects model unveiled substantial evidence indicating that an improper driving posture was a risk factor for LBP in drivers (OR = 2.37; 95% CI 1.91–2.94; P < 0.00001) (Fig. 15).

**Handling of heavy objects:** Five studies investigated the correlation between engaging in manual handling of heavy objects and the incidence of LBP among

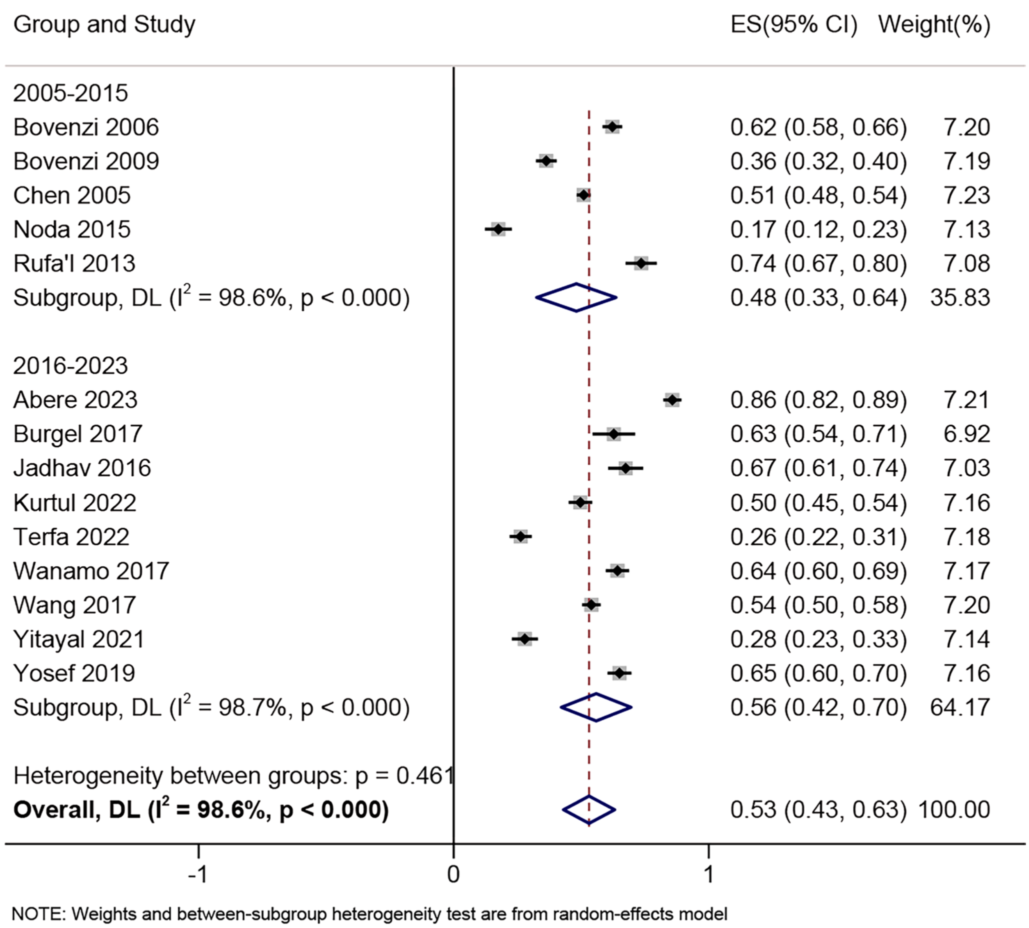


**Fig. 4** Occurrence of LBP within 12 months among the professional drivers of different year

drivers [15, 17, 24, 28, 32]. Through the heterogeneity test ($I^2=0\%$; $P=0.48$) employing a fixed-effects model, compelling evidence emerged supporting the association between the manual handling of heavy objects and an increased risk of LBP in drivers (OR = 2.23; 95% CI 1.72–2.88; $P<0.00001$) **(Fig.** 16**).**

**Daily working hours:** Nine studies investigated the association between daily working hours and the incidence of LBP in drivers [12, 13, 17, 22, 23, 25, 27, 31, 32]. Significant heterogeneity was observed among studies ($I^2=98\%$; $P<0.00001$) **(Fig.** 17A**).** Following the sensitivity analysis, the Rufa'i study was identified as the primary contributor to this heterogeneity [13]. After the exclusion of this study, the heterogeneity across studies diminished ($I^2=0\%$; $P=0.85$) **(Fig.** 17B**).** The findings of a fixed-effects model provided moderate evidence that working > 10 h/day is a risk factor for LBP among drivers (OR = 2.49; 95% CI 1.89–3.28; $P<0.00001$)**.**

**Years of driving experience:** Seven studies reported on the relationship between years of driving experience and the occurrence of LBP in drivers [12, 14–17, 23, 27]. The heterogeneity test ($I^2=35\%$; $P=0.16$), utilizing a fixed-effects model indicated moderate evidence of > 5 years of driving experience as a risk factor for LBP in drivers (OR = 2.12; 95% CI 1.66–2.69; $P<0.00001$) **(Fig.** 18**).**

**Back support:** Three studies investigated the association between back support and the incidence of LBP in drivers [12, 14, 22]. Significant heterogeneity was detected initially ($I^2=66\%$; $P=0.05$) **(Fig.** 19A**).** Following a sensitivity analysis, Abere's study was identified as the primary contributor to this heterogeneity [12]. After its exclusion, no heterogeneity was observed among studies ($I^2=0\%$, $P=0.58$) **(Fig.** 19B**).** A fixed-effects model provided moderate evidence that the absence of back support in seats poses a risk factor for LBP in drivers (OR = 1.81; 95% CI 1.25–2.62; $P=0.002$)**.**

### Psychological factors

**Job stress:** Six studies investigated the association between job stress and the incidence of LBP among drivers [12, 17, 25, 28, 30, 31]. A heterogeneity test ($I^2=46\%$;

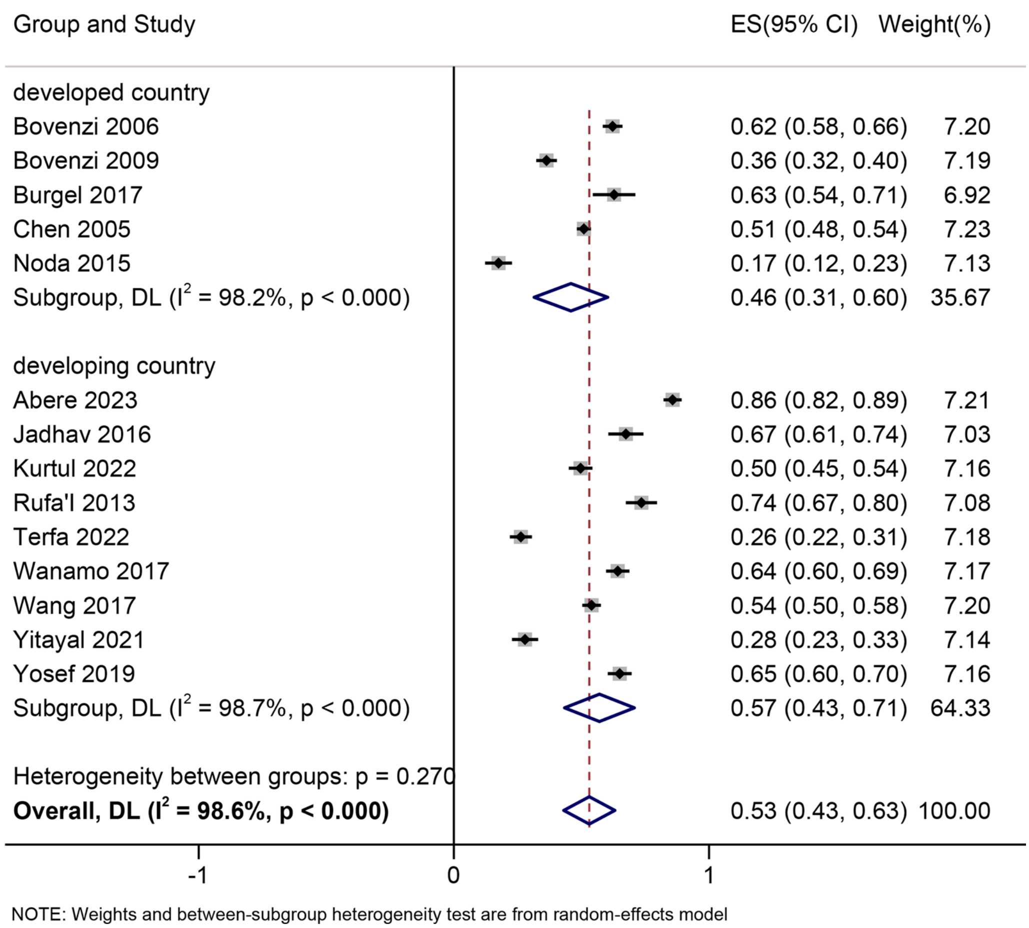


**Fig. 5** Occurrence of LBP within 12 months among the professional drivers of different country

$P = 0.10$) utilizing a fixed-effects model indicated moderate evidence of job stress as a risk factor for the development of LBP in drivers (OR = 2.04; 95% CI 1.59–2.61; $P < 0.00001$) (Fig. 20).

**Job satisfaction:** Four studies reported a relationship between job satisfaction and the occurrence of LBP among drivers [12, 14, 28, 31]. A heterogeneity test ($I^2 = 12\%$; $P = 0.33$) utilizing a fixed-effects model indicated is moderate evidence that job dissatisfaction is a risk factor for the development of LBP in drivers (OR = 1.57; 95% CI 1.23–2.01; $P = 0.0003$) (Fig. 21).

### Publication *Bias* assessment

The meta-analysis included only the overall prevalence of LBP among drivers in the previous year from studies with ≥ 10 publications. Subsequently, publication bias assessment was conducted. Egger's test yielded p of 0.826, indicating no statistical significance ($p > 0.05$). Furthermore, the funnel plot exhibited a symmetrical distribution, suggesting a minimal risk of publication bias (Fig. 22).

## Discussion

Three key findings emerged from this study. First, the incidence of LBP among drivers was 39% within 7 days and 53% within 12 months. Second, factors contributing to LBP in drivers included age ≥ 41 years, alcohol consumption, inadequate exercise, sleeping < 6 h/night, the manual handling of heavy objects, working > 10 h/day, > 5 years of driving experience, uncomfortable seating, absence of seat back support, poor driving posture, high work-related stress, and job dissatisfaction. Finally, a high BMI and smoking were not associated with the occurrence of LBP among the drivers.

LBP is a prevalent ailment posing a substantial challenge to global healthcare systems. A worldwide review of the prevalence of LBP among the general adult population revealed an annual prevalence of 38% and a lifetime prevalence of 40% [33]. An analysis of 19 studies revealed that, within a 7-day period, drivers experienced a 39% incidence of LBP (95% CI 0.20–0.57); this value increased to 53% within 12 months (95% CI 0.43–0.63), surpassing

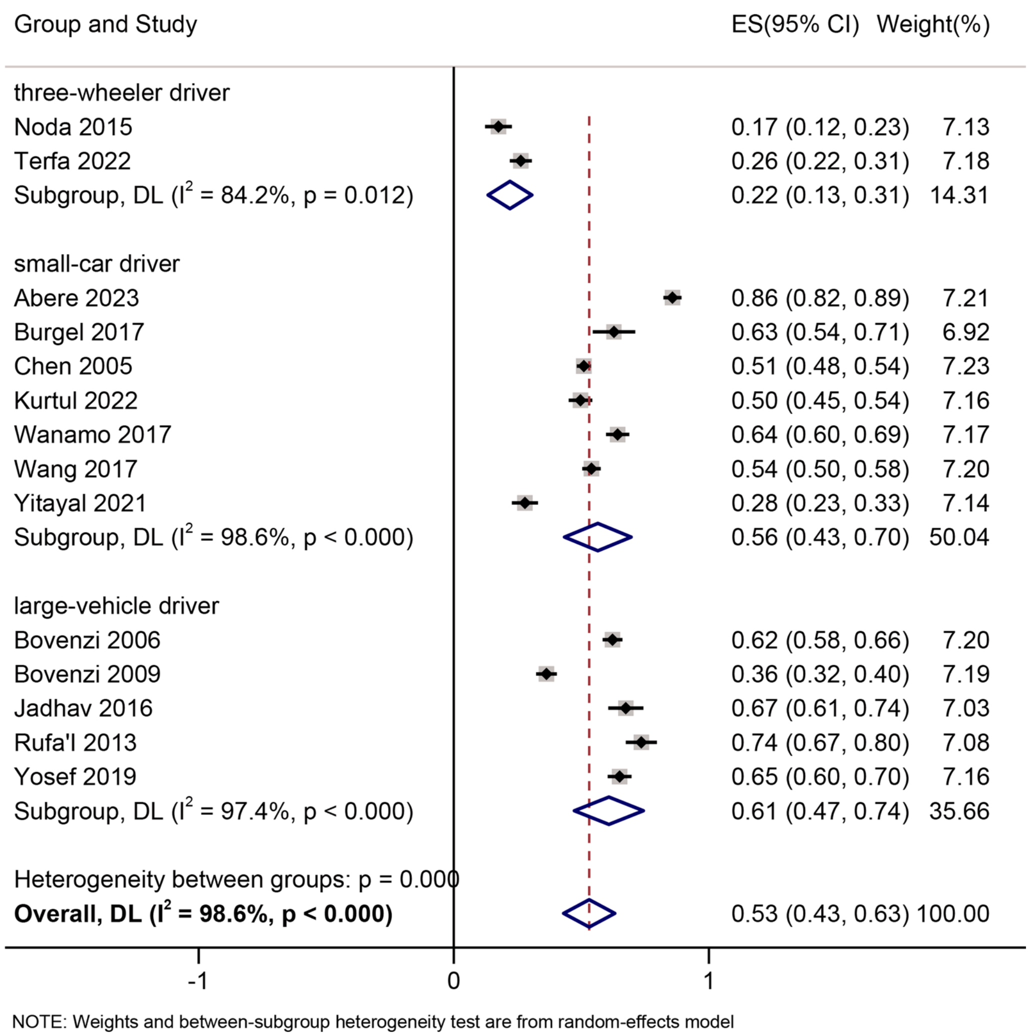


**Fig. 6** Occurrence of LBP within 12 months among the professional drivers of different vehicle type

the levels among average adult populations. This finding indicates a direct association between the occupational aspects of driving and increased LBP rates among drivers. A subgroup analysis by year, country, and vehicle type highlighted a higher incidence of LBP in 2016–2023 among drivers in underdeveloped nations and those operating large vehicles. Three causative factors were identified. 1. Recent advancements in the transportation sector led to more demanding driving responsibilities post-2016. A 2019 World Health Organization report underscored the increase in illnesses and fatalities due to road traffic, emphasizing a critical public health concern and the rapid evolution of the global transport industry [34]. 2. Drivers in underdeveloped countries commonly have a lower socioeconomic status, education levels, and income, all of which are correlated with the occurrence of LBP [35]. Moreover, strenuous labor in these regions is directly linked to increased LBP rates [36]. 3. Large-vehicle operators endure extended work hours and irregular routines compared with other drivers that subjects them to heightened WBV intensity and an elevated risk of LBP development [37].

#### Patient-related factors

Previous studies established a strong correlation between LBP and aging in humans. A study of healthy female subjects undergoing magnetic resonance imaging revealed that around 30% of individuals in their twenties experienced LBP, a figure that escalated to 90% among those in their seventies [38, 39]. In our study, age was a significant risk factor for LBP among professional drivers, with individuals aged ≥ 41 years being 2.10 times more likely to develop LBP than younger drivers. Intervertebral disc degeneration was identified as a key risk factor for LBP, with degeneration levels increasing with age, particularly among the elderly. Furthermore, as individuals age,

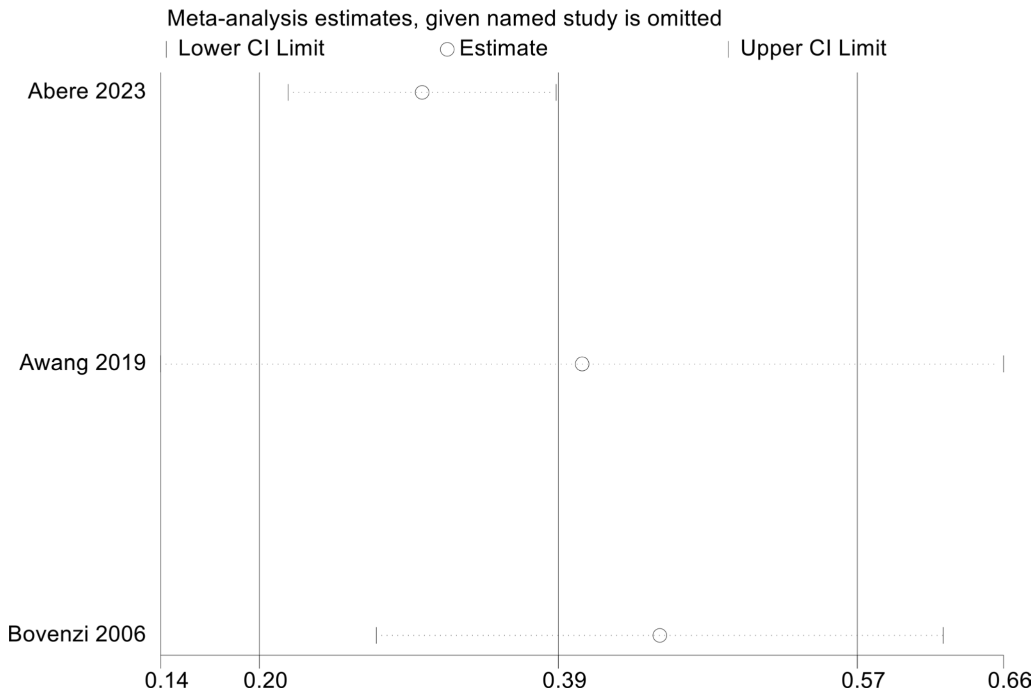


**Fig. 7** The sensitivity analysis of the prevalence rate of lower back pain among drivers over the previous week

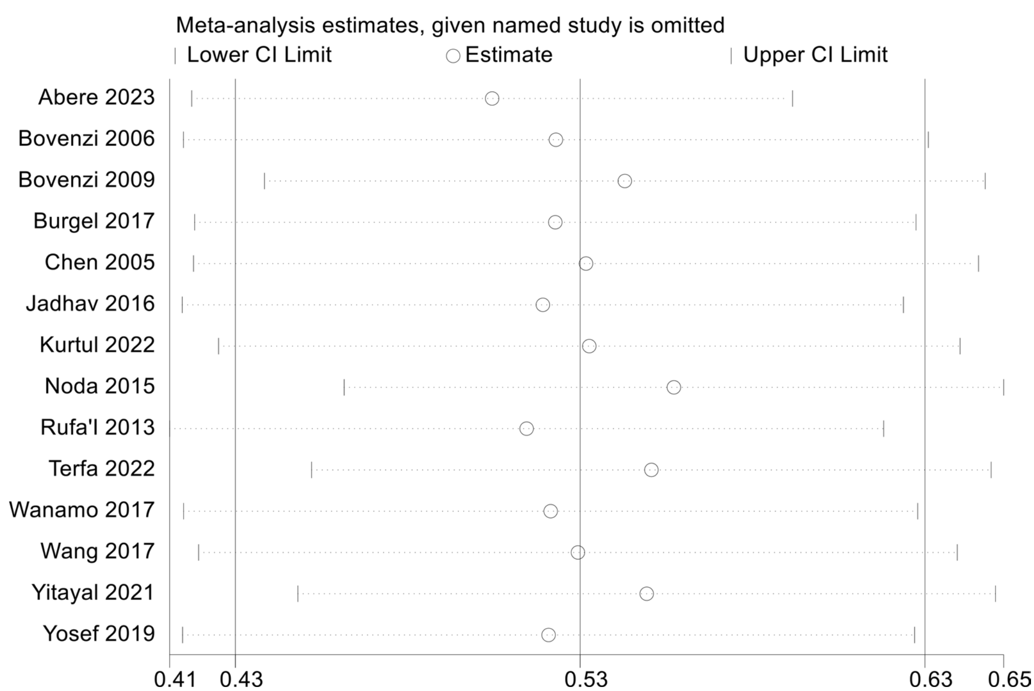


**Fig. 8** The sensitivity analysis of the prevalence rate of lower back pain among drivers over the previous year

pain intensity tends to increase, establishing a detrimental cycle between pain and inadequate physical activity, thereby exacerbating LBP.

Exploration of the intricate molecular mechanisms linking LBP to aging has gained prominence. Studies revealed that age-related secretion patterns can trigger

**Table 2** Overall study-provided evidence quality according to GRADE score

| Risk factors | Number of studies | Study design | Certainty assessment | | | | | Effect of estimate | Certainty |
|---|---|---|---|---|---|---|---|---|---|
| | | | Risk of bias | Inconsistency | Indirectness | Imprecision | Publication bias | OR/MD (95%CI) | |
| *Patient-related factors* | | | | | | | | | |
| Age ≥ 41Y | 4 | Observational studies | Not serious | Not serious | Not serious | Not serious | None | 2.10 (1.36,3.24) | ⊕⊕⊕⊕ High |
| Alcohol consumption | 4 | Observational studies | Not serious | Not serious | Not serious | Not serious | None | 1.75 (1.31,2.34) | ⊕⊕⊕⊕ High |
| Lack of sleep | 3 | Observational studies | Not serious | Not serious | Not serious | Not serious | None | 1.60 (1.13, 2.24) | ⊕⊕⊕⊕ High |
| Lack of exercise | 5 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 1.78 (1.37, 2.31) | ⊕⊕⊕ Moderate |
| High BMI | 5 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 1.49 (0.90,-2.47) | ⊕⊕⊕ Moderate |
| Smoking | 6 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 1.46 (0.77, 2.76) | ⊕⊕⊕ Moderate |
| *Work-related factors* | | | | | | | | | |
| Seat discomfort | 3 | Observational studies | Not serious | Not serious | Not serious | Not serious | None | 1.71 (1.23, 2.36) | ⊕⊕⊕⊕ High |
| Poor driving posture | 5 | Observational studies | Not serious | Not serious | Not serious | Not serious | None | 2.37 (1.91, 2.94) | ⊕⊕⊕⊕ High |
| Handling heavy objects | 5 | Observational studies | Not serious | Not serious | Not serious | Not serious | None | 2.23 (1.72, 2.88) | ⊕⊕⊕⊕ High |
| Extended daily working hours | 9 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 2.49 (1.89, 3.28) | ⊕⊕⊕ Moderate |
| Extended years of driving | 7 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 2.12 (1.66, 2.69) | ⊕⊕⊕ Moderate |
| Lack of back support | 3 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 1.81 (1.25, 2.62) | ⊕⊕⊕ Moderate |
| *Psychological-related factors* | | | | | | | | | |
| High job stress | 6 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 2.04 (1.59, 2.61) | ⊕⊕⊕ Moderate |
| Low job satisfaction | 4 | Observational studies | Not serious | Serious | Not serious | Not serious | None | 1.57 (1.23, 2.01) | ⊕⊕⊕ Moderate |

*CI* Confidence interval, *GRADE* Grading of Recommendations, Assessment, Development and Evaluation, *OR* Odds ratio, *MD* Mean difference.

inflammation and metabolic changes through autocrine and paracrine pathways, ultimately affecting tissue microstructure and contributing to LBP onset and progression [40–42]. The potential causal link between alcohol consumption and LBP has sparked debate.

Previous studies indicated higher instances of alcohol abuse among individuals with LBP than in the general population [43]. Although Khatun et al. highlighted the adverse effects of alcohol consumption on LBP occurrence in young adult males, the Kovacs et al. study did not support this notion [44, 45]. Our research revealed a robust correlation between alcohol consumption and LBP incidence, with drivers who consume alcohol facing a 2.34 times higher risk of developing LBP than non-drinkers. Individuals with LBP tend to exhibit elevated alcohol consumption, possibly as a coping mechanism for the pain and negative emotions exacerbated by their condition. This interplay between LBP and alcohol use may manifest bidirectionally, in which pain drives alcohol consumption for relief but alcohol consumption can exacerbate pain severity [46]. Concrete evidence of a direct causal association between alcohol intake and intervertebral disc degeneration is currently lacking, indicating the necessity for further exploration of the specific mechanisms.

Decreased sleep duration is increasingly prevalent in modern society, and closely linked to various physiological and psychological disorders [47]. Research suggests that chronic sleep deprivation boosts the expression of inflammatory markers, such as interleukin-1 and -6 in

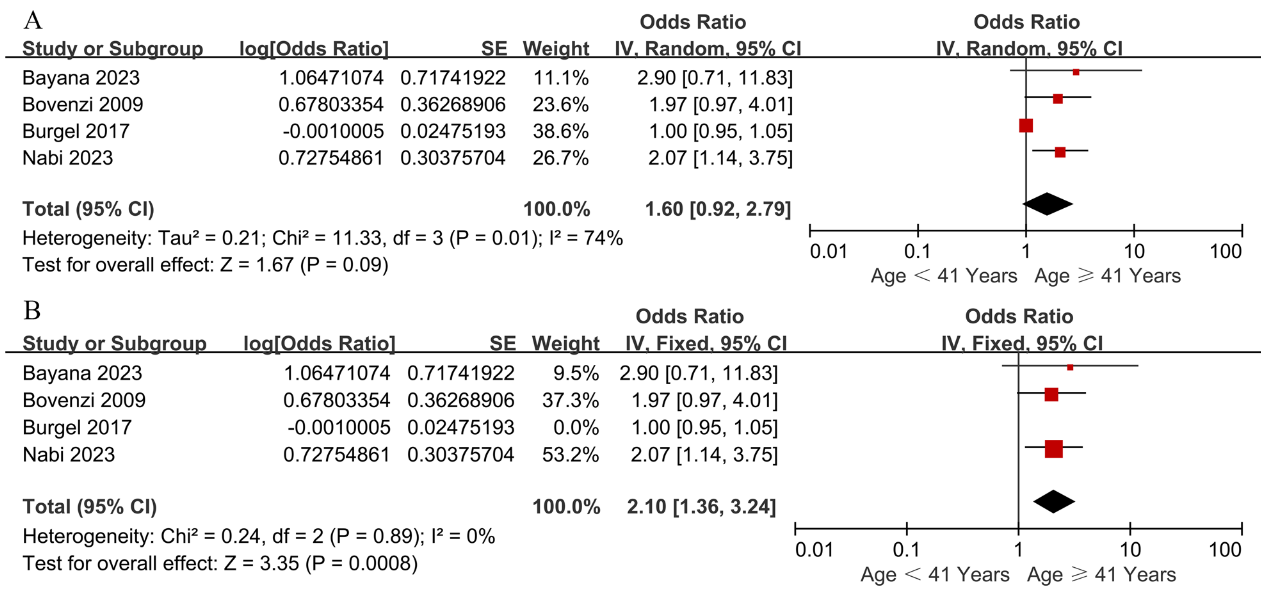


**Fig. 9** Age ≥ 41 years as a risk factor for low back pain among professional drivers. CI confidence interval; IV, instrumental variable; SE, standard error.

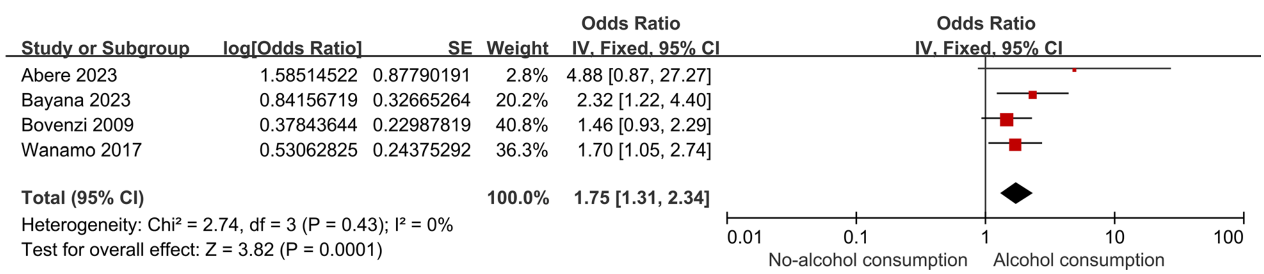


**Fig. 10** Alcohol consumption as a risk factor for low back pain among professional drivers

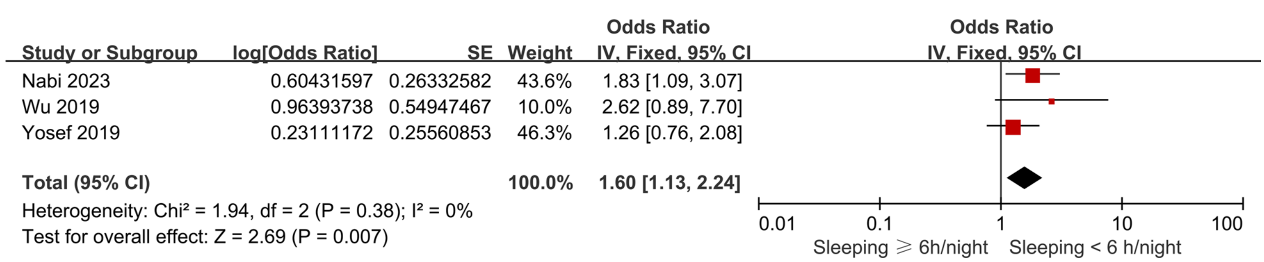


**Fig. 11** Sleeping < 6 h/night as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

men and women, significantly affecting LBP development and occurrence [48–50]. Our findings suggest a substantial relationship between sleeping < 6 h/night and LBP among drivers, potentially influenced by irregular schedules and late-night work habits. Furthermore, pain, a significant clinical manifestation of LBP, often disrupts sleep patterns and leads to poor sleep quality, exacerbating pain and perpetuating a vicious cycle. Studies have shown that sleep disturbances can compromise downstream pain pathways, increase spinal excitability, and increase the sensitivity of peripheral pathways to cold- and pressure-induced pain [51]. Two studies demonstrated a notable relationship between sleep and biological aging, highlighting that sufficient sleep can mitigate the health risks associated with prolonged sedentary behaviour [52, 53]. Thus, sleep quality and duration are important

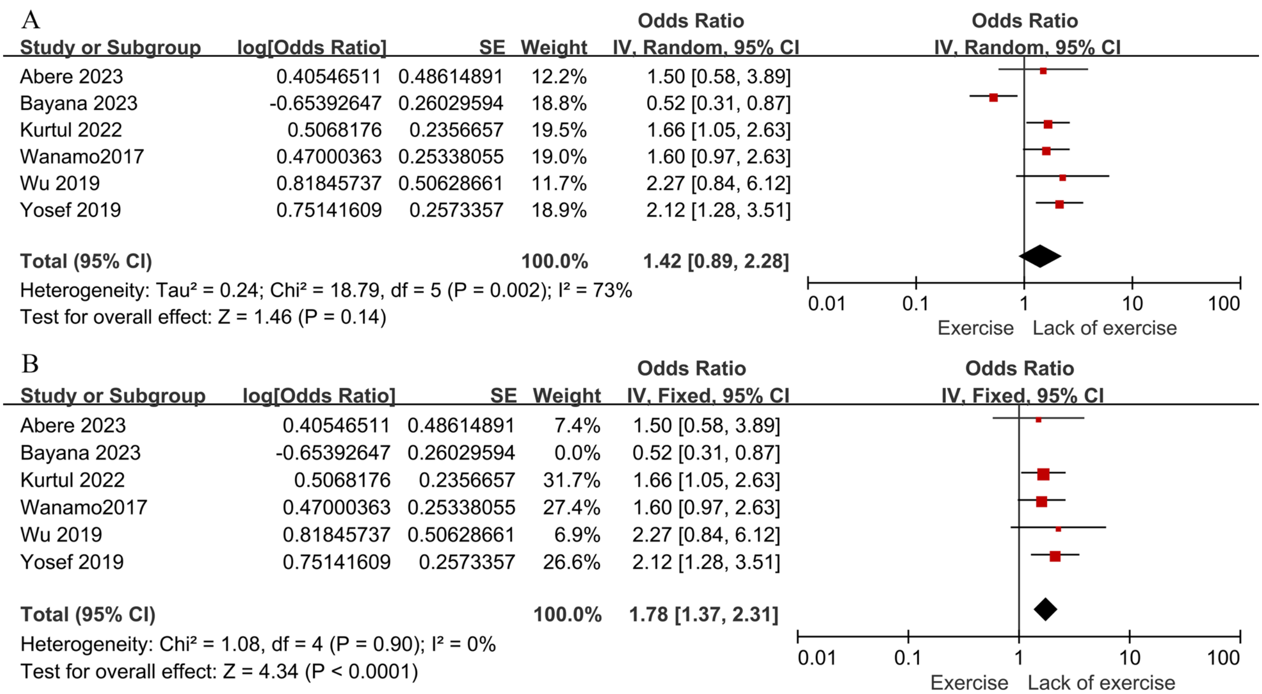


**Fig. 12** Lack of exercise as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

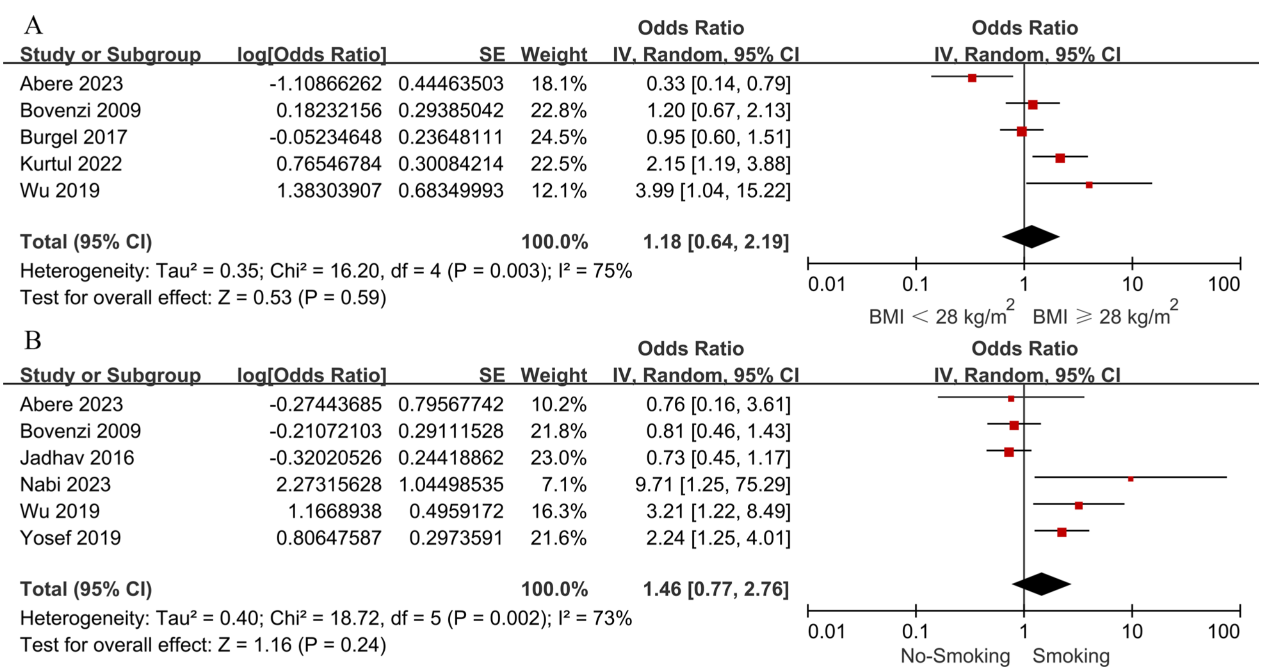


**Fig. 13** **A** Body mass ≥ 28 kg/m$^2$ as a risk factor for low back pain among professional drivers; **B** Smoking as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable; SE, standard error

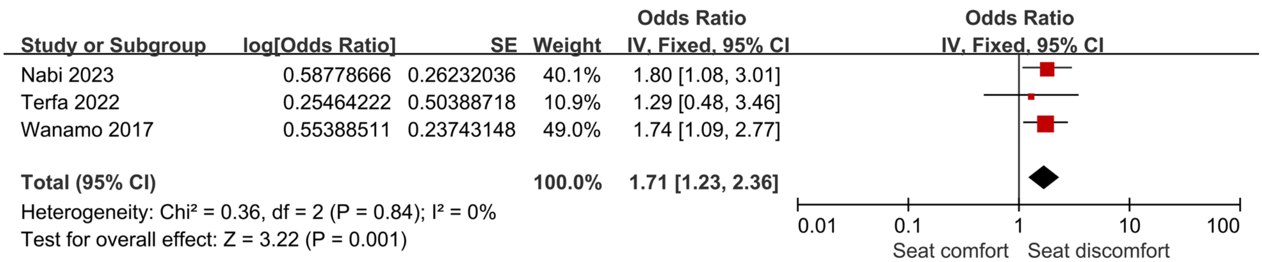


**Fig. 14** Seat discomfort as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

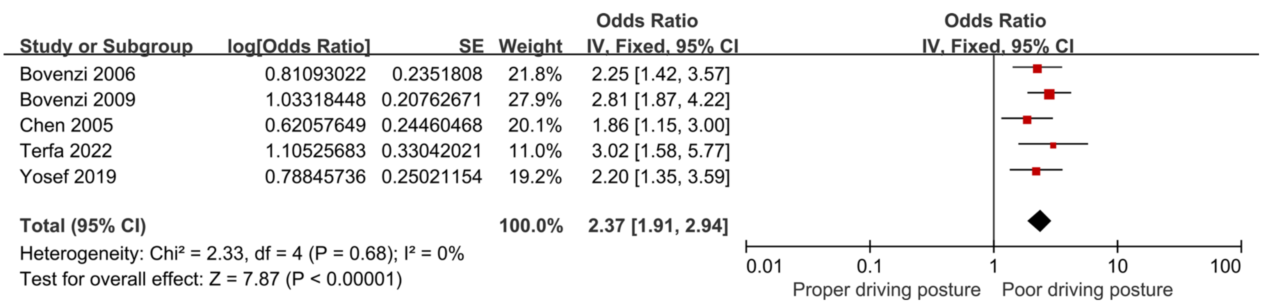


**Fig. 15** Poor driving posture as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

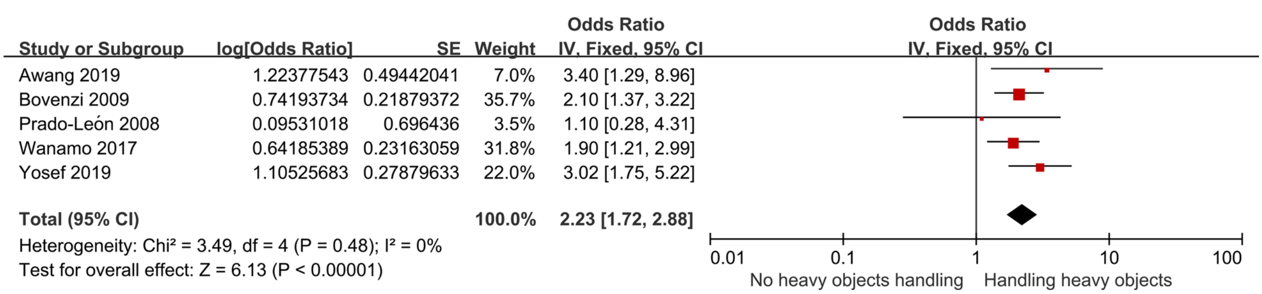


**Fig. 16** Handling heavy objects as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

in preserving physical health and cognitive function and averting potential complications.

Moreover, the absence of physical activity may predispose professional drivers to LBP. Engaging in physical activity is crucial in enhancing cardiovascular health, muscle strength, and overall endurance, which are all essential for coping with the physical demands and fatigue associated with LBP. Research indicates that engaging in moderate exercise 1–5 times weekly is associated with a reduced risk of LBP compared with lower or higher exercise frequency [54]. Recent studies have underscored the crucial role of moderate physical activity in health outcomes and disease management. You et al. discovered that the interplay between physical activity and immune function positively influences the recovery and overall health of individuals with LBP [50, 55]. Here, lack of exercise was a risk factor for LBP among drivers, and this finding was likely influenced by their demanding work schedules and limited time and energy.

## Work-related factors

Most occupational risk factors are related to the types of activities performed at work, and ergonomic factors are known risk factors for LBP. These factors include WBV, manual material handling, awkward postures, and others [56]. The current study found that uncomfortable seating and improper driving postures increased the risk of LBP development by 1.71 and 2.37 times, strongly

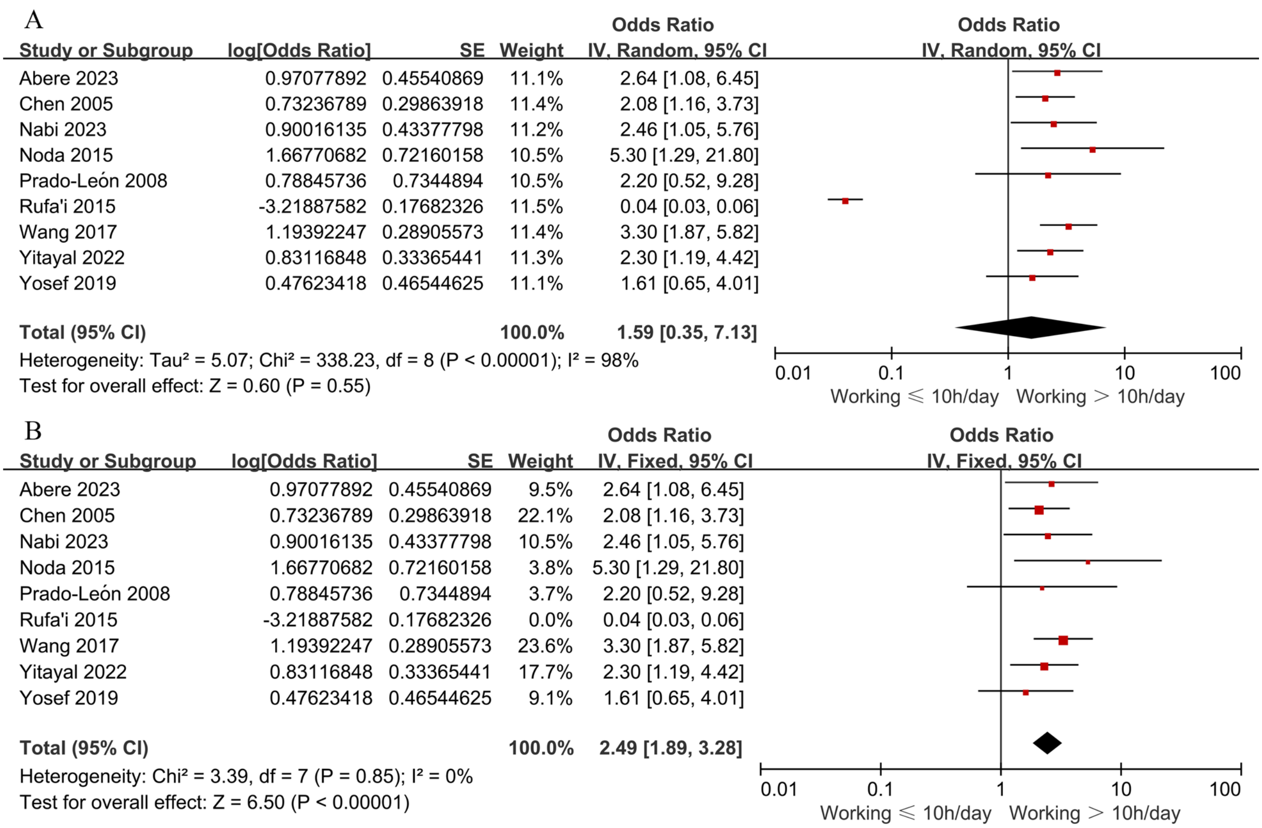


**Fig. 17** Working > 10 h/day as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

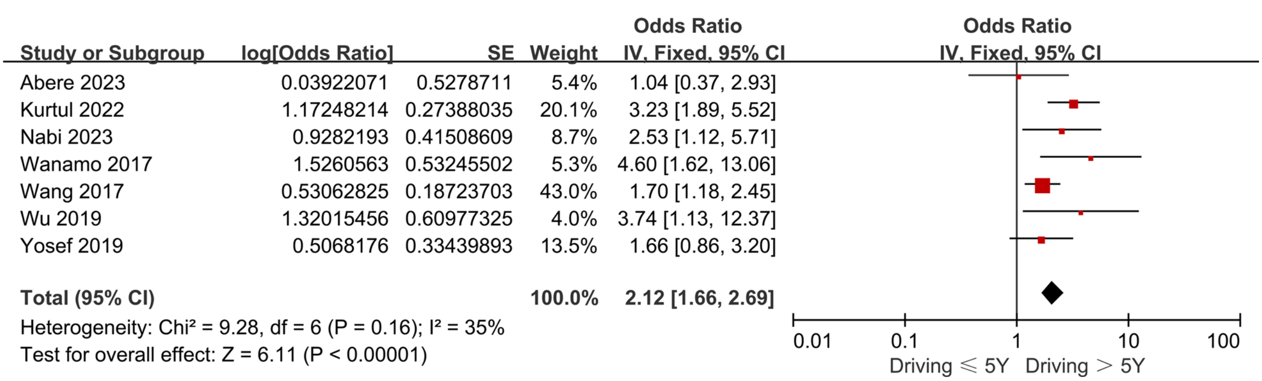


**Fig. 18** Driving > 5 years as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

indicating that uncomfortable seating and poor driving postures are significant risk factors for LBP among drivers. This may be because, in professional drivers engaged in long-term driving tasks, uncomfortable seating and a poor driving posture exacerbate WBV exposure, leading to increased pressure on the lumbar discs, impaired nutrition, enhanced release of neuropeptides, and muscle fatigue. Hansson et al. suggested that constrained work postures and WBV induce muscle fatigue, thereby causing LBP through neurophysiological changes at the cellular level [57]. Increasing evidence indicates that vertebral body injuries caused by mechanical factors such

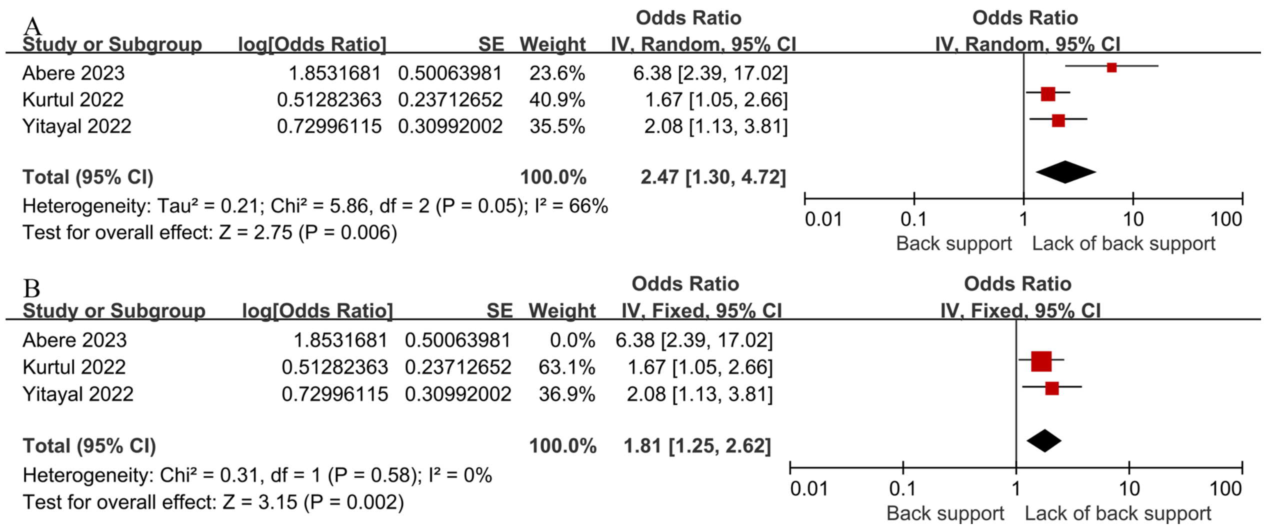


**Fig. 19** Lack of back support as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

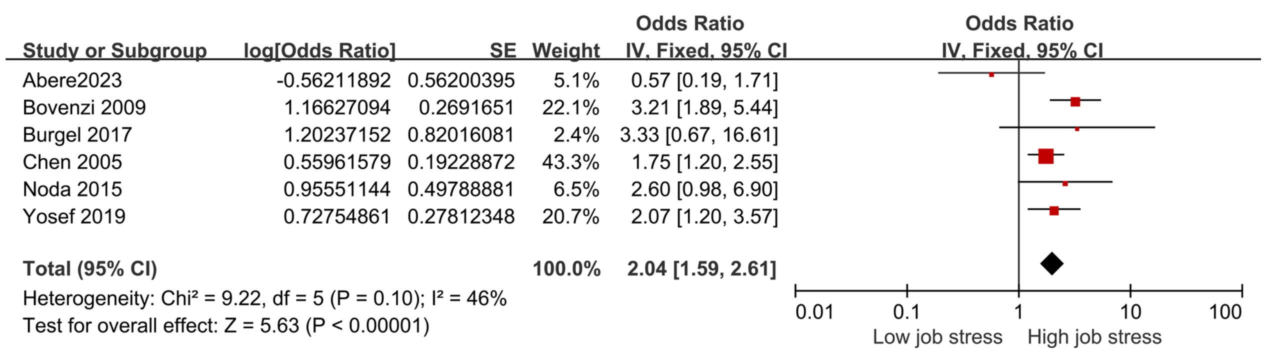


**Fig. 20** High job stress as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

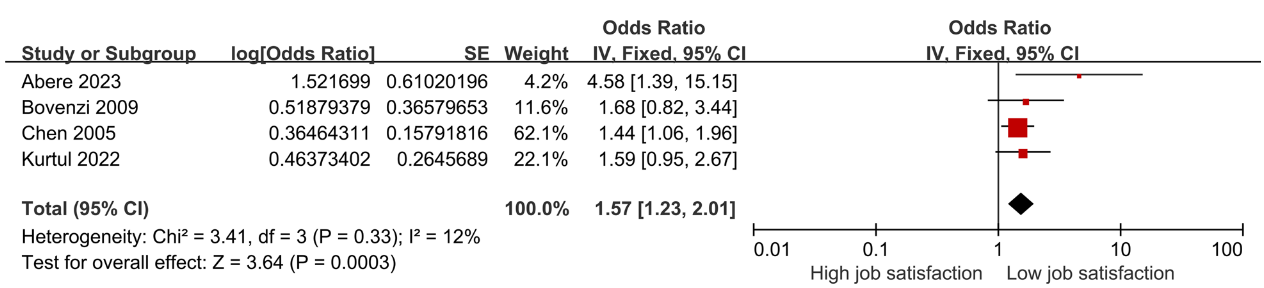


**Fig. 21** Low job satisfaction as a risk factor for low back pain among professional drivers. *CI* Confidence interval, *IV* Instrumental variable, *SE* Standard error

as heavy lifting are key mechanisms in the occurrence of LBP [58]. We found that drivers with lifting requirements had a 2.23 times higher risk of developing LBP. This may be because of the significant impact of lifting on the lower back, especially during lifting tasks, as it greatly increases the pressure within the intervertebral discs and may lead to disc damage [59]. Furthermore, we identified prolonged driving experience, excessively long daily driving hours, and a lack of back support as risk factors for LBP among professional drivers. Previous studies

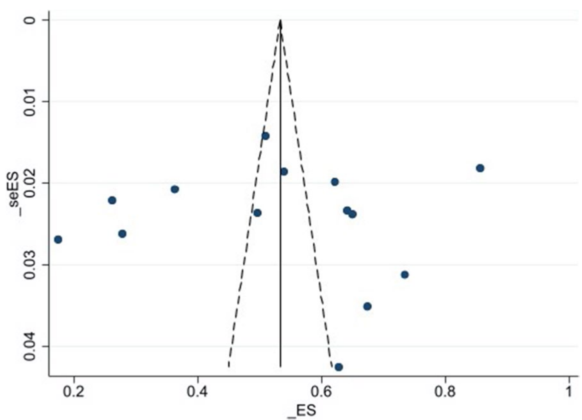


**Fig. 22** The funnel plot of lower back pain prevalence among drivers in the previous year

reported that driving prolonged hours exacerbates discomfort among individuals [60]. This could be due to drivers being confined to a limited space behind the steering wheel, sitting for prolonged periods, and using insufficient back support, factors that lead to the lumbar muscle fatigue and LBP. Therefore, drivers should avoid prolonged WBV exposure, feeling work-related pressure, and performing repetitive, monotonous tasks. Moreover, they should learn self-regulation techniques and rest adequately during extended work periods.

### Psychological factors

A cohort study of 4,712 elderly Chinese individuals found a noteworthy correlation between depression and LBP onset [61]. Our study corroborated these findings by revealing that drivers facing high work-related stress and dissatisfaction were more susceptible to developing LBP. LBP is a chronic recurring pain ailment that frequently induces fear and emotional upheaval in patients. Emotionally unstable states can stimulate the release of corticotropin-releasing hormone by the hypothalamic neurons, influencing endocrine and immune metabolic processes at the biological and behavioral levels. Moreover, this can trigger immune-cell activation in the central and peripheral nervous systems, leading to the secretion of pro-inflammatory cytokines that can breach the blood–brain barrier, causing a detrimental cycle that significantly impacts LBP development and progression [62, 63]. Engaging in practices that foster emotional equilibrium, such as yoga and meditation, can ameliorate LBP by enhancing emotional well-being. For professional drivers, listening to soothing and enjoyable music while driving may serve as a preventive measure.

Overall, LBP, a prevalent degenerative spinal condition, has emerged as a global health concern. Therefore, preventive strategies should be established to address the occurrence of LBP among drivers. Considering patient-related factors, we posit that cessation of smoking, ensuring adequate sleep, and engaging in moderate weekly exercise are pivotal for improving cardiovascular health, muscle strength, and overall endurance. Moreover, research suggests that adequate energy intake and optimal nutrition can aid in physical function recovery and overall health maintenance while decreasing inflammatory responses [64]. Therefore, we recommend the daily intake of a healthy and balanced diet. Considering the work-related factors, we suggest that drivers install ergonomic seats in the driving cabins according to their needs. If constrained by economic factors, comfortable pillows or back supports can effectively reduce the impact of ergonomic factors on LBP. Additionally, maintaining the correct driving posture is equally important. It is advisable to minimise the frequency of lifting heavy objects. Using lumbar supports or tools can help reduce the pressure on intervertebral discs during lifting. Incorporating psychological factors, alleviating work stress for drivers, and enhancing the work environment are fundamental preventive measures. Governments and industry regulatory agencies should establish reasonable work hours and rest policies to safeguard the legal rights of drivers. Furthermore, regular health checkups and psychological counselling for drivers are indispensable. Notably, researchers, such as You, have found a certain correlation between dietary nutrition and reducing depressive symptoms [65]. Hence, proper dietary intake aids in improving the psychological well-being of drivers and preventing the occurrence of LBP.

Original studies on the risk factors for LBP in drivers still face ethical concerns and lack clear research directions. Hence, future studies should prioritise safeguarding the privacy of the investigators. Moreover, researchers should offer valuable guidance for enhancing the working conditions and health outcomes of professional drivers, while ensuring confidentiality. Longitudinal research is essential to establish the causal relationships between specific risk factors and LBP. The implementation of tailored interventions, such as structured exercise programs, ergonomic training, and balanced nutrition, are crucial for assessing their effectiveness and long-term impact on reducing LBP among drivers. Additionally, conducting multicentre studies across diverse demographics is necessary to establish standardised preventive measures for LBP in driver cohorts, ultimately enhancing their long-term occupational status and quality of life.

This study has certain limitations. First, variations in the definitions and measurement standards of influencing factors can result in notable interstudy heterogeneity. Furthermore, the heterogeneity evaluations highlighted the variability among studies. Finally, this study incorporated cross-sectional research, utilizing the Nordic Musculoskeletal Questionnaire or self-developed questionnaires as assessment tools, potentially introducing selection bias. Despite its limitations, this study provides a comprehensive and lucid discussion of the prevalence of and associated risk factors for LBP among professional drivers. Our study provides empirical support for the escalating problem of LBP in the driving community, aids the promotion of healthy behavioral habits among professional drivers, and serves as a valuable resource for society to enhance relevant social security and healthcare frameworks.

## Supplementary Information

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**Supplementary file 1.**

**Supplementary file 2.**

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**Author contributions**
J.J and M.Z collected the literature and wrote the article. Z.Y, W.L and X.K revised the article. Z.C, S.L and Y.Z designed the study. J.J, X.H and M.Z prepared figures and tables. All authors contributed toward data analysis, drafting and critically revising the paper and agree to be accountable for all aspects of the work.

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**Data availability**
No datasets were generated or analysed during the current study.

## Declarations

**Ethics approval and consent to participate**
Not applicable.

**Informed consent**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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