Influence of Grip Strength and the Onset of Musculoskeletal Disorders in Professional Drivers in Ibarra and Chone, 2024

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KEYWORDS
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ABSTRACT:
B Musculoskeletal disorders represent a significant problem in the workplace, affecting the health and productivity of workers, potentially leading to permanent disabilities. They are common in occupations involving repetitive activities or prolonged postures. The aim of the study was to determine the influence of grip strength on the onset of musculoskeletal disorder symptoms in professional drivers. A cross-sectional, quantitative, descriptive, correlational, non-experimental study was conducted, the sample consisted of 277 professional drivers. Grip strength was measured using a CAMRY hand dynamometer, and the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) was administered. Drivers exhibited adequate grip strength, with a slight dominance in the right hand (42.1 kg vs. 41.6 kg), 22% (n=61) of the drivers were at moderate or high risk of musculoskeletal disorders in the neck, 17% (n=46) in the shoulders, and 25% (n=68) in the lower back. In conclusion, no statistically significant association was found between grip strength and the occurrence of MSDs; grip strength alone is not a determining factor in the development of these disorders in the studied population.

1. Introduction

Musculoskeletal disorders (MSDs) represent a significant issue in the workplace due to their high prevalence and impact on workers' health and productivity. As Balderas (2019) points out, these disorders affect various structures of the body, including muscles, joints, tendons, ligaments, nerves, bones, and the circulatory system, and are frequently triggered or exacerbated by repetitive or prolonged activities [1]. The CMQD questionnaire is a tool used to assess the degree of musculoskeletal discomfort in various parts of the body. Each item of the questionnaire is designed to provide a detailed view of how pain or discomfort affects the worker, both in terms of their ability to perform work tasks and their overall well-being [2].

The World Health Organization (WHO) recognizes more than 150 disorders that affect the musculoskeletal system, ranging from acute injuries to chronic diseases that can result in permanent disabilities [3].

According to data from the WHO and the International Labour Organization (ILO), in 2016, work-related illnesses and injuries resulted in the loss of 1.9 million lives worldwide, underscoring the magnitude of the problem. [4]. Globally, it is estimated that approximately 1.71 billion people suffer from some type of musculoskeletal disorder, affecting individuals of all ages [5,6].

Professional drivers are exposed to multiple risk factors that may contribute to the development of MSDs, such as grip strength, prolonged posture, and exposure to vibrations, making them a vulnerable group [7]. In a cross-sectional study conducted in 2021 in Yaoundé, Cameroon, involving 151 professional taxi drivers, a high prevalence of MSDs (86.8%) was identified, with the most affected areas being the lower back (72.8%), neck (42.4%), and knees [8]. Similarly, in Ecuador, recent research has shown that a high percentage of drivers experience musculoskeletal discomfort, with 43.7% affected, highlighting the need for more specific studies addressing factors such as grip strength [9].

Although previous research on MSDs in drivers exists, there is a notable absence of recent studies that specifically examine grip strength as a determining factor in the early detection and prevention of these disorders. This justifies the need to address this gap in the current literature by exploring the association between grip strength and the onset of MSDs, contributing to a more comprehensive approach in the assessment and management of drivers' occupational health. Therefore, the present study aims to determine the influence of grip strength on the onset of MSD symptoms in professional drivers and to establish a foundation for future research.

2. Materials And Methods

A cross-sectional, quantitative, descriptive, and correlational study with a non-experimental design was conducted. The study took place from March 1, 2024, to August 30, 2024, under the supervision of the Postgraduate Department of the Universidad Técnica del Norte. The population consisted of 1,011 professional taxi drivers from Ibarra and Chone, belonging to the Provincial Association of Professional Drivers of Imbabura and the Association of Chone Drivers and the sample size was calculated using the statistical formula for finite populations with a 95% confidence level and a 5% margin of error, resulting in a total of 277 individuals.

The subjects were selected based on inclusion and exclusion criteria. The inclusion and exclusion criteria were as follows: Inclusion criteria: Drivers with at least six months of experience of both genders, without any pathology that would prevent proper hand grip, and aged between 20 and 70 years. Exclusion criteria: Drivers who do not voluntarily participate, do not sign the informed consent, suffer from a pathology that impedes proper hand grip, or do not complete the survey.

Professional drivers were recruited after a series of meetings with the representatives and members of both Associations. The professional drivers voluntarily attended the premises of their Associations, both in Chone and Ibarra, where they agreed to participate in the study and signed the informed consent form. For the measurement of the drivers' handgrip strength, a CAMRY hand dynamometer was used, and the Cornell Musculoskeletal Discomfort Questionnaire was employed to assess the presence of musculoskeletal disorders.

The CAMRY dynamometer is equipped with a high-precision sensor to measure tension, allowing for accurate grip strength measurements, with a maximum capacity of 198 lb/90 kg and an accuracy of 0.2 lb/100 g. Participants were instructed to squeeze the dynamometer handle as hard as possible while seated upright, with their arms at their sides, elbows flexed at 90°, and forearms in a neutral position. Due to time limitations for the grip strength test, a single submaximal practice trial was conducted for each hand, followed by a 30-second rest and a single maximum trial lasting 3 to 4 seconds for each hand (Figure 1). Grip strength was measured by age and sex groups, with the profiles of age and sex being entered into the dynamometer. The ranges for weak, normal, and strong grip strength measurements are found on page 6 of the user manual in English [10] and on page 11 of the user manual in Spanish [11].

The CMDQ questionnaire consists of several items designed to assess three key aspects: the frequency, intensity of discomfort, and the interference of this discomfort with work in nine body areas: Neck; Shoulders; Upper back; Lower back (lumbar region); Arms and elbows (right and left); Wrists and hands (right and left); Hips and thighs; Knees (right and left); and Legs and feet. The process for calculating scores using the CMDQ is based on the combination of three key elements: frequency of discomfort, level of discomfort, and degree of interference with daily activities. The calculation is as follows: Frequency of discomfort: The frequency with which the individual experiences discomfort is evaluated using the following categories and their respective weighted scores: Never: 0; 1-2 times/week: 1.5; 3-4 times/week:

3.5; Every day: 5; Several times a day: 10. Level of discomfort: Participants rate the level of discomfort they feel on a scale from 1 to 3, where: 1: Mild discomfort; 2: Moderate discomfort; 3: Severe discomfort. Degree of interference: Finally, the extent to which discomfort interferes with daily activities is assessed on a scale of 1 to 3: 1: Low interference; 2: Moderate interference; 3: High interference [12].

Total Score for Each Body Part: For each of the nine body parts evaluated in the CMDQ (such as the neck, shoulders, back, etc.), the total score is calculated by multiplying the frequency score (0, 1.5, 3.5, 5, 10), by the discomfort score (1, 2, 3), by the interference score (1, 2, 3). For example, if a participant reports experiencing neck discomfort 3-4 times per week (3.5), with moderate discomfort (2), and low interference (1), the score for that body part would be: (Discomfort 3-4 times per week) 3.5 × (moderate discomfort) 2 ×

(low interference) 1 = 3.5 × 2 × 1 = 7. The risk of developing MSDs is determined based on the total scores obtained for each body part. A higher risk is associated with higher scores, as they reflect a combination of discomfort frequency, level of discomfort, and the impact on daily life. Lower scores suggest a lower risk or occasional discomfort with low interference in daily activities; moderate scores indicate a higher frequency or severity of discomfort, with more noticeable interference in daily life, while high scores reflect a high frequency of severe discomfort that considerably interferes with daily activities, indicating a high risk of developing MSDs [12].

The collected data were entered into a database, and the analysis included frequency, percentage, and the use of various statistical tests, such as the Chi² test, Odds Ratio, and Relative Risk. IBM SPSS Statistics version 26.0 was used as the statistical analysis software, with a significance level of $p < 0.05$. Participant confidentiality was ensured, and informed consent was obtained prior to data collection, in accordance with current ethical standards.

3. Results

The study population consisted of 277 professional drivers aged between 22 and 68, with a mean age of 39 ± 6.19 years. Of these, 89.9% were male, with the highest prevalence in the 50 to 59 age range (27.1%), followed by the 30 to 39 and 40 to 49 ranges (21.7% each). Regarding the duration of their professional driving career, 36.8% had between 1 to 9 years of experience, followed by the 10 to 19 years range with 26.7% (Table 1).

Table 1 Sociodemographic Data of Professional Drivers in Ibarra and Chone, 2024

Item	frecuency
Gender	
Female	28 (10.1 %)
Male	249 (89.9 %)
Age	
20-29 years	37 (13.4 %)
30-39 years	60 (21.7 %)
40-49 years	60 (21.7 %)
50-59 years	75 (27.1 %)
≥ 60 years	45 (16.2 %)
Years as a professional driver	
1 to 9 years	102 (36.8 %)
10 to 19 years	74 (26.7 %)
20 to 29 years	52 (18.8 %)
30 to 39 years	34 (12.3 %)
40 to 49 years	15 (5.4 %)
n = 277	

In relation to the measurement of grip strength through dynamometry, it is evident that the strength in the right hand is slightly higher than that of the left hand (42.1 vs. 41.6 kg), with a median of 42.8 kg for the right hand and 41.8 kg for the left; SD ± 9.03 kg for the right hand and ± 8.86 kg for the left. The minimum values are identical in both hands (26.6 kg), but the maximum is slightly higher in the right hand (R: 62.2 kg vs. L: 60.1 kg), results that suggest a homogeneous distribution of grip strength between both hands, with a slight preference for the right hand, which is consistent with the general population's manual dominance (Table 2).

Table 2 Grip Strength Dynamometry in Professional Drivers in Ibarra and Chone, 2024

Measure	Right hand Dynanometry	Left hand Dynanometry
Mean	42.1	41.6
Median	42.8	41.8
Mode	44.6	51.3
Standard Deviation	9.03	8.86

Variance	81.5	78.6
Minimum	26.6	26.6
Maximum	62.2	60.1

Note: The unit of measurement for grip strength is the kilogram.
n = 277

Regarding the evaluation of grip strength in the right hand, 65% exhibit normal grip strength, 20.2% weak, and only 14.8% have strong grip strength. This suggests that the majority of drivers maintain adequate strength (Table 3).

Table 3 Grip Strength in Professional Drivers in Ibarra and Chone, 2024

Rip strength	frecuency
Right hand	
Weak HGS	56 (20.2 %)
Strong HGS	41 (14.8 %)
Normal HGS	180 (65.0 %)
Left hand	
Weak HGS	63 (22.7 %)
Strong HGS	42 (15.2 %)
Normal HGS	172 (62.1 %)

Note: Hand grip strength ranges [10,11]. *HGS = Hand Grip Strength.
n = 277

Concerning the risk of developing musculoskeletal disorders (MSDs), 22% of the drivers were at moderate or high risk of MSDs in the neck, while 78% had a low or no risk, with the neck being one of the most affected areas. Regarding the shoulders and upper back, 17% and 22% of drivers, respectively, were at moderate/high risk, suggesting a relationship between posture, physical exertion, and the occurrence of discomfort in these regions. In reference to the lower back, 25% of the drivers had a moderate/high risk, while the elbows and ankles showed the lowest percentages of moderate/high risk (8% and 6%, respectively) (Table 4).

Table 4 Risk of Musculoskeletal Disorders in Professional Drivers in Ibarra and Chone, 2024

Body Part	No risk MSDs* and Low risk MSDs	Moderate risk MSDs and Hight risk MSDs
Neck	216 (78%)	61 (22%)
Shoulders	231 (83%)	46 (17%)
Upper back	216 (78%)	61 (22%)
Lower back	209 (75%)	68 (25%)
Elbows	255 (92%)	22 (8%)
Wrists/hands	240 (87%)	37 (13%)
Hips/thighs	236 (85%)	41 (15%)
Knees	227 (82%)	50 (18%)
Ankles	258 (93%)	19 (7%)

*MSDs = Musculoskeletal Disorders
**Musculoskeletal disorder risk calculation according to the Cornell questionnaire [12].
n = 277

In relation to the impact on work performance, 51% of drivers reported that musculoskeletal discomfort affected their ability to perform their job, while 49% indicated that they had not experienced such an impact, highlighting the importance of these conditions in job performance. Regarding the search for medical treatment, only 27% of the affected drivers sought medical care, compared to 73% who did not, indicating a low tendency to seek medical assistance, which may be related to the underestimation of the severity of the discomfort or potential barriers to accessing healthcare services. In terms of absenteeism due to musculoskeletal discomfort, 28% of drivers missed work due to such discomfort, while 72% did not; despite the majority not being absent, the percentage of those who did is significant and suggests an economic impact associated with these conditions (Table 5).

Table 5 Influence of Musculoskeletal Discomfort on Work Capacity in Professional Drivers in Ibarra and Chone, 2024

Item	Yes	No
Has this discomfort affected your ability to work?	140 (51%)	137 (49%)
Have you sought medical treatment for this discomfort?*	75 (27%)	202 (73%)
Have you ever missed work due to musculoskeletal discomfort?	78 (28%)	199 (72%)

Note: The questions do not belong to the CMDQ Questionnaire. *Medical treatment refers to having consulted any healthcare professional for musculoskeletal discomfort.
n = 277

Among the drivers who missed work due to musculoskeletal discomfort, 19% were absent for 1 to 2 days, 7% for 3 to 5 days, and only 2% were absent for more than 5 days; however, the fact that 72% did not miss work suggests that, although discomfort is prevalent, it is generally not severe enough to warrant prolonged absences (Table 6).

Table 6 Days Absent from Work Due to Musculoskeletal Discomfort

Item	frecuency
None	199 (72%)
1-2 days	53 (19%)
3-5 days	19 (7%)
More than 5 days	6 (2%)

Note: The questions do not belong to the CMDQ Questionnaire. *Days of absence over a 3-month period
n = 277

In relation to grip strength and the risk of developing musculoskeletal disorders, in both hands (right and left), the proportion of individuals at moderate/high risk is low (2%) for those with weak or strong grip strength, while it is notably higher for those with normal grip strength (Table 7).

Table 7 Grip Strength and Risk of Musculoskeletal Disorders in Professional Drivers in Ibarra

Item	Moderate risk MSDs* and High risk MSDs	No risk MSDs and Low risk MSDs
Right hand		
Weak Grip Strength	5 (2%)	51 (18%)
Normal Grip Strength	20 (7%)	160 (58%)
Strong Grip Strength	6 (2%)	35 (13%)
Left hand		
Weak Grip Strength	5 (2%)	58 (21%)
Normal Grip Strength	20 (7%)	152 (55%)
Strong Grip Strength	6 (2%)	36 (13%)

Note: MSD = Musculoskeletal Disorders n = 277

When performing the hypothesis test, it is observed that the Chi² values are low in all cases. The odds ratio (OR) values range from less than 1 to more than 1, but all 95% confidence intervals include the value of 1; furthermore, the p-values are greater than 0.05. These results indicate that there is no statistically significant evidence to reject the null hypothesis in any of the scenarios. Therefore, no significant association is found between grip strength and musculoskeletal disorders in drivers, concluding that grip strength does not appear to have a clear and consistent effect on the risk of developing musculoskeletal disorders (Table 8)

Table 8 Influence of Grip Strength on the Risk of Musculoskeletal Disorders in Professional Drivers Ibarra and Chone 2024

	Moderate Risk MSD and High Risk MSD vs no Risk MSD and Low Risk MSD					
Grip Strength	Chi²	p-value	Odds Ratio (OR)	OR 95% CI	Relative Risk (RR)	RR 95% CI
Weak HRGS vs Normal HRGS	0.215	0.643	0.784	[0.280, 2.20]	0.804	[0.316, 2.04]

Strong HRGS vs Normal HRGS	0.399	0.527	1.37	[0.513, 3.66]	1.32	[0.565, 3.07]
Weak HRGS vs Strong HRGS	0.766	0.381	0.572	[0.162, 2.02]	0.610	[0.200, 1.86]
Weak HLGS vs Normal HLGS	0.661	0.416	0.655	[0.235, 1.83]	0.683	[0.268, 1.74]
Strong HLGS vs Normal HLGS	0.223	0.636	1.27	[0.474, 3.38]	1.23	[0.526, 2.87]
Weak HLGS vs Strong HLGS	1.08	0.298	0.517	[0.147, 1.82]	0.556	[0.181, 1.70]

Note: MSD= Musculoskeletal Disorders HRGS= Hand Rigth Grip Strength HLGS = Hand Left Grip Strength

For females, the p-values are greater than 0.05 in all comparisons, suggesting that there is insufficient evidence to reject the null hypothesis (H_0), meaning there is no association between grip strength and musculoskeletal disorders. In the case of males, although some comparisons show p-values < 0.5, these do not reach a statistically significant level, so the null hypothesis (H_0) is accepted, that is, there is no association between grip strength and the occurrence of musculoskeletal disorders in either gender (Table 9).

Table 9 Influence of Grip Strength on the Risk of Musculoskeletal Disorders by Gender in Professional Drivers Ibarra and Chone 2024

Grip Strength	Moderate Risk MSD* and High Risk MSD vs No risk MSD and Low Risk MSD					
	Chi²	p-value	Odds Ratio (OR)	OR 95% CI	Relative Risk (RR)	RR 95% CI
Female						
Weak HRGS** vs Normal HRGS	122.283	0.269	0.305	[0.0132, 7.09]	0.000	[0.000, 0.000]
Strong HRGS vs Normal HRGS	0.419	0.517	0.829	[0.0320, 21.43]	0.00	[0.000, 0.000]
Weak HRGS vs Strong HRGS	NaN	NaN	NaN	[NaN, NaN]	NaN	[NaN, NaN]
Weak HLGS vs Normal HLGS	1.147	0.284	0.326	[0.0141, 7.55]	0.000	[0.000, 0.000]
Strong HLGS vs Normal HLGS	0.263	0.608	1.24	[0.0450, 34.20]	0.00	[0.00, 0.00]
Weak HLGS vs Strong HLGS	NaN	NaN	NaN	NaN	NaN	NaN
Male						
Weak HRGS vs Normal HRGS	0.00428	0.948	0.966	[0.338, 42.76]	0.969	[0.380, 2.47]
Strong HRGS vs Normal HRGS	0.683	0.409	1.521	[0.559, 5.13]	1.44	[0.612, 3.38]
Weak HRGS vs Strong HRGS	0.495	0.482	0.635	[0.178, 2.27]	0.674	[0.223, 2.04]
Weak HLGS vs Normal HLGS	0.227	0.634	0.777	[0.273, 2.20]	0.797	[0.311, 0.311]
Strong HLGS vs Normal HLGS	0.338	0.561	1.34	[0.495, 3.64]	1.29	[0.549, 3.04]
Weak HLGS vs Strong HLGS	0.733	0.392	0.578	[0.163, 2.05]	0.617	[0.203, 1.88]

Note: MSD= Musculoskeletal Disorders HRGS= Hand Rigth Grip Strength HLGS = Hand Left Grip Strength NaN = Not-A-Number

The null hypothesis is accepted in all cases. In workers with 24 years or less of service, the association between weak grip strength in the right hand and the risk of musculoskeletal disorders is not significant ($\chi^2 = 13.496$, p-value = 0.245, OR = 0.422, RR = 0.469), suggesting that the null hypothesis (H_0) cannot be rejected in this group. Similarly, in workers with 25 years or more of service, the association between weak grip strength in the left hand and the risk of musculoskeletal disorders is also not significant ($\chi^2 = 11.099$, p-value = 0.292, OR = 0.385), reinforcing that there is insufficient evidence to reject the independence between the variables in this case. The high Chi² results could indicate an area of interest despite not being statistically significant (Table 10).

Table 10 Influence of Grip Strength on the Risk of Musculoskeletal Disorders by Years of Service in Professional Drivers Ibarra and Chone 2024

Grip Strength	Moderate Risk MSD and High Risk MSD vs No risk MSD and Low Risk MSD*					
	Chi²	p-value	Odds Ratio (OR)	OR 95% CI	Relative Risk (RR)	RR 95% CI
Years of Service ≤ 24						
Weak HRGS vs Normal HRGS**	0.23426	0.628	0.753	[0.237, 2.39]	0.773	[0.269, 2.22]
Strong HRGS vs Normal HRGS	0.9057	0.341	1.782	[0.535, 5.94]	1.646	[0.599, 4.53]
Weak HRGS vs Strong HRGS	13.496	0.245	0.422	[0.0955, 1.87]	0.469	[0.129, 1.71]
Weak HLGS*** vs Normal HLGS	0.0860	0.769	0.851	[0.2882, 2.51]	0.864	[0.323, 2.31]
Strong HLGS vs Normal HLGS	1.169	0.280	1.843	[0.6006, 5.66]	1.698	[0.6569, 4.39]
Weak HLGS vs Strong HLGS	1.342	0.247	0.462	[0.1220, 1.75]	0.509	[0.160, 1.62]
Years of Service ≥ 25						
Weak HRGS vs Normal HRGS	0.00651	0.936	1.100	[0.108, 11.15]	1.086	[0.148, 7.94]
Strong HRGS vs Normal HRGS	0.0468	0.829	0.825	[0.144, 4.72]	0.844	[0.181, 3.94]
Weak HRGS vs Strong HRGS	0.0481	0.826	1.333	[0.1013, 17.55]	1.286	[0.137, 12.03]
Weak HLGS vs Normal HLGS**	11.099	0.292	0.385	[0.0195, 7.58]	0.000	[0.000, 0.000]
Strong HLGS vs Normal HLGS	0.562	0.454	0.440	[0.0491, 3.95]	0.484	[0.0653, 0.0653]
Weak HLGS vs Strong HLGS	0.487	0.485	0.641	[0.0228, 18.05]	NaN****	[NaN, NaN]

Note: *MSD= Musculoskeletal Disorders **HRGS= Hand Rigth Grip Strength *** HLGS = Hand Left Grip Strength ****NaN = Not-A-Number

Regarding the relationship between grip strength and the risk of musculoskeletal disorders, in individuals aged 45 years or younger, strong grip strength in the right hand is associated with a higher risk of developing these disorders ($\chi^2 = 5.134$, p-value = 0.023, OR = 4.514, RR = 3.236), leading us to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_1), meaning there is an association between grip strength and musculoskeletal disorders in this age group. In contrast, weak grip strength in the same hand in this age group is associated with a significantly lower risk of musculoskeletal disorders ($\chi^2 = 7.181$, p-value = 0.007, OR = 0.103, RR = 0.153). However, for individuals aged 46 years or older, no significant association was found between grip strength and the risk of disorders, as the χ^2 (10.600), p-value (0.303), OR (0.345), and RR (0.374) values do not support a clear relationship, suggesting that, in this age group, grip strength is not a determining factor in the occurrence of musculoskeletal disorders. Therefore, grip strength may be a factor associated with the risk of musculoskeletal disorders only in younger individuals (Table 11).

Table 11 Influence of Grip Strength on the Risk of Musculoskeletal Disorders by Age Range in Professional Drivers Ibarra and Chone 2024

Item	Moderate Risk and High Risk MSD vs No risk and Low Risk MSD					
	Chi²	p-value	Odds Ratio (OR)	OR 95% CI	Relative Risk (RR)	RR 95% CI
Age ≤ 45 years						
Weak HRGS vs Normal HRGS**	0.953	0.329	0.465	[0.0966, 2.23]	0.494	[0.114, 2.15]
Strong HRGS vs Normal HRGS	5.134	0.023	4.514	[1.120, 18.19]	3.236	[1.220, 2.15]
Weak HRGS vs Strong HRGS	7.181	0.007	0.103	[0.0157, 0.676]	0.153	[0.0322, 0.725]
Weak HLGS vs Normal HLGS***	0.0733	0.787	0.844	[0.2479, 2.88]	0.860	[0.2871, 2.58]
Strong HLGS vs Normal HLGS	0.5741	0.449	1.90	[0.353, 10.23]	1.72	[0.437, 6.77]
Weak HLGS vs Strong HLGS	0.758	0.384	0.444	[0.0690, 2.86]	0.500	[0.1062, 2.35]
Age ≥ 46 years						
Weak HRGS vs Normal HRGS	0.255	0.613	1.429	[0.355, 35.75]	1.365	[0.413, 4.51]
Strong HRGS vs Normal HRGS	0.472	0.492	0.579	[0.119, 2.80]	0.607	[0.141, 2.61]
Weak HRGS vs Strong HRGS	0.926	0.336	2.471	[0.374, 16.320]	2.250	[0.412, 12.284]
Weak HLGS vs Normal HLGS	10.600	0.303	0.345	[0.0419, 2.85]	0.374	[0.0504, 2.77]
Strong HLGS vs Normal HLGS	0.0170	0.896	1.09	[0.315, 3.74]	1.07	[0.363, 3.19]
Weak HLGS vs Strong HLGS	1.076	0.300	0.318	[0.0332, 3.05]	0.348	[0.0416, 2.91]

Note: MSD: Musculoskeletal Disorders;; HRGS= Hand Rigth Grip Strength; HLGS = Hand Left Grip Strength; NaN = Not-A-Number

4. Discussion

The study reveals that most of the evaluated drivers (65% right hand; 62% left hand) exhibit grip strength within normal parameters. However, a slight superiority of strength in the right hand is noted, which could be attributed to the general population's manual dominance. Additionally, most drivers possess adequate grip strength to perform their occupational tasks.

The study results indicate that 25% of drivers are at moderate or high risk of musculoskeletal disorders (MSDs) in the lower back, while 75% are at low or no risk. These results are lower than those found in the study by Becerra et al. [13] in professional drivers in Lima, where 82.7% had low back pain and 68.3% had upper back pain. In a subsequent study by Becerra and Vela [14], low back pain was present in 40% of workers employed as laborers, sales personnel, and professional drivers.

The impact on work capacity and the low percentage of drivers seeking medical treatment (27%) may be related to the underestimation of symptom severity, a situation that may be caused by barriers to healthcare access, as discussed in the action plan for MSD prevention, which highlights the need to raise awareness and improve access to health services [15]. In a study conducted on drivers from a transportation company in Bogotá, despite having neck (31%), shoulder (28%), lumbar region (34%), elbow/forearm (12%), and hand/wrist (17%) discomfort, most drivers did not receive medical attention [16].

This study did not find a significant association between grip strength and MSDs in women, consistent with Nordander et al. [17], who reported that, in female industrial workers, p-values were greater than 0.05, suggesting that grip strength is not a relevant predictor for the development of MSDs in women. However, in men, p-values mostly did not reach the significance threshold ($p < 0.05$), consistent with the results of this analysis, where the null hypothesis cannot be rejected for either gender.

A significant association was found between strong right-hand grip strength and a higher risk of MSDs in individuals aged 45 or younger, contrasting with the lack of association in individuals over 46. This pattern is similar to that reported by Silverstein et al. [18], who found that grip strength is a more relevant risk factor in younger age groups, possibly due to greater physical effort and less adaptation to musculoskeletal wear related to aging.

The lack of significance in the association between weak grip strength and MSDs in workers with less than 25 years of service is consistent with Punnett et al. [19], who highlight that the duration of occupational exposure has a moderating impact on the development of MSDs, but this effect is more noticeable in individuals with prolonged exposure (more than 25 years). Thus, the current results reinforce the idea that weak grip strength in workers with less service time is not a significant predictor of MSDs.

The present study on the influence of grip strength and the occurrence of musculoskeletal disorders (MSDs) in professional drivers presents several limitations that should be considered. Firstly, the cross-sectional design limits the ability to establish causal relationships between grip strength and MSDs, as the data was collected at a single point in time, preventing the assessment of how grip strength evolution over time may influence MSD development.

Secondly, although a precise dynamometer was used to measure grip strength, other factors that could influence the results, such as accumulated fatigue or individual differences in driving technique, were not considered. These factors could bias the observed association between grip strength and MSDs. Moreover, the study sample was predominantly male (89.9%, n=249), which limits the generalizability of the results to female drivers. While gender-specific analyses were conducted, the proportion of women was insufficient to draw robust conclusions for this group.

Finally, the assessment of MSDs was based on a self-reported questionnaire (CMQD), which may be subject to recall bias or symptom underestimation. It is important to consider that the lack of access to healthcare services, identified as a barrier to seeking treatment, could also influence participants' willingness to accurately report their symptoms.

These limitations suggest the need for longitudinal studies that include greater female representation, more comprehensive evaluation of risk factors, and more rigorous symptom tracking over time to strengthen the understanding of the relationship between grip strength and MSDs in professional drivers.

5. Conclusions

Most professional drivers evaluated exhibit adequate grip strength, with a slight preference for the right hand, reflecting typical manual dominance. However, 23% of these workers are at moderate or high risk of developing musculoskeletal disorders, particularly in areas such as the neck (22%), upper (22%), and lower back (25%), and shoulders (17%), related to posture and physical exertion required by their occupation. Additionally, half of the drivers report that these discomforts affect their ability to work, although most do not seek medical care.

No statistically significant association was found between grip strength and the onset of MSDs. Grip strength alone is not a determining factor in the development of these disorders in the studied population. Furthermore, there is a prevalence of musculoskeletal discomfort, especially in the neck and lower back, highlighting the importance of other factors such as seat quality and driving posture in the occupational health of drivers. This implies the need for ergonomic interventions and preventive strategies aimed at reducing the risk of MSDs beyond grip strength evaluation.

Additional Information Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. Comité Académico Institucional del Instituto ITCA Universitario, Ibarra - Ecuador issued approval ITA-CAI-2024-03-28.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work.

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Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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