Risk factors for ischemic heart disease in professional drivers: a meta-analysis

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Summary. **Objective**. To identify risk factors for ischemic heart disease (IHD) in professional drivers through a systematic review and meta-analysis. **Methods**. A comprehensive literature search was conducted across multiple databases, including CNKI, CBM, Wanfang Data, VIP, FMRS Medline, The Cochrane Library, PubMed, Embase, and Web of Science, for studies published from January 1, 1990, to December 31, 2024. Keywords such as "ischemic heart disease," "coronary heart disease," "myocardial infarction," "driver," and "risk factor" were used. Relevant case-control studies were included based on predefined criteria and quality assessed using the Newcastle-Ottawa Scale (NOS), with studies scoring ≥7 considered high quality for meta-analysis. **Results**. Eleven studies involving 95,791 cases and 29,621 controls were included. The meta-analysis revealed a significant association between the driving profession and an increased risk of IHD (OR = 1.85, 95% CI: 1.63-2.11). Drivers with hypertension (OR = 2.58), smoking (OR = 2.70), obesity (OR = 1.54), diabetes (OR = 1.77), physical inactivity (OR = 2.12), dyslipidemia (OR = 1.82), and occupational stress (OR = 2.31) all exhibited significantly higher risks of IHD. **Conclusions**. The driving profession is a significant risk factor for IHD. Drivers with chronic conditions, unhealthy lifestyles, dyslipidemia, and occupational stress face an elevated risk. Health interventions should focus on lifestyle changes, managing hypertension and diabetes, and reducing work-related stress.

Fattori di rischio per la cardiopatia ischemica nei conducenti professionisti: una metanalisi

Riassunto. **Obiettivo**. Identificare i fattori di rischio per la cardiopatia ischemica (CI) nei conducenti professionisti attraverso una revisione sistematica e metanalisi. **Metodi**. È stata condotta una ricerca bibliografica esaustiva su diverse banche dati, tra cui CNKI, CBM, Wanfang Data, VIP, FMRS Medline, The Cochrane Library, PubMed, Embase e Web of Science, per studi pubblicati dal 1° gennaio 1990 al 31 dicembre 2024. Sono state utilizzate parole chiave quali "cardiopatia ischemica" (ischemic heart disease), "cardiopatia coronarica" (coronary heart disease), "infarto miocardico" (myocardial infarction), "conducente" (driver) e "fattore di rischio" (risk factor). Sono stati inclusi studi caso-controllo pertinenti, selezionati in base a criteri predefiniti e la cui qualità è stata valutata utilizzando la Newcastle-Ottawa Scale (NOS); gli studi con un punteggio ≥7 sono stati considerati di alta qualità per la metanalisi. **Risultati**. Sono stati inclusi undici studi per un totale di 95.791 casi e 29.621 controlli. La metanalisi ha evidenziato un'associazione significativa tra la professione di conducente e un aumento del rischio di CI (Odds Ratio, OR = 1.85, IC 95%: 1.63-2.11). I conducenti con ipertensione (OR = 2.58), fumo (OR = 2.70), obesità (OR = 1.54), diabete (OR = 1.77), inattività fisica (OR = 2.12), dislipidemia (OR = 1.82) e stress occupazionale (OR = 2.31) hanno tutti mostrato rischi significativamente più elevati di CI. **Conclusioni**. La professione di conducente costituisce un fattore di rischio significativo per la CI. I conducenti affetti da condizioni croniche, stili di vita non salutari, dislipidemia e stress occupazionale presentano un rischio elevato. Gli interventi sanitari dovrebbero concentrarsi sulle modifiche dello stile di vita, sulla gestione dell'ipertensione e del diabete e sulla riduzione dello stress lavorativo.

Key words. Ischemic heart disease, professional drivers, risk factors, case-control study, meta-analysis.

Parole chiave. Cardiopatia ischemica, conducenti professionisti, fattori di rischio, studio caso-controllo, metanalisi.

Introduction

Ischemic heart disease represents a significant public health concern, particularly among occupational groups exposed to prolonged working hours, heavy workloads, and extended driving periods. Research indicates that professional drivers exhibit a higher incidence of cardiovascular disease due to chronic occupational stress, prolonged sedentary behavior, and irregular dietary habits[1]. In recent years, the rapid expansion of the road transportation industry has resulted in a growing number of professional drivers, paralleled by an increasing prevalence of cardiovascular disease, making it a critical occupational health issue[2]. Although numerous studies have investigated the risk factors for ischemic heart disease in professional drivers, a systematic and comprehensive analysis remains lacking. This study aims to identify the key risk factors for ischemic heart disease in professional drivers and quantify their association through a meta-analysis of literature published from January 1990 to December 2024. By synthesizing and analyzing data from multiple studies, this research establishes a scientific foundation for preventing and managing ischemic heart disease in professional drivers, guiding to reduce morbidity and mortality.

Data and methods

Literature search

A comprehensive literature search was conducted in the following databases: China National Knowledge Infrastructure (CNKI) China Biological Medicine Database (CBM), Wanfang Data, VIP Chinese Science and Technology Journals Database, FMRS Medline, The Cochrane Library, PubMed, Embase, and Web of Science. The following keywords: ("ischemic heart disease" OR "coronary artery disease" OR "myocardial infarction") AND ("drivers" OR "professional drivers") AND ("risk factors" OR "related factors" OR "influencing factors") were used.

Literature inclusion and exclusion criteria

Inclusion criteria: 1. The study was a case-control study. 2. Cases were obtained from medical examination records registered by healthcare institutions across different regions and from occupational drivers with established health records. The control group was matched to cases by gender and age, selected from a broader community population within the same region. 3. Studies published between January 1, 1990, and December 31, 2024, from domestic and international sources were included. 4. The adjusted risk factors included occupation (driver), hypertension, smoking, obesity, age, diabetes, physical inactivity, dyslipidemia, occupational stress, years of employment, high-fat diet, family history of coronary heart disease, exposure to occupational vibration, sleep disorders, shift work, professional driving time-to-age ratio, and geographic region. 5. Studies providing data that could be extracted or converted into odds ratios (ORs), 95% confidence intervals (CIs), and standard errors (SEs) were included[3].

Exclusion criteria: 1. Duplicate publications were excluded. 2. Studies with unclear outcome measures, inappropriate statistical methods, or incomplete data were excluded. 3. Studies lacking a control group, missing essential baseline data, or experiencing excessive loss to follow-up were excluded. 4. Reviews, systematic reviews, meta-analyses, and animal studies were excluded. 5. Studies defining risk factors significantly differently from standard research criteria were excluded.

Literature screening process

Initially, 473 articles were identified. After removing duplicates, systematic reviews, meta-analyses, and animal studies, 81 articles remained for further evaluation. After screening abstracts, 67 articles were excluded due to irrelevance. After a full-text review, 11 articles met the inclusion and exclusion criteria and were included in the meta-analysis[4-14]. The literature selection process is illustrated in figure 1.

Essential characteristics and quality assessment of included literature

The 11 included studies, published between 1990 and 2024, comprised 95,791 cases in the case group and 29,621 in the control group, with one study published in Chinese and the rest in English. All studies were case-control designs, and the quality of each study was assessed using the Newcastle-Ottawa Scale (NOS)[15], which evaluates selection bias, group comparability, and outcome accuracy. Higher NOS scores reflect better study quality, with all 11 studies receiving a score of ≥7, indicating high quality. The detailed characteristics and evaluation results of the included studies, along with their quality assessment, are presented in table 1.

Data processing and analysis

The meta-analysis was performed using Review Manager 5.3. Study heterogeneity was assessed using the Cochrane Q test, while I^2 quantified the degree of heterogeneity across the included studies[16]. Statistical heterogeneity was considered low when $P > 0.05$ and $I^2 < 50\%$, in which a fixed-effect model was

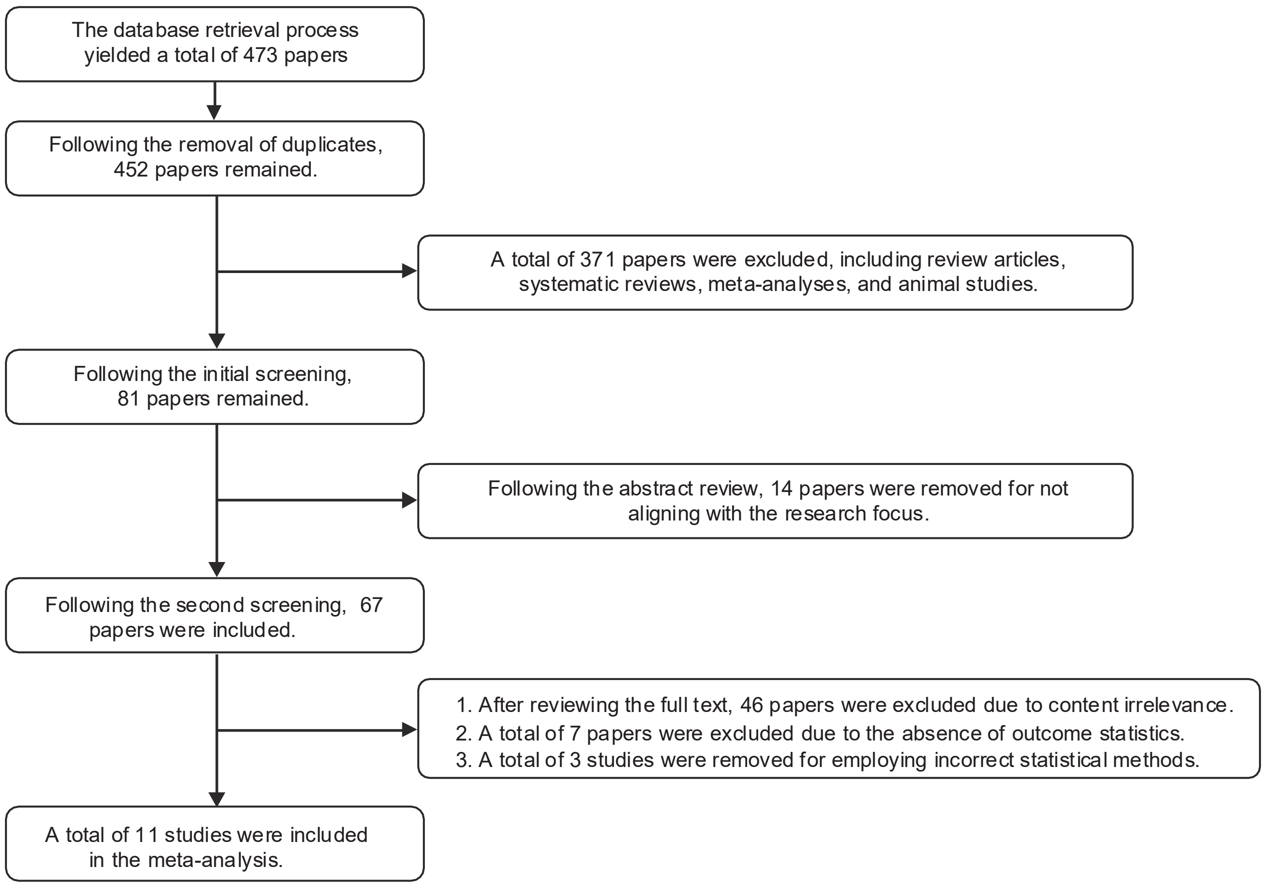


Figure 1. Literature selection flow diagram.

applied. When P≤0.05 and I^2≥50%, a random-effects model was used, and a sensitivity analysis was conducted to explore heterogeneity.

Results

Meta-analysis of occupational drivers and ischemic heart disease

A meta-analysis was conducted to assess professional driving as a risk factor for ischemic heart disease. The included studies exhibited low heterogeneity (I^2= 48%, below 50%), with borderline statistical significance (P = 0.06), slightly above the conventional threshold of 0.05. Consequently, a fixed-effect model was applied, suggesting that the results across individual studies were generally consistent. Notably, the analysis identified professional driving as a significant risk factor for myocardial infarction, with a Z-score of 9.26 (P < 0.05), indicating that drivers are 1.85 times more likely to experience myocardial infarction than the general population. These findings highlight the increased cardiovascular risk associated with professional driving (figure 2).

A separate meta-analysis of drivers' combined risk factors

A meta-analysis was performed to evaluate the combined risk factors among drivers, including hypertension, smoking, obesity, diabetes, physical inactivity, dyslipidemia, and occupational stress. The findings demonstrated that the combination of these factors substantially elevates the risk of ischemic heart disease among drivers (table 2, figure 3).

I. A meta-analysis evaluating hypertension as a risk factor for ischemic heart disease in drivers initially showed high heterogeneity (I^2= 78%, P < 0.05) among the included studies. Sensitivity analysis identified "Carolina Bigert 2003" as the primary source of heterogeneity. After excluding this study, the re-conducted meta-analysis showed markedly reduced heterogeneity (I^2= 4%, P = 0.39, < 50%, and > 0.05, respectively). Consequently, a fixed-effect model was applied for further analysis. The final results demonstrated that hypertension significantly elevated the risk of ischemic heart disease in drivers (Z = 15.63, P < 0.05), with hypertensive drivers exhibiting a

Table 1. General characteristics of studies included in the meta-analysis.

First Author	Year	Study type	Number of cases	Number of controls	Control population source	Total Score of the NOS	Risk factor
Dexin Tang	2020	case-control study	427	399	Logistics Workforce (China)	7 Stars	2, 3, 5, 9, 11
Hedberg GE	1993	case-control study	440	1000	Healthy population (Sweden)	7 Stars	2, 4, 7, 9, 12
Annika Rosengren	1991	case-control study	103	6699	Healthy population (Sweden)	7 Stars	1, 2, 3, 4, 6, 8, 9, 12
Carolina Bigert	2003	case-control study	1067	1482	Male population without myocardial infarction (Sweden)	7 Stars	1, 2, 3, 4, 6, 7, 9
J N Bluzhas	2003	case-control study	448	1777	Healthy male (Lithuania)	7 Stars	1, 4, 13
Stefan Pires	2000	case-control study	2318	3016	Healthy male (Sweden)	7 Stars	1, 2, 3, 4, 8, 17
PD Wang	2001	case-control study	1761	536	Technical workers (China)	8 Stars	1, 3, 4, 8
Matthew S. Thiese, PhD,	2017	case-control study	88246	11918	Healthy population (United States of America)	7 Stars	1, 3, 6, 14
Asmaa El-Sayed Awaad	2023	case-control study	100	100	University mana-gement population (Egypt)	7 Stars	1, 2, 3, 4, 5, 7, 8
Malinauskiene	2003	case-control study	448	1777	Healthy male (Kaunas)	7 Stars	1, 2, 4
Seung Yong Shin	2013	case-control study	433	917	Healthy population (South Korea)	7 Stars	15, 16

Note:1. Hypertension, 2. Smoking, 3. Obesity, 4. Drivers, 5. Age, 6. Diabetes, 7. Physical inactivity, 8. Dyslipidemia, 9. Occupational stress,10. Years of employment, 11. High-fat diet, 12. Family history of coronary heart disease, 13. Occupational vibration exposure, 14. Sleep disorders, 15. Shift work patterns, 16. The ratio of professional driving time to age, 17. Region.

2.58-fold increased risk compared to the general population.

II. A meta-analysis was conducted to assess smoking as a risk factor for ischemic heart disease in drivers. The initial heterogeneity test showed high heterogeneity among the included studies (I^2= 88%, $P < 0.05$). Sensitivity analysis identified "Tang Dexin 2022" as the primary source of heterogeneity. After excluding this study, the re-conducted meta-analysis showed a substantial reduction in heterogeneity (I^2= 0%, P = 0.75). Consequently, a fixed-effect model was applied for further analysis. The final results demonstrated that smoking significantly elevated the risk of ischemic heart disease in drivers (Z = 14.98, $P < 0.05$), with smo-

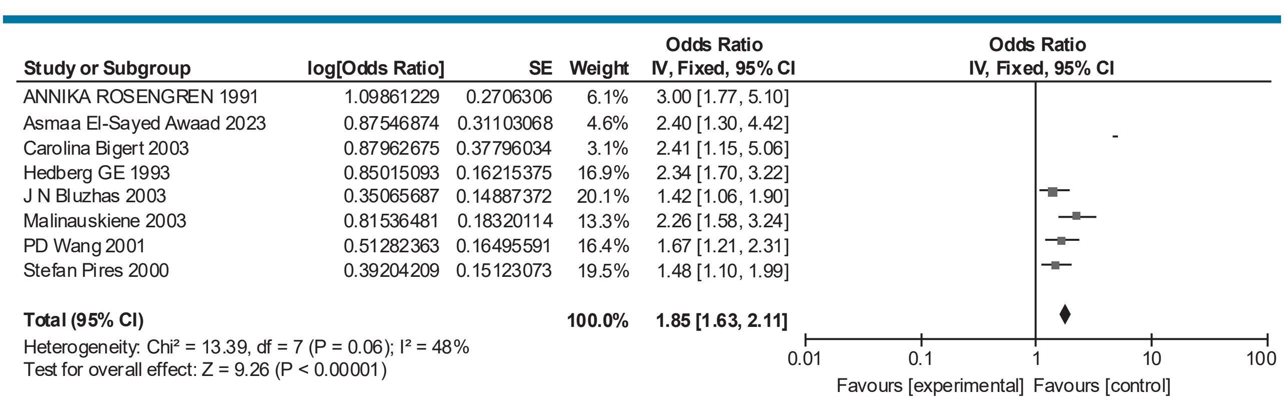


Figure 2. Forest Plot of the Meta-Analysis on Occupational Factors (Drivers)

Table 2. Meta-analysis of combined risk factors and ischemic heart disease in drivers.

Risk factor	Number of studies	Odds Ratio	95%CI	Heterogeneity test			Overall effect test	
				Q	P	I^2(%)	Z-value	P-value
I. Hypertension	7	2.58	2.29 ~ 2. 90	6.26	0.39	4	15.63	<0. 05
II. Smoking	6	2.70	2.37 ~ 3.07	2.66	0.75	0	14.98	<0. 05
III. Obesity	6	1.54	1. 32 ~ 1. 81	11.35	0.04	56	5.37	<0. 05
IV. Diabetes	3	1.77	1.39 ~ 2.25	4.42	0.11	55	4.63	<0. 05
V. Physical Inactivity	3	2.12	1. 09 ~ 4.15	23.69	<0.01	92	2.21	<0.05
VI. Dyslipidemia	4	1.82	1. 27 ~ 2.59	20.79	<0.01	86	3.30	<0. 05
VII. Occupational stress	3	2.31	1.86 ~ 2.86	4.35	0.11	54	7.55	<0.05

kers exhibiting a 2.70-fold increased risk compared to the general population.

III. A meta-analysis assessed obesity as a risk factor for ischemic heart disease in drivers. The initial heterogeneity test indicated high heterogeneity among the included studies (I^2= 81%, P < 0.05). Sensitivity analysis identified "Matthew S. Thiese 2017" as the primary source of heterogeneity. After excluding this study, the re-conducted meta-analysis showed a reduction in heterogeneity (I^2= 56%, P = 0.04). Consequently, a random-effects model was applied for further analysis. The final results demonstrated that obesity significantly elevated the risk of ischemic heart disease in drivers (Z = 5.37, P < 0.05), with obese drivers exhibiting a 1.54-fold increased risk compared to the general population.

IV. A meta-analysis assessed diabetes as a risk factor for ischemic heart disease in drivers. The initial heterogeneity test indicated moderate heterogeneity (I^2= 55%, P = 0.11), though it was not statistically significant. Sensitivity analysis confirmed substantial heterogeneity among the included studies, leading to the direct application of the random-effects model for further analysis. The final results demonstrated that diabetes significantly elevated the risk of ischemic heart disease in drivers (Z = 4.63, P < 0.05), with diabetic drivers exhibiting a 1.77-fold increased risk compared to the general population.

V. A meta-analysis assessed physical inactivity as a risk factor for ischemic heart disease in drivers. The initial heterogeneity test indicated substantial heterogeneity among the included studies (I^2= 92%, P < 0.05). Sensitivity analysis confirmed significant heterogeneity among the included studies, leading to the direct application of the random-effects model for further analysis. The final results demonstrated that physical inactivity significantly increased the risk of ischemic heart disease in drivers (Z = 2.21, P < 0.05), with physically inactive drivers exhibiting a 2.12-fold increased risk compared to the general population.

VI. A meta-analysis was conducted to assess dyslipidemia as a risk factor for ischemic heart disease in drivers. The initial heterogeneity test indicated substantial heterogeneity among the included studies (I^2= 86%, P < 0.05). Sensitivity analysis confirmed significant heterogeneity among the included studies, leading to the direct application of the random-effects model for further analysis. The final results demonstrated that dyslipidemia significantly elevated the risk of ischemic heart disease in drivers (Z = 3.30, P < 0.05), with drivers exhibiting a 1.82-fold increased risk compared to the general population.

VII. A meta-analysis assessed occupational stress as a risk factor for ischemic heart disease in drivers. The initial heterogeneity test indicated substantial heterogeneity among the included studies (I^2= 84%, P < 0.05). Sensitivity analysis identified "Annika Rosengren 1991" as the primary source of heterogeneity. After excluding this study, the re-conducted meta-analysis showed a reduction in heterogeneity (I^2= 54%, P = 0.11). Consequently, a random-effects model was applied for further analysis. The final results demonstrated that occupational stress significantly elevated the risk of ischemic heart disease in drivers (Z = 7.55, P < 0.05), with exposed drivers exhibiting a 2.31-fold increased risk compared to the general population.

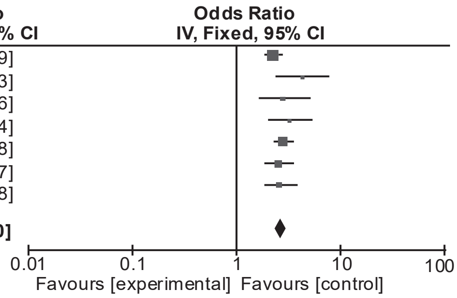
Publication bias analysis

The association between professional driving and ischemic heart disease, as well as the risk factors associated with it, was assessed for publication bias among the included studies. The funnel plot for professional driving and ischemic heart disease showed that most data points fell within the 95% confidence interval, forming a relatively symmetrical inverted funnel shape, suggesting no significant publication bias. This pattern was also observed for each risk fac-

I. Hypertension

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
ANNIKA ROSENGREN 1991	0.78845736	0.10343498	34.3%	2.20 [1.80, 2.69]
Asmaa El-Sayed Awaad 2023	1.43508452	0.30490794	3.9%	4.20 [2.31, 7.63]
J N Biuzhas 2003	1.02961942	0.29183186	4.3%	2.80 [1.58, 4.96]
Malinauskiene 2003	1.16315081	0.24167891	6.3%	3.20 [1.99, 5.14]
Matthew S. Thiese 2017	1.02245093	0.11467477	27.9%	2.78 [2.22, 3.48]
PD Wang 2001	0.91629073	0.1674408	13.1%	2.50 [1.80, 3.47]
Stefan Pires 2000	0.95551144	0.19061592	10.1%	2.60 [1.79, 3.78]
Total (95% CI)			**100.0%**	**2.58 [2.29, 2.90]**

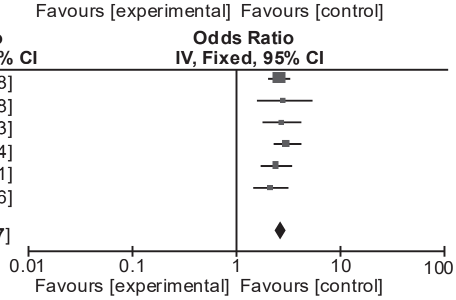
Heterogeneity: Chi² = 6.26, df = 6 (P = 0.39); I² = 4%
Test for overall effect: Z = 15.63 (P < 0.00001)



II. Smoking

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
ANNIKA ROSENGREN 1991	0.99325177	0.11530233	33.0%	2.70 [2.15, 3.38]
Asmaa El-Sayed Awaad 2023	1.06471074	0.90553653	4.7%	2.90 [1.59, 5.28]
Carolina Bigert 2003	1.02961942	0.19885562	11.1%	2.80 [1.90, 4.13]
Hedberg GE 1993	1.141093	0.14229741	21.7%	3.13 [2.37, 4.14]
Malinauskiene 2003	0.90825856	0.16224203	16.7%	2.48 [1.80, 3.41]
Stefan Pires 2000	0.78845796	0.18518801	12.8%	2.20 [1.53, 3.16]
Total (95% CI)			**100.0%**	**2.70 [2.37, 3.07]**

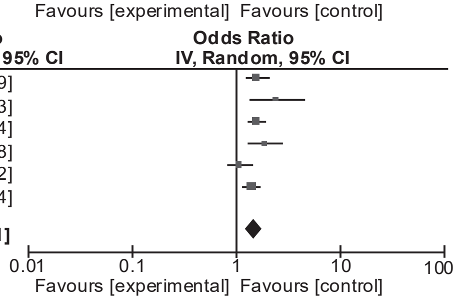
Heterogeneity: Chi² = 2.66, df = 5 (P = 0.75); I² = 0%
Test for overall effect: Z = 14.95 (P < 0.00001)



III. Obesity

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
ANNIKA ROSENGREN 1991	0.47000363	0.12234007	18.6%	1.60 [1.26, 2.09]
Asmaa El-Sayed Awaad 2023	0.91629073	0.30346532	5.8%	2.50 [1.38, 4.53]
Carolina Bigert 2003	0.48242615	0.09249576	22.8%	1.62 [1.35, 1.94]
PD Wang 2001	0.65752	0.1861687	11.9%	1.93 [1.34, 2.78]
Stefan Pires 2000	0.09531018	0.19031266	17.6%	1.10 [0.85, 1.42]
Tang Dexin 2022	0.37843644	0.08871604	23.3%	1.46 [1.23, 1.74]
Total (95% CI)			**100.0%**	**1.54 [1.32, 1.81]**

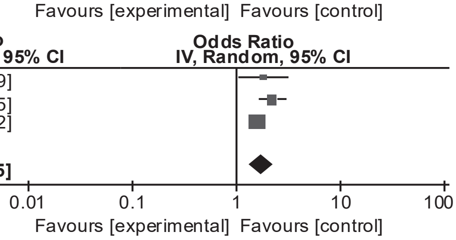
Heterogeneity: Tau² = 0.02; Chi² = 11.35; df = 5 (P = 0.04); I² = 56%
Test for overall effect: Z = 5.37 (P < 0.00001)



IV. Diabetes

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
ANNIKA ROSENGREN 1991	0.58778666	0.29118685	13.8%	1.80 [1.02, 3.19]
Carolina Bigert 2003	0.77932488	0.15361617	31.2%	2.18 [1.61, 2.95]
Matthew S. Thiese 2017	0.44468582	0.0506976	55.1%	1.56 [1.41, 1.72]
Total (95% CI)			**100.0%**	**1.77 [1.39, 2.25]**

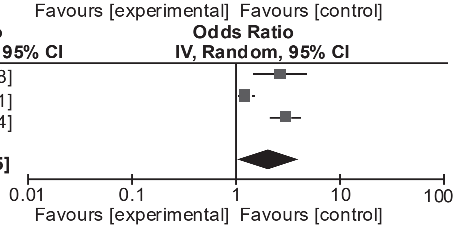
Heterogeneity: Tau² = 0.02; Chi² = 4.42; df = 2 (P = 0.11); I² = 55%
Test for overall effect: Z = 4.63 (P < 0.00001)



V. Physical Inactivity

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Asmaa El-Sayed Awaad 2023	0.99325177	0.30198217	29.10%	2.70 [1.49, 4.88]
Carolina Bigert 2003	0.23111172	0.09098851	36.60%	1.26 [1.05, 1.51]
Hedberg GE 1993	1.10856262	0.1718455	34.30%	3.03 [2.16, 4.24]
Total (95% CI)			**100.00%**	**2.12 [1.09, 4.15]**

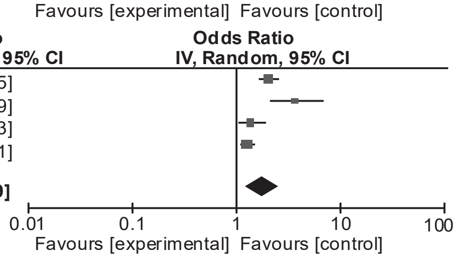
Heterogeneity: Tau² = 0.31; Chi² = 23.69; df = 2 (P < 0.00001); I² = 92%
Test for overall effect: Z = 2.21 (P < 0.03)



VI. Dyslipidemia

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
ANNIKA ROSENGREN 1991	0.74193734	0.1180162	27.8%	2.10 [1.67, 2.65]
Asmaa El-Sayed Awaad 2023	1.33500107	0.30346532	16.7%	3.80 [2.10, 6.89]
PD Wang 2001	0.35065687	0.15528822	25.6%	1.42 [1.05, 1.93]
Stefan Pires 2000	0.26236426	0.07767581	29.8%	1.30 [1.12, 1.51]
Total (95% CI)			**100.0%**	**1.82 [1.27, 2.59]**

Heterogeneity: Tau² = 0.10; Chi² = 20.79; df = 3 (P = 0.0001); I² = 86%
Test for overall effect: Z = 3.30 (P = 0.0010)



VII. Occupational stress

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Carolina Bigert 2003	0.5068176	0.19845503	20.6%	1.66 [1.13, 2.45]
Hedberg GE 1993	1.02245093	0.14953445	28.8%	2.78 [2.07, 3.73]
Tang Dexin 2022	0.86288995	0.06351213	50.6%	2.37 [2.09, 2.68]
Total (95% CI)			**100.0%**	**2.31 [1.86, 2.86]**

Heterogeneity: Tau² = 0.02; Chi² = 4.35; df = 2 (P = 0.11); I² = 54%
Test for overall effect: Z = 7.55 (P < 0.00001)

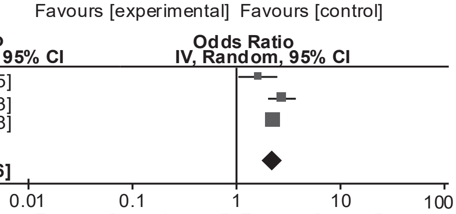


Figure 3. Forest plot of the meta-analysis on combined risk factors and ischemic heart disease in drivers.

tor in professional drivers, reinforcing the stability of the meta-analysis findings. These results are illustrated in figure 4.

Discussion

This study systematically evaluated the impact of multiple factors, including professional driving, hypertension, smoking, obesity, diabetes, physical inactivity, dyslipidemia, and occupational stress, on the risk of ischemic heart disease in professional drivers. The meta-analysis incorporated studies published from January 1990 to December 2024. The findings demonstrated that occupational exposure, chronic diseases, and lifestyle factors substantially elevate the risk of ischemic heart disease in professional drivers.

The strong association between professional driving and ischemic heart disease suggests that driving as an occupation is a significant risk factor. A 2019 study by Wang L et al. reported that professional drivers with extended driving hours faced a significantly higher risk of cardiovascular disease than individuals in other occupations. The study found that professional drivers had a 1.8-fold increased risk of cardiovascular disease (OR = 1.80, 95% CI: 1.60-2.10)[1], a conclusion that aligns with the findings of the present study. Hypertension and smoking were identified as

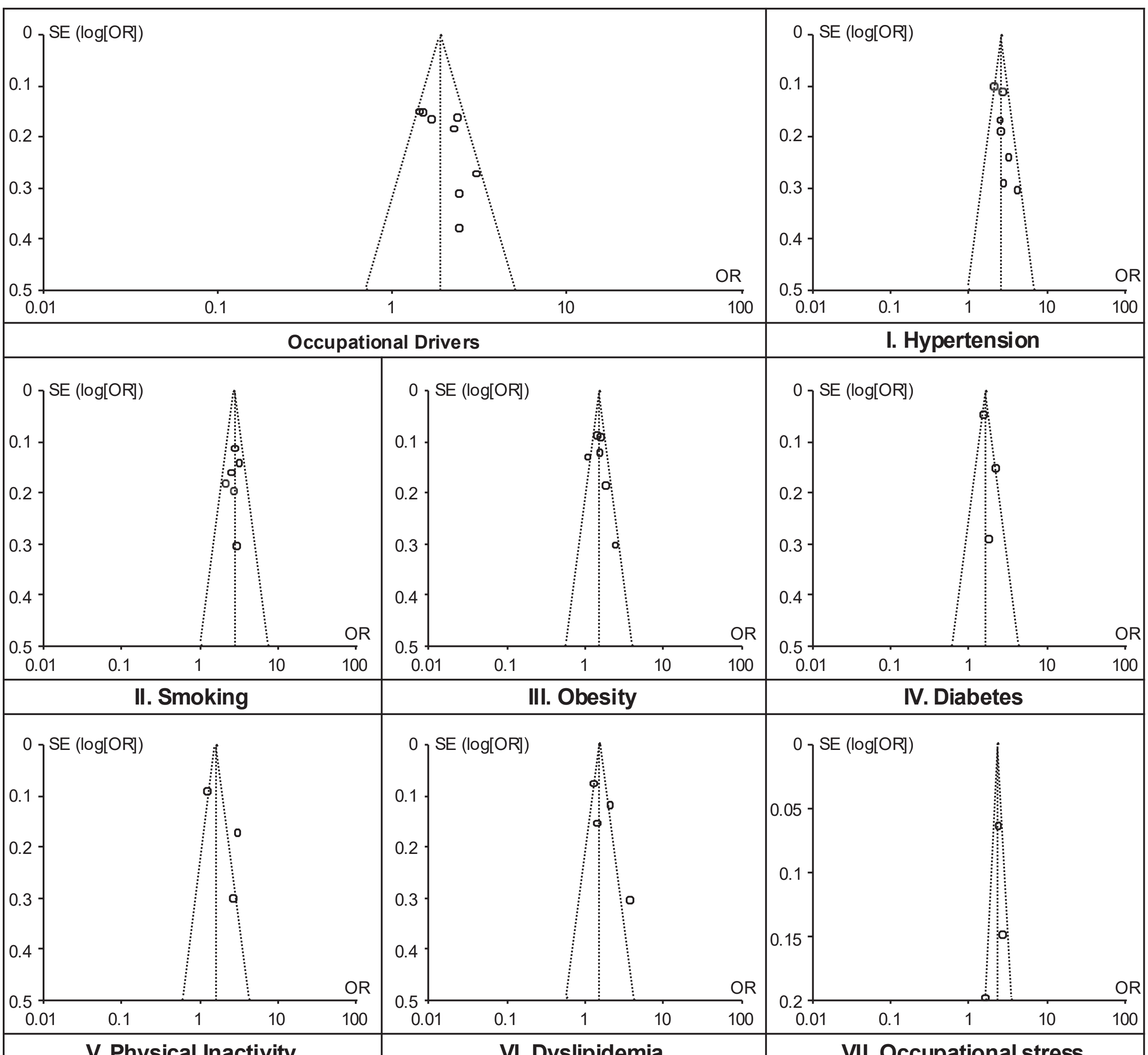


Figure 4. Funnel plot of the meta-analysis on combined risk factors in drivers.

independent and significant risk factors for ischemic heart disease in professional drivers. Wang M et al. reported that hypertensive individuals had a 2.6-fold increased risk of ischemic heart disease compared to those with normal blood pressure (OR = 2.60, 95% CI: 2.30-2.90) [17]. Smoking is widely recognized as a significant risk factor for ischemic heart disease. Hernandez J et al. demonstrated that smokers exhibited a 2.5-fold increased risk of ischemic heart disease (OR = 2.50, 95% CI: 2.20-2.80)[18]. The present study confirmed that hypertension and smoking among professional drivers were significantly associated with an increased risk of ischemic heart disease (OR = 2.58, 95% CI: 2.29-2.90) and (OR = 2.70, 95% CI: 2.37-3.07), reinforcing the critical role of these factors in disease development. Obesity, diabetes, and physical inactivity were also identified as key risk factors in this study, consistent with the global trend of increasing cardiovascular disease prevalence. Zhang J et al. reported that the incidence of ischemic heart disease was 2.1 times higher in obese individuals (OR = 2.10, 95% CI: 1.80-2.40) and 2.3 times higher in diabetic individuals (OR = 2.30, 95% CI: 2.00-2.60)[19]. The present study further demonstrated significant associations between obesity (OR = 1.54, 95% CI: 1.32-1.81) and diabetes (OR = 1.77, 95% CI: 1.39-2.25) with an increased risk of ischemic heart disease. Dyslipidemia is another critical risk factor for ischemic heart disease. Xu L et al. identified dyslipidemia as a major contributor to coronary atherosclerosis. Research has demonstrated that individuals with elevated cholesterol and low-density lipoprotein levels face a 2.4-fold increased risk of ischemic heart disease (OR = 2.40, 95% CI: 2.10-2.70)[20]. The present study further confirmed a significant association between dyslipidemia in drivers and ischemic heart disease (OR = 1.82, 95% CI: 1.27-2.59). Occupational stress is also a significant determinant of cardiovascular health in professional drivers. A 2017 study by Zhao X et al. demonstrated that professional drivers exposed to chronic work stress had a 2.4-fold increased risk of cardiovascular disease (OR = 2.40, 95% CI: 2.10-2.70), highlighting that high workload and stressful work environments significantly increase the likelihood of ischemic heart disease in these drivers[2]. The present study supports this finding, demonstrating that occupational stress substantially contributes to the incidence of ischemic heart disease in drivers (OR = 2.31, 95% CI: 1.86-2.86). Both the random-effects and fixed-effects models applied in this study confirmed the significant impact of these risk factors on ischemic heart disease development. Sensitivity analysis and heterogeneity testing in this study further validated the significant association between these factors and ischemic heart disease, providing a scientific basis for targeted health interventions in professional drivers. Future research should investigate additional potential risk factors, including environmental pollution, prolonged driving hours, and dietary patterns, in relation to ischemic heart disease. Despite addressing multiple established risk factors, this study has certain limitations. First, the number of included studies was relatively small, with certain risk factors (e.g., diabetes and physical inactivity) examined in only three studies, potentially limiting the generalizability and reliability of the findings. A small sample size may reduce statistical power, thereby affecting the stability and credibility of the results. Therefore, future studies should incorporate larger sample sizes to generate more robust conclusions. Second, substantial heterogeneity was observed among the included studies. For instance, the I^2values for physical inactivity and dyslipidemia were 92% and 86%, respectively, indicating considerable variability among study findings. This heterogeneity may originate from variations in study design, sample selection, and measurement criteria. Although the heterogeneity test reached statistical significance, the high degree of heterogeneity necessitates a cautious interpretation of these findings. Future research should standardize the definition and assessment of risk factors and implement multicenter, large-scale prospective studies to validate these findings.

In summary, professional drivers are exposed to numerous risk factors for cardiovascular disease. Targeted interventions and preventive measures-particularly those aimed at improving lifestyle, managing hypertension and diabetes, and reducing occupational stress-will be essential in lowering the incidence and mortality of ischemic heart disease.

Conflict of interest. The authors declare that there is no conflict of interest.

Authors' contributions. GF-Z designed the research; GR-Z performed meta-analysis; GR-Z and GF-Z wrote and edited the paper. All authors reviewed the manuscript.

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Availibality of data. All data used in this meta-analysis are publicly available. The datasets used in this study are available in online repositories, and the names of these repositories can be found in the article.

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