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EVALUATION OF THE MULTIPLE RISK FACTORS FOR THE DEVELOPMENT OF WMSD IN THE HANDS OF BACKCOUNTRY WORKERS

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Abstract

Many ergonomic interventions have sought to solve the so-called Work-Related Musculoskeletal Disorders (WRMD). Inadequate postures, excessive forces, material handling, and repetitive movements have been responsible for a high number of cases, especially in the upper limbs. The present study aims to identify and evaluate the risk factors that influence the development of WRMD in the hand region of workers from the health, education, industry, and commerce sectors in enterprises in the backlands of Alagoas. This is a cross-sectional study of exploratory characteristics, seeking to understand the risk factors and musculoskeletal symptoms in the hands of these workers. Data were collected through questionnaires and ordinal logistic regression modeling was performed to assess their relationships. The results demonstrated that the symptoms have a multifactorial origin. Some factors may affect only one hand or both. The use of vibrating tools for more than 6 hours a day increased the chance of symptoms by six times and three times for the right and left hemispheres of the hands, respectively. On the other hand, jobs that require the use of hands and fingers for more than an hour are up to four times more likely to report symptoms only in the right hand. It is concluded that the factors vary in intensity according to the analyzed side, the time of exposure to risk and the presence of indirect action factors, such as psychosocial factors.

Keywords: WMSD; Logistic Regression; Hands; Dimids; Biomechanical factors; Psychosocial variables.

1. INTRODUCTION

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Work-Related Musculoskeletal Disorders (WMSD) are a set of diseases that affect the bones, joints, muscles, and spine (ALI *et al*., 2018), leading to occupational health problems in workers. Work-related factors such as repetitive work, long working hours, and intensified work increase the possibility of WMSDs. Thus, these disorders have a multifactorial origin (NAMBIEMA *et al*., 2020) and occur predominantly in the upper limbs (BRASIL, 2002).

Some individual factors (age, body mass index, among others) and biomechanical factors, such as physical demands and stress, act directly on WMSDs; however, in a similar way, organizational and psychosocial factors also act indirectly (BODIN *et al*., 2020). The recognition of these factors is relevant, because it brings benefits to employers and employees, being able to support scientific data that will help in the development of public policies aimed at reducing the prevalence and incidence of these problems. In addition, they can also minimize health-related costs for employees (MÉNDEZ-HERNANDEZ *et al*., 2012), reducing leave certificates and social security expenses (LAUX *et al*., 2016) and significantly improving working conditions (BISPO *et al*., 2020).

The use of the hands to perform work activities is one of the oldest ways used by man to ensure conditions for his subsistence. Depending on the activity, the hands are the part most affected by typical accidents and, despite the injuries, many workers return to work activities without the full reestablishment of functions, that is, still presenting difficulties (GONÇALVES *et al*., 2018). Focusing on the upper limbs, it is noteworthy that equipment, tools and utensils are essentially designed for right-handers. In this sense, for claims, this becomes a challenge, as people have significantly better muscle performance when they use the dominant hand (IIDA, 2005).

Some accidents in the production environment in the upper limbs (hands and fingers) are related to the incorrect use of machinery and equipment, lack of attention or overconfidence of employees in the execution of their tasks (ARAÚJO *et al*., 2018). Workers who provide services dedicate greater efforts to training for the acquisition of skills, not taking into account preventive techniques, for example. Such a scenario causes symptoms to be frequent due to the lack of adequate breaks during the workday, high work pace or for prolonged periods (KOZAK *et al*., 2019).

Studies among workers in the health, education, industry and commerce sectors in enterprises in the Alagoas hinterland are scarce, deserving greater attention in their evaluation and understanding. Thus, this article aims to carry out a multifactorial evaluation

(sociodemographic, occupational, psychosocial and biomechanical) of occupational risks and their relationships with WMSD symptoms mainly in the hands of sertanejo workers.

2. METHODS

The population of this research consists of 13 establishments located in the Alagoas and Bahian hinterlands, belonging to the health, industry, commerce and education sectors. The sample was composed of individuals who met the requirements: voluntary participation, minimum age of 18 years, effective contract in the company and good health condition. Thus, the total sample consisted of 420 workers.

For the development of this study, a self-administered questionnaire was applied with the objective of collecting information, which is composed of two parts related to the dependent variable (hand symptoms) and the independent variables (sociodemographic, biomechanical, occupational and psychosocial factors).

The symptoms of musculoskeletal pain in the hands of the workers were extracted using the adapted version of the *Nordic Musculoskeletal Questionnaire* (NMQ) (KUORINKA *et al*., 1987), with a five-level *Likert scale* (1 – no pain; 2 – mild pain; 3 – moderate pain; 4 – severe pain; 5 – extreme pain). The sociodemographic factors collected were sex, age, BMI (Brazilian Association for the Study of Obesity and Metabolic Syndrome, 2016), education, marital status (single and married), whether they have children, and whether they practice physical activity.

Regarding biomechanical factors, data were collected to assess how many hours a day the worker was exposed to the following situations: standing work; seated work; work with the torso twisted; work handling loads; work performing repetitive movements; I work using hands and fingers, and I work using hand tools. These factors were categorized as rarely (less than 1 hour per day), often (between 1 and 6 hours per day), and always (more than 6 hours per day).

Occupational factors were considered the professional category, the work environment, the time worked in the company, the time worked in the week, the time worked between vacations, whether they have another job and the variation in activities based on the items of the *Copenhagen Psychosocial Questionnaire* II -COPSOQ II) (PEJTERSEN *et al.*, 2010).

The psychosocial factors extracted were "psychological demands", "control over work", "job insecurity", "support from co-workers", which were measured through the *Job Content Questionnaire* (JCQ) (KARASEK *et al*., 1998); "the meaning of work", "commitment to the workplace", "job satisfaction" and "work-family conflict" were assessed using the COPSOQ II (PEJTERSEN *et al*., 2010) and the categories of workers' perception of reward and excessive

commitment were verified by the items of the *Effort-Reward Imbalance* (ERI) *Questionnaire* (SIEGRIST *et al*)., 1996). "Physical demands" and "effort" were assessed using items from the JCQ (KARASEK *et al*., 1998) and the ERI (SIEGRIST *et al*., 1996), respectively. An item on motivation was also considered as a psychosocial factor. All items used a five-point *Likert* scale as an alternative answer (1 - never; 2 - rarely; 3 - sometimes; 4 - frequently; and 5 - always).

All data collected via items from the JCQ, COPSOQ II and ERI had their internal consistency and reliability evaluated using Cronbach's alpha (α) and McDonald's omega (ωt). The adjustment of the confirmatory factor analysis (CFA) data was performed through the test

Bartlett sphericity test and Kaiser-Meyer-Olkin (KMO) test. By means of an ordinal logistic regression model, the relationship between WMSD factors and symptoms was verified, and the *odds ratio* (OR) was extracted by the model, to demonstrate the increase or reduction in the chances of workers developing musculoskeletal disorders.

Observations that behaved as leverage points (influential and inconsistent) were excluded. Finally, the accuracy of the models was estimated, considering good precision to be those with a value above 50% (SILVA *et al*., 2017). These statistical procedures were all carried out with the aid of the R software (R CORE TEAM, 2020) version 3.6.3.

3. FINDINGS

To characterize the sample, data collected via items from the Nordic questionnaire, JCQ, COPSOQ II and ERI were used, which had their internal consistency and reliability evaluated using Cronbach's alpha (α) and McDonald's omega (ωt), the parameters used for the results were: greater than or equal to 0.70 with ωt > α (ZINBARG *et al.*, 2005). The test results have been shown to be reliable and have good internal consistency. The Bartlett sphericity test and the KMO are in agreement with what is said by Hair *et al.* (2009), presenting $\chi2$=63.55 (p = 0.000), $\chi2$=211.11 (p = 0.000) and $\chi2$=38.49 (p = 0.002); and KMO equal to 0.73, 0.74 and 0.76, respectively, for the items of COPSOQ II, JCQ and ERI. The results of CFA are presented in (Table 1). F<0.30 and h2 values <0.20 were excluded from the study.

Table 1 – Synthesis of factors by CFA

Biomechanical Factors						**Psychosocial Factors**											
Independent Variables	F	h2		F*	h2*	**Independent Variables**	F	h2		F*	h2*	**Independent Variables**	F	h2		F*	h2*
Physical demands	0,45	0,2		0,45	0,2	Meaning of the job	0,55	0,3		0,55	0,3	Control over work	0,45	0,2		0,45	0,2
	0,45	0,2		0,45	0,2		0,86	0,74		0,87	0,75		0,45	0,2		0,45	0,2
	0,45	0,2		0,45	0,2		0,66	0,44		0,66	0,44		0,45	0,2		0,45	0,2
	0,45	0,2		0,45	0,2		0,64	0,4		0,67	0,44		0,45	0,2		0,45	0,2

	0,45	0,2		0,45	0,2	Compromise with the workplace	0,71	0,51		0,74	0,55		0,45	0,2		0,45	0,2
Effort	0,75	0,57		0,76	0,57		0,34	**0,12**		-	-		0,45	0,2		0,45	0,2
	0,75	0,57		0,75	0,56	Psychologic al demands	0,45	0,2		0,45	0,2	Job Satisfaction	0,5	0,25		0,5	0,3
	-0,28	**0,08**		-	-		0,45	0,2		0,45	0,2		0,42	0,2		0,42	0,2
	0,55	0,3		0,55	0,3		0,45	0,2		0,45	0,2		0,78	0,61		0,78	0,6
	0,33	**0,11**		-	-		0,45	0,2		0,45	0,2		0,82	0,67		0,82	0,7
	0,46	0,22		0,46	0,22		0,45	0,2		0,45	0,2	Social support from co-workers	0,45	0,2		0,45	0,2
Occupational factors							0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2
Independent Variables	F	h2		F*	h2*	Job insecurity	0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2
Variation in work	0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2
							0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2
							0,45	0,2		0,45	0,2		0,45	0,2		0,45	0,2
							0,45	0,2		0,45	0,2	Motivation	0,45	0,2		0,45	0,2
							0,45	0,2		0,45	0,2	Work control family	0,7	0,5		0,7	0,5
						Social support from supervisors	0,45	0,2		0,45	0,2		0,9	0,82		0,9	0,8
							0,45	0,2		0,45	0,2		0,57	0,33		0,57	0,3
							0,45	0,2		0,45	0,2	Reward	0,72	0,51		0,71	0,5
							0,43	0,2		0,44	0,21		0,95	0,9		0,95	0,9
							0,57	0,32		0,57	0,33		0,7	0,5		0,7	0,5
						Overcommitment	**0,23**	**0,05**		-	-		0,43	0,2		0,42	0,2
							0,59	0,35		0,6	0,36		**0,05**	**0**		-	-
							0,84	0,71		0,83	0,68		**0,08**	**0,01**		-	-
							0,71	0,5		0,71	0,5						

Note 1: F* and h2* are the values of F and h2 after deleting items.
Note 2: Excluded items have F and h2 values in **bold**.

Source: Authors (2021)

The profile of most of the workers who participated in the research are women aged between 18 and 44 years, married, with at least one child and a BMI classified as normal, but with some tendency to be overweight (Table 2). Despite this trend, a little more than half of the workers said they practiced physical activity. With regard to education, the professionals are grouped more prominently into two groups, high school and complete higher education.

Table 2 – Synthesis of sociodemographic factors by economic activity

Variables	**Health (n=167)**		**Industry (n=59)**		**Education (n=159)**		**Trade (n=35)**		**General (n=420)**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	%
Biological sex										
Female	134	80,24	21	35,59	122	76,73	27	77,14	304	72,38
Male	33	19,76	38	64,41	37	23,27	8	22,86	116	27,62
Age										
18-44 years	119	71,26	47	79,66	107	67,30	30	85,71	303	72,14
45 years or older	48	28,74	12	20,34	52	32,70	5	14,29	117	27,86
BMI (Kg/m²)										
Underweight	3	1,80	1	1,69	2	1,26	3	8,57	9	2,14
Normal weight	64	38,32	33	55,93	103	64,78	17	48,57	217	51,67
Overweight	65	38,92	20	33,90	38	23,90	12	34,29	135	32,14
Type I obesity	24	14,37	5	8,47	13	8,18	3	8,57	45	10,71
Type II obesity	7	4,19	0	0,00	3	1,89	0	0,00	10	2,38
Type III obesity	4	2,40	0	0,00	0	0,00	0	0,00	4	0,95
Schooling										

Incomplete Elementary School	5	2,99	19	32,20	0	0,00	4	11,43	28	6,67
Complete Elementary School	4	2,40	11	18,64	2	1,26	2	5,71	19	4,52
Incomplete high school	1	0,60	9	15,25	0	0,00	5	14,29	15	3,57
High School	84	50,30	18	30,51	19	11,95	22	62,86	143	34,05
Incomplete higher education	9	5,39	0	0,00	27	16,98	0	0,00	36	8,57
Complete higher education	60	35,93	2	3,39	71	44,65	2	5,71	135	32,14
Postgraduate	4	2,40	0	0,00	40	25,16	0	0,00	44	10,48
Marital status										
Single	81	48,50	26	44,07	74	46,54	19	54,29	200	47,62
Married	86	51,50	33	55,93	85	53,46	16	45,71	220	52,38
Offspring										
Yes	113	67,66	51	86,44	102	64,15	24	68,57	290	69,05
No	54	32,34	8	13,56	57	35,85	11	31,43	130	30,95
Physical activity										
It does not perform	71	42,51	25	42,37	85	53,46	20	57,14	201	47,86
Performs	96	57,49	34	57,63	74	46,54	15	42,86	219	52,14

Source: Authors (2021)

The description of the professionals in each sector (Table 3) is, in general, homogeneous. The health sector is the only group with a higher percentage of prevalence of overweight, even though the category indicates physical activity. Education professionals have a higher level of education, having completed higher education. Finally, only in the industrial sector is the male participation rate higher than that of women. Table 4 presents data on biomechanical factors. As a diagnosis of work positions and movements, activities that require repetitive movements vary from up to 1 hour (43.81%) of the workday. Only 9 workers (2.14%) perform activities with hand tools for more than 6 hours, but 91.9% work in a period of less than 1 hour, while for the use of hands and fingers it is done for more than 6 hours by most workers (44.76%).

Among the psychosocial factors addressed, almost all had a higher prevalence in the 'high' classification (Table 5). Most workers have high meaning for work (68.33%), high motivation (56.9%), high commitment (56.90%), high support from co-workers (56.19%) and high reward (54.05%). Low job stability was pointed out by 55.71% of the respondents and the conflict between work and family was low for 52.86% of the workers.

Table 3 – Summary of occupational factors by economic activity

Variables	**Health (n=167)**		**Industry (n=59)**		**Education (n=159)**		**Trade (n=35)**		**General (n=420)**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	%
Working environment										
Private	34	20,35	59	100,00	2	1,26	35	100,00	130	30,95

Public	133	79,65	0	0,00	157	98,74	0	0,00	290	69,05
Time worked in the company (years)										
Less than or equal to 1 year	35	20,95	3	5,08	20	12,58	16	45,71	74	17,62
Between 2 and 15 years old	99	59,28	54	91,53	75	47,17	17	48,57	245	58,33
Between 16 and 30 years old	24	14,37	2	3,39	60	37,74	2	5,71	78	18,57
More than 30 years	9	5,39	0	0,00	5	3,14	0	0,00	23	5,48
Hours worked in the week										
Less than or equal to 15 hours	2	1,20	16	27,12	19	11,95	25	71,43	62	15,00
Between 16 and 40 hours	114	68,26	0	0,00	126	79,25	0	0,00	240	57,00
Between 41 and 60 hours	49	29,34	43	72,88	12	7,55	10	28,57	114	27,00
More than 60 hours	2	1,20	0	0,00	2	1,26	0	0,00	4	1,00
Working time between Vacation (in months)										
Less than or equal to 6 months	2	1,20	0	0,00	31	19,5	0	0,00	33	7,86
Between 7 and 11 months	88	52,69	16	27,12	57	35,85	3	8,57	164	39,05
More than 11 months	77	46,11	43	72,88	71	44,65	32	91,43	223	53,1
Other Employment										
Yes	55	32,93	2	3,39	59	37,11	4	11,43	120	28,57
No	112	67,07	57	96,61	100	62,89	31	88,57	300	71,43

Source: Authors (2021)

Table 4 – Synthesis of biomechanical factors by economic activity

Variables	**Health (n=167)**		**Industry (n=59)**		**Education (n=159)**		**Trade (n=35)**		**General (n=420)**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	%
Works in a standing position										
Less than 1 hour	19	11,38	4	6,78	15	9,43	6	17,14	44	10,48
Between 1 and 6 hours	50	29,94	4	6,78	109	68,55	17	48,57	180	42,86
More than 6 hours	98	58,68	51	86,44	35	22,01	12	34,29	196	46,67
Works in a seated position										
Less than 1 hour	49	29,34	51	86,44	50	31,45	13	37,14	163	38,81
Between 1 and 6 hours	101	60,48	5	8,47	95	59,75	20	57,14	221	52,62
More than 6 hours	17	10,18	3	5,08	14	8,81	2	5,71	36	8,57
Works in a squatting position										
Less than 1 hour	158	94,61	57	96,61	154	96,86	53	151,43	403	95,95
Between 1 and 6 hours	7	4,19	2	3,39	5	3,14	1	2,86	15	3,57
More than 6 hours	2	1,20	0	-	0	-	0	-	2	0,48
Upper limbs in an uncomfortable position										
Less than 1 hour	102	61,08	29	49,15	93	58,49	24	68,57	248	59,05
Between 1 and 6 hours	50	29,94	11	18,64	61	38,36	4	11,43	126	30,00
More than 6 hours	15	8,98	19	32,20	5	3,14	7	20,00	46	10,95
Lower limbs in an uncomfortable position										
Less than 1 hour	88	52,69	21	35,59	84	52,83	24	68,57	217	51,67
Between 1 and 6 hours	56	33,53	12	20,34	71	44,65	4	11,43	143	34,05
More than 6 hours	23	13,77	26	44,07	4	2,52	7	20,00	60	14,29
Works with curved torso										
Less than 1 hour	90	53,89	24	40,68	104	65,41	24	68,57	242	57,62
Between 1 and 6 hours	65	38,92	14	23,73	109	68,55	11	31,43	144	34,29
More than 6 hours	12	7,19	21	35,59	1	0,63	0	-	34	8,10
Works with twisted torso										
Less than 1 hour	115	68,86	13	22,03	120	75,47	32	91,43	280	66,67

Between 1 and 6 hours	37	22,16	13	22,03	38	23,90	3	8,57	91	21,67
More than 6 hours	15	8,98	33	55,93	1	0,63	0	-	49	11,67
Works using hands/fingers										
Less than 1 hour	34	20,36	2	3,39	36	22,64	6	17,14	78	18,57
Between 1 and 6 hours	52	31,14	0	-	93	58,49	9	25,71	154	36,67
More than 6 hours	81	48,50	57	96,61	30	18,87	19	54,29	188	44,76
Carrying loads of up to 6Kg										
Less than 1 hour	119	71,26	40	67,80	109	68,55	24	68,57	292	69,52
Between 1 and 6 hours	40	23,95	10	16,95	47	29,56	10	28,57	107	25,48
More than 6 hours	8	4,79	9	15,25	3	1,89	1	2,86	21	5,00
Carrying load from 6Kg to 15Kg										
Less than 1 hour	154	92,22	54	91,53	132	83,02	34	97,14	374	89,05
Between 1 and 6 hours	12	7,19	3	5,08	25	15,72	1	2,86	41	9,76
More than 6 hours	1	0,60	2	3,39	2	1,26	0	-	5	1,19
Carrying load from 16Kg to 25Kg										
Less than 1 hour	149	89,22	49	83,05	156	98,11	34	97,14	388	92,38
Between 1 and 6 hours	14	8,38	6	10,17	3	1,89	1	2,86	24	5,71
More than 6 hours	4	2,40	4	6,78	0	-	0	-	8	1,90
Repetitive movements										
Less than 1 hour	78	46,71	3	5,08	85	53,46	18	51,43	184	43,81
Between 1 and 6 hours	38	22,75	0	-	69	43,40	13	37,14	120	28,57
More than 6 hours	51	30,54	56	94,92	5	3,14	4	11,43	116	27,62
Use of hand tools										
Less than 1 hour	156	93,41	42	71,19	154	96,86	34	97,14	386	91,90
Between 1 and 6 hours	10	5,99	10	16,95	4	2,52	1	2,86	25	5,95
More than 6 hours	1	0,60	7	11,86	1	0,63	0	-	9	2,14

Source: Authors (2021)

Table 5 – Synthesis of psychosocial factors by economic activity

Variables	**Health (n=167)**		**Industry (n=59)**		**Education (n=159)**		**Trade (n=35)**		**General (n=420)**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	%
Meaning of the job										
Low meaning	32	19,16	30	50,85	56	35,22	15	42,86	133	31,67
High Significance	135	80,84	29	49,15	103	64,78	20	57,14	287	68,33
Commitment to the workplace										
Low commitment	78	46,71	23	38,98	65	40,88	15	42,86	181	43,10
High commitment	89	53,29	36	61,02	94	59,12	20	57,14	239	56,90
Psychological demands										
Low demands	75	44,91	30	50,85	75	47,17	24	68,57	204	48,57
High demands	92	55,09	29	49,15	84	52,83	11	31,43	216	51,43
Control over work										
Low control	65	38,92	52	88,14	55	34,59	22	62,86	194	46,19
High control	102	61,08	7	11,86	104	65,41	13	37,14	226	53,81
Physical demands										
Low demands	74	44,31	16	27,12	96	60,38	19	54,29	205	48,81
High demands	93	55,69	43	72,88	63	39,62	16	45,71	215	51,19
Insecurity at work										
Low stability	100	59,88	28	47,46	89	55,97	17	48,57	234	55,71
High stability	67	40,12	31	52,54	70	44,03	18	51,43	186	44,29
Motivation										
Low motivation	74	-	15	25,42	72	45,28	15	42,86	176	41,90
High motivation	93	55,69	44	74,58	87	54,72	20	57,14	244	58,10

Supervisor Support										
Low support	73	43,71	27	45,76	79	49,69	21	60,00	200	47,62
High support	94	56,29	32	54,24	80	50,31	14	40,00	220	52,38
Support from co-workers										
Low support	66	39,52	20	33,90	82	51,57	16	45,71	184	43,81
High support	101	60,48	39	66,10	77	48,43	19	54,29	236	56,19
Effort										
Low effort	76	45,51	36	61,02	74	46,54	19	54,29	205	48,81
High effort	91	54,49	23	38,98	85	53,46	16	45,71	215	51,19
Reward										
Low reward	79	47,31	19	32,20	78	49,06	17	48,57	193	45,95
High reward	88	52,69	40	67,80	81	50,94	18	51,43	227	54,05
Overcommitment										
Low commitment	85	50,90	30	50,85	70	44,03	22	62,86	207	49,29
High commitment	82	49,10	29	49,15	89	55,97	13	37,14	213	50,71
Job satisfaction										
Low satisfaction	76	45,51	20	33,90	84	52,83	14	40,00	194	46,19
High satisfaction	91	54,49	39	66,10	75	47,17	21	60,00	226	53,81
Work-family conflict										
Low conflict	95	56,89	30	50,85	76	47,80	21	60,00	222	52,86
High conflict	72	43,11	29	49,15	83	52,20	14	40,00	198	47,14

Source: Authors (2021)

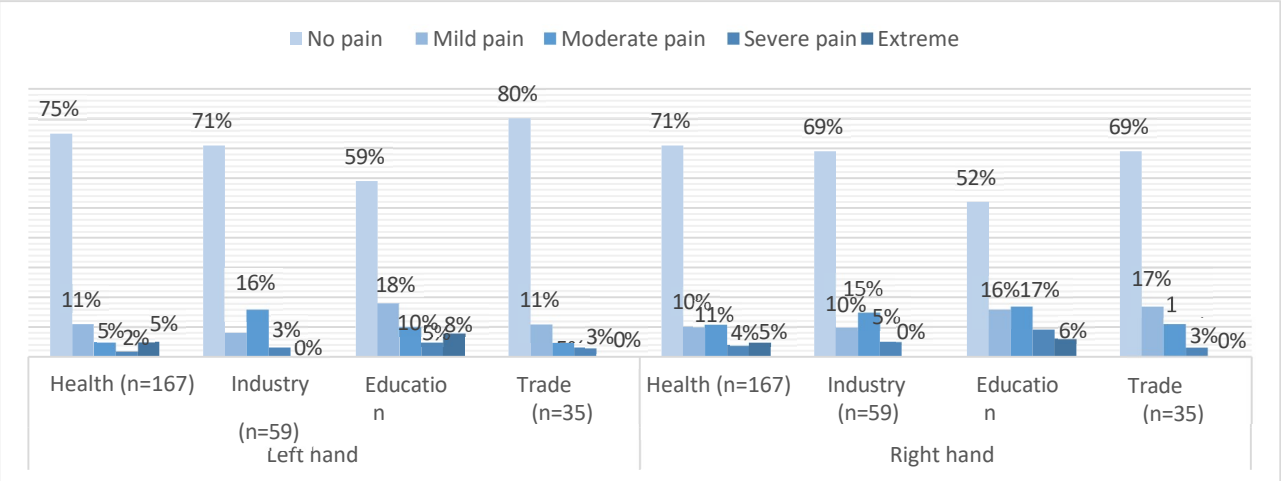
Table 6 presents a summary of the levels of musculoskeletal discomfort of workers in the hands. In general, the left hand has a lower report of discomfort, 69.05% of the sample described being pain-free; however, it has the highest percentage for extreme pain (5.25%). On the other hand, the right hand had a higher percentage of moderate pain (13.81%) and severe pain (5.71%). Figure 1 shows the same information by economic activity performed, for the item 'mild pain' the highest incidence in the right hand is in the commerce sector (17%) and for the left hand it is in education (18%), the item 'moderate pain' is presented in 17% for education professionals in the right hand, and in 16% for industry, to the left limb. On both sides, the perceived intensity of severe and extreme pain stands out for education workers, 'severe pain' with 9% and 5% and 'extreme pain' with 6% and 8% for the right and left hand, respectively.

Table 6 - Levels of musculoskeletal discomfort

Variables	**Right hand Left hand**			
	No.	**%**	**No.**	**%**
No pain	266	63,33	290	69,05
Mild pain	55	13,10	56	13,33
Moderate pain	58	13,81	37	8,81
Severe pain	24	5,71	15	3,57
Extreme pain	17	4,05	22	5,24

Source: Authors (2021)

Figure 1 - Levels of musculoskeletal discomfort by economic activity



Source: Authors (2021)

Table 7 shows the results of the ordinal logistic regression models for the hands, so that the accuracy of the model, demonstrated by accuracy, for the right side was 65% and for the left side was 69%, proving its acceptability. There is some similarity in the risk factors in relation to the dimids, their results indicate that some of these contribute with greater chances to a certain side of the body. The existing factors that have a chance of developing WMSD in this model for both sides are, in the case of sociodemographic data, schooling; for biomechanics, vibrant tools; and, for the

job satisfaction. On the other hand, when analyzing the elements: BMI, children, repetitive movements, work using hands and fingers, and excessive impairment, it is observed that they fit only the model for the right hand. Otherwise, physical activity, uncomfortable lower limbs, physical demands and support from co-workers, only for the left hand.

Among the factors obtained as significant for the hands, the factor that presented a higher chance was education in the category of incomplete high school (Table 5), indicating that the chance of the individual reporting a new level of symptom in the left hand increases by 11 times for the response category 'incomplete medium'. Another piece of data that stands out is for the category of complete higher education, in which the chance for the individual to have WMSD increases by almost seven times (OR= 6.87) for the right hand and almost 12 times (OR=11.83) for this category. For BMI, there was direct significance only for type I obesity, with a 2.31% chance of having symptoms in the hands and an indirect relationship for overweight with 0.45% less chance.

On the other hand, for biomechanical factors, the use of tools that vibrate the hands presented more expressive chances for the right hand, being up to six times (OR=6.37) for

individuals who perform activities of this type for more than six hours a day, while for the left side it is three times more (OR=3.37), for the number of hours less than specified the relationship was inverse, having 0.61% less chance of developing symptoms. For psychosocial factors, high job satisfaction was linked to reported pain alleviation, being up to 24% and 18% for the right and left hands, respectively.

Table 7 – Levels of musculoskeletal discomfort and risk factors

Variables	**Right hand (n=417)**	**Left hand (n=420)**
	Accuracy 65%	**Accuracy 69%**
	OR (95% CI) *p-value*	**OR (95% CI) *p-value***
Sociodemographic Factors		
BMI		
Normal weight	1.00 (Reference)	1.00 (Reference)
Underweight	0.00 (0.00 - 5.33x10^26) 0.81	-
Overweight	**0,55 (0,33 - 0,94) 0,03***	-
Obese type I	**2,31 (1,14 - 4,69) 0,02***	-
Obese type II	0.00 (0.00 - 1.07x10^25) 0.81	-
Obese type III	0.00 (0.00 - 1.01x10^41) 0.87	-
Schooling		
Incomplete elementary school	1.00 (Reference)	1.00 (Reference)
Complete Elementary School	2,10 (0,29 -15,17) 0,46	2,21 (0,19 - 25,41) 0,52
Incomplete high school	2,68 (0,33 - 21,35) 0,35	**11,81 (1,12 - 124,19) 0,04***
High School	**6,85 (1,43 - 32,89) 0,02***	**8,50 (1, 07 - 67,45) 0,04***
Incomplete higher education	**6,63 (1,22 - 36,14) 0,03***	6,33 (0,72 - 55,65) 0,09
Complete higher education	**6,87 (1,43 - 33,03) 0,02***	**11,83 (1,48 - 94,25) 0,02***
Postgraduate	3,99 (0,75 - 21,39) 0,11	6,43 (0,73 - 56,42) 0,09
Offspring		
None	1.00 (Reference)	1.00 (Reference)
At least one	**0,51 (0,31 - 0,84) 0,01***	-
Physical activity		
It does not perform	1.00 (Reference)	1.00 (Reference)
Performs	-	**0,62 (0,40 - 0,98) 0,04***
Biomechanical Factors		
Repetitive movements		
Less than 1 hour	1.00 (Reference)	1.00 (Reference)
Between 1 and 6 hours	**0,35 (0,19 - 0,64) 0,00***	-
More than 6 hours	**0,40 (0,21 - 0,75) 0,00***	-
Tools that vibrate your hands		
Less than 1 hour	1.00 (Reference)	1.00 (Reference)
Between 1 and 6 hours	0,39 (0,12 - 1,28) 0,12	0,39 (0,13 - 1,17) 0,0929
More than 6 hours	**6,37 (2,52 - 16,05) 0,00***	**3,37 (1,29 - 8,76) 0,01***
Works using hands and fingers		
Less than 1 hour	1.00 (Reference)	1.00 (Reference)
Between 1 and 6 hours	**4,21 (1,76 - 10,10) 0,00***	-
More than 6 hours	**2,78 (1,13 - 6,8) 0,03***	-
Uncomfortable lower limbs		
Less than 1 hour	1.00 (Reference)	1.00 (Reference)
Between 1 and 6 hours	-	**2,30 (1,34 - 3,94) 0,00***

More than 6 hours	-	1,68 (0,88 - 3,26) 0,11
Psychosocial factors		
Job satisfaction		
Low satisfaction	1.00 (Reference)	1.00 (Reference)
High satisfaction	**0,76 (0,66 - 0,89) 0,00***	**0,82 (0,70 - 0,97) 0,02***
Psychosocial factors		
Overcommitment		-
Low commitment	1.00 (Reference)	1.00 (Reference)
High commitment	**1,01 (1,01 - 1, 19) 0,02***	-
Physical Demands		-
Low demand	1.00 (Reference)	1.00 (Reference)
High demand	-	**1,22 (1,09 - 1,36) 0,00***
Co-worker support		
Low support	1.00 (Reference)	1.00 (Reference)
High support	-	**0,63 (0,46 - 0,85) 0,00***

Note: * indicates a significant relationship (in **bold**) with a *p-value* less than 0.05.
Source: Authors (2021)

4. DISCUSSION

According to Table 4, the sectors participating in this study have a prevalence of 36% of hand pain. Specifying strong and extreme pain, there is a prevalence of around 9%. The relationship of factors in the symptoms of hand pain indicated the association with biomechanical, psychosocial and sociodemographic factors. The sectors of economic activities addressed in this research are predominantly distinct and require specific competencies and skills for the execution of the work. The results found in this study strengthen the association between risk factors in the workplace and the development of musculoskeletal disorders both on both sides of the hand and separately.

Of the factors that are present only in the right hand, it can be mentioned that the prevalence is in the biomechanical factors (Repetitive movements and Work using hands and fingers) and for the left hand in the psychosocial factors (Physical Demands and Support from co-workers). On the other hand, the factors of schooling, tools that vibrate the hands and job satisfaction are present in both hands.

Most of the risk factors were mainly for the right hand, possibly due to the sample presenting as right-handed. This observation is supported by Iida (2005), who indicates the existence of a dominant hand to carry out activities. Dimate-Garcia and Rodríguez-Romero (2021) also point out that being right-handed is statistically associated with the appearance of symptoms in the hands and that this is linked to a dominance relationship.

Several studies include 'vibrating tools' as one of the risk factors responsible for WMSDs in the hands. As can be seen in the study by Xu *et al.* (2017), and long-term exposure

to hand-transmitted vibrations is associated with an increased risk of hand-arm vibration syndrome. Bovenzi *et al.* (2016) point out that with increased exposure to vibration, the occurrence of WMSD increases, both in the hands and in the elbows, forearms and wrists. In addition, Veisi *et al.* (2019) demonstrates the importance of the relationship between the sizing of the tools and the symptoms in the hands and the anthropometry of the operators, being able to reduce symptoms and improve posture.

Regarding the schooling data, the final model indicates that pain increases according to the worker's level of education, changing mainly from high school onwards. This can be confirmed through the study by Guertler *et al.* (2021), in which they show that workers on mollusk farms, mostly with less education, believe that they are better able to identify risks and receive training in occupational health and safety than those with higher education, even though they suffer almost three times as many accidents.

This study demonstrated an increase in the chances of pain for workers who perform repetitive movements. In the study by Park *et al.* (2021) there were results from the comparison of ergonomic risk factors for WMSD between kitchen workers and other employees showed that repetitive movements of the hands or arms have a proportion of 73.98% *versus* 54.25%. A study of hairdressers by Chen *et al.* (2010) points out that ergonomic risk factors such as the relatively greater effort and wrist speed of female hairdressers combined with prolonged exposure may be responsible for the higher rate of hand/wrist pain in female hairdressers than in barbers. For Kozak (2019), the hands are among the most affected places on the body in hairdressers, indicating as causes the lack of intervals between activities exceeding tolerance limits, unfavorable posture, prolonged periods of standing, combined with constant repetition and fast pace.

Studies indicate that the influence of psychosocial factors is not direct, but is associated with the adoption of unfavorable postures and inappropriate movements (GOVINDU, 2017). There is also an association between physical demands and hand pain. According to Batista *et al.* (2019), within the health sector, work demand becomes a considerable risk factor due to insufficient time to work in activities outside the work environment, such as health care and leisure time. Maciel *et al.* (2019) show that among 53.8% of the sample, made up of nurses and technicians, suggests the existence of musculoskeletal symptoms associated with the activities developed by these professionals, pointing to the prevalence of musculoskeletal disorders in the hands as equivalent to 9.7%. And also the lack of support and support as directed by Silva *et al.* (2019) is also a potential risk factor.

5. CONCLUSION

The results indicated that hand pain has a multifactorial origin for the research participants. It is important to consider the differences presented on both sides of the body, and some factors induced the symptoms in only one of the hands, associated more with the right hand. Despite this, the left hand had the highest percentage of extreme pain (5.71%). As for the sectors, it was pointed out that education and industry were the ones that presented the highest levels of discomfort in the left hand, respectively, and the education and commerce sectors for the right hand.

Among the most significant factors for hand pain are vibrations from vibrating tools and repetitive movements. However, the model showed a relevance for hand pain associated with the level of education, which was not so supported in the literature. Thus, the study reports findings that are rarely scientifically found.

From this, assertive mitigating actions on working conditions can be implemented to improve the quality of life, health and safety of workers, in addition to converting into positive effects on productivity, avoiding organizational costs and other losses. These measures must be aimed at ergonomics, work organization and governed by regulatory standards and other legislation in force; so that it proposes to place employees as a key point of the entire production process. It is important to highlight that, due to its multifactorial origin, the model may vary according to the sample and its items analyzed, and it may be concluded that other parts of the body and even other factors not mentioned can influence hand pain.

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