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Musculoskeletal Acute and Chronic Pain Surveyed among Construction Workers in Wisconsin, United States: A Pilot Study

Oscar Arias, Gabe Koenig and Sang D. Choi *

Department of Occupational and Environmental Safety and Health, University of Wisconsin–Whitewater, Whitewater, WI 53190, USA
* Correspondence: chois@uww.edu

Abstract: This pilot study assessed work-related acute and chronic musculoskeletal pain, identified how workers deal with musculoskeletal pain and recognized work-related factors associated with musculoskeletal pain in 23 commercial construction workers. Workers answered a survey about musculoskeletal pain, pain severity, functional limitations, and perceived exertion at work (Borg RPE scale). Eighty-six percent reported acute musculoskeletal pain and 24% chronic pain in the last 12 months. Among those reporting acute pain, 67% sought treatment from a healthcare professional, 64% had prescribed medication, and 39% modified their work habits to handle pain at work. About 80% of the workers reporting chronic pain sought healthcare treatment, had prescribed medication, and modified their work habits to manage pain. Almost 60% of the participants experienced pain in the last seven days. Among them, 46% reported moderate pain in their legs or knees, 31% in their low back, and 23% severe pain in their arms, shoulders, or hands. The assessment of the functional limitations indicated they experienced moderate to severe limitations in performing activities of daily living (ADLs). The logistic regression models suggested a direct relationship between workers' work physical exertion and their Body Mass Index (BMI) with the occurrence of musculoskeletal pain. Construction workers are dealing with acute and chronic pain at work that negatively impacts their work and ADLs. Work-related and individual factors such as work physical exertion and BMI seem to play a significant role in the presence of acute and chronic pain associated with MSDs. This study's findings can help guide sustainable ergonomic interventions and future research to alleviate acute and chronic musculoskeletal pain while promoting workers' health and wellbeing in the construction industry.

Keywords: musculoskeletal diseases; prevention; acute pain; chronic pain; surveys and questionnaires; wellness; workload; construction

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1. Introduction

Construction is one of the most physically demanding and dangerous occupations in the United States [1,2]. The injury rate for construction workers is 70% higher than the national average for other occupations [3]. Construction workers also continue to face a high prevalence of musculoskeletal injuries or pains caused by ergonomic-related issues [2]. Different construction trades workers are exposed to musculoskeletal disorders (MSDs) risk factors associated with work-related activities [4]. Strains and sprains are the most prevalent type of injuries due to overexertion associated with manual materials handling tasks/activities, involving in awkward body postures such as bending or twisting the trunk [5]. The construction job tasks are constantly changing, and the working body positions can range from above the shoulder work to below the knees work and a variety in between [6], and often requre the workers to work outdoors exposed to all weather conditions such as hot or cold [7]. Construction workers have the lowest levels of education among all industries except argriculture. In 2015, only 40% of

construction workers had some post-secondary education, versus 65% of the total workforce [7]. Typical construction workers directly engaged in construction operations such as apprentices, foremen/forewomen, carpenters, roofers and laborers, whereas supervisors and office staff, executives, architects/designers and engineers mostly engaged in non-construction activites [7].

Individual, biomechanical, psychosocial, and work-related factors have been identified as causal or contributing factors of MSDs [6–9]. A one-year follow-up study on MSDs among brick layers and supervisors in construction reported that most participants perceived work-related physical tasks/activities as causes or aggravating factors for their MSDs [9]. An interview study on musculoskeletal pain or injuries among construction workers treated in the emergency room found that acute musculoskeletal injuries in construction workers frequently result in chronic symptoms, and those with chronic symptoms report considerable effects of the injury on their quality of life [10]. Their study also reported that a substantial number of participants continued having musculoskeletal symptoms or related problems beyond two months. The prevalence of the chronic symptoms for more than two months seems to be related to the body part affected (most frequently seen for knee/leg/hip/groin injuries, followed by workers with shoulder, low back, and neck injuries) [10].

Though the prevalence and causes of musculoskeletal injuries are widely researched in construction, how individuals deal with their musculoskeletal pain is not extensively researched. One study done in the Netherlands determined that one in seven workers in the construction field reported chronic musculoskeletal pain. They also noted that only about half of that population reporting chronic musculoskeletal pain sought out a form of treatment [11]. Another study in Hong Kong found that about one fourth of construction workers with musculoskeletal pain simply ignored the pain [12]. A mixed method study on construction workers working in musculoskeletal pain and engaging in leisure-time physical activity (LTPA) found that construction workers work in and through pain on the worksite and engage in LTPA even when experiencing musculoskeletal pain [13]. Moreover, with prevalent chronic pain claims in the construction industry, pain medication usage continues to present substantial challenges to construction contractors who find it increasingly difficult to manage rising medical costs and sustain a productive workforce [14]. In recent years, most workers' compensation claims have involved prescription pain medications such as opioids accounting for about 20% of all total spending on prescription drugs in the construction industry [3]. These studies indicated that construction workers are living with musculoskeletal pain and none or little doing anything about it. Musculoskeletal disorders or pain may adversely affect workplace efficiency, attitude and overall health of the construction workforce as well as may increase the chances of injuries and accidents among construction workers.

The objectives of this paper are to: (1) identify the presence of work-related acute and chronic musculoskeletal pain in the construction workforce, (2) discover how construction workers deal with their acute and chronic musculoskeletal pain, and (3) determine work-related factors associated with the occurrence of musculoskeletal acute and chronic pain that can be easily assessed by an Environmental Health and Safety (EHS) professional. The results of this research could help further studies in education for construction workers about musculoskeletal pain management, finding ergonomic solutions on the job site, and encouraging more research into identifying sustainable remedies for acute or chronic musculoskeletal pain specific to construction workers.

2. Materials and Methods

2.1. Subjects and Study Design

We used convenience sampling to recruit participants for the study. A total of 26 safety directors or managers of general commercial construction contracting firms responsible for developing new commercial building/housing projects, including apartments and houses in the state of Wisconsin were contacted via email and phone. Three of those companies

were willing to participate in our research study. Construction workers who were at least 18 years old were eligible to participate in the study. Office workers were excluded from the study. A total of 23 construction workers were consented and enrolled between January 2021–November 2021. All the study materials and protocols were approved by the University of Wisconsin-Whitewater review board.

2.2. Musculoskeletal Symptoms, Pain Severity, Functional Limitation, and Perceived Exertion Survey

Each worker was asked to complete a survey that included characteristics of their work, the presence of musculoskeletal pain (yes/no) for less and more than three months during the past 12 months, the severity of the pain in the last 7 days, the type of treatment seek out to handle those symptoms, their functional limitations, and the Borg ratings of perceived exertion (RPE) scale [15] to measure their perceived exertion at work for the last 7 work days.

A modified version of the Nordic questionnaire [16] was used to collect information on the presence of musculoskeletal pain in six different body areas in the last 12 months. The pain was reported as a binary variable (yes/no). For this study, we considered pain that lasted between one day to three months as acute pain. Pain that lasted more than three months was categorized as chronic pain [17].

Pain severity measure consisted of five items assessing pain severity for the past seven days in five body areas (low back, neck/shoulder, wrist/forearm, knee, ankle/feet). Responses were rated on a 5-point Likert-type scale ranging from 1 (none) to 5 (extreme pain) [18]. Scores were tabulated to identify pain severity by body area.The functional limitations measure asked the participants about their ability to perform 10 routine daily activities of living during the past 7 days (e.g., ability to carry a shopping bag). Workers rated levels of difficulty performing these tasks on a 5-point Likert-type scale, with 1 ("no difficulty in carrying out the task") to 5 ("unable to do task without help") [19]. Scores were tabulated to identify specific activities with a high difficulty level to perform.

The self-reported Borg ratings of perceived exertion (RPE) of the job for the last 7 work days were used as a proxy to characterize the average physical demands of the job. We assumed that the assessment of the last 7 days will give a fair estimate of the physical demands considering they perform similar tasks every day.

2.3. Survey Questionnaire Instrument Outline

The developed final survey questionnaire comprised as follows.

- Demographic and general information
- Work characteristics include the time expended in different postures and the perceived exertion using the Borg RPE Scale
- Acute and chronic musculoskeletal pain were assessed using questions from the validated Nordic musculoskeletal questionnaire (for instance): (1) "During the last three months, have you had pain or aching in any of the areas shown on the body diagram?," with response options: lower back, shoulder, wrist or forearm, knee, neck, and ankles or feet; and (2) "In general, how much did this pain interfere with your normal work in the last seven days?" with response options: not at all, a little bit, moderately, quite a bit, and extremely
- Pain severity in the last seven days was assessed using a five-point Likert scale (none, mild, moderate, severe, and extreme) to quantify pain intensity in five body regions (for instance): (1) "Please rate the severity of the following symptoms that you may have experienced in the last 7 days. (a) Pain in your low back . . . "
- Functional limitations were assessed using a five-point Likert scale (no difficulty, mild difficulty, moderate difficulty, severe difficulty, and unable to do without help) to evaluate the ability to do different activities (for instance): (1) "do heavy household chores (some examples include washing wall or washing floors)"
- Content validation was performed by a group of experts

2.4. Statistical Analyses

To evaluate the associations between our binary outcomes of interest, defined as the presence (yes/no) of different types of musculoskeletal pain (pain in the last 7 days, acute, and chronic pain) with a set of risk factors (Borg RPE scale, years of work, BMI and smoking status) we run binary multiple logistic regression models. These risk factors were chosen because we consider they can be easily assessed by EHS professionals interested in implementing controls to reduce musculoskeletal pain in the construction industry. The goodness of fit and omnibus tests were performed as part of the assessment of the models. The reliability test (Crombach α) and scalability test (Loevinger H coefficients) were calculated for the questionnaire. All analyses were carried out in STATA 15.1 (StataCorp, College Station, TX, USA).

3. Results

3.1. Study Population

We collected survey data on 23 construction workers from three commercial construction companies in Wisconsin. The sociodemographic characteristics of the participants are shown in Tables 1 and 2. More than 90% of the participants were white and male. The participants' trades/occupations were carpenter, laborer, framing, and brick mason. Their median age was 38 years, and they had a median body mass index (BMI) of 28, corresponding to being overweight. The smoking status indicated that 35% of the participants were current smokers. Their median work experience in construction was 10 years, working about 10 h per day, more than five days per week. Their self-reported exertion using the Borg RPE scale corresponded to a median score of 13 (somewhat hard; it is quite an effort—feel tired but can continue).

Table 1. Sociodemographic and work characteristics among participants (n = 23).

Sociodemographic and Work Characteristics		
Sex, n (%)		
Male	21	91
Female	2	9
Race, n (%)		
White	22	96
Black	1	4
Trade/Occupation, n (%)		
Carpenter	8	35
Brick Mason	1	4
Laborer	7	30.5
Framing	7	30.5
Smoking population, n (%)	8	35
Age, *M* (Range), years	38	19–56
Body mass index, *M* (Range), Kg/m^2	28	19–37
Years in construction, *M* (Range)	10	0–32
Hours of work per day, *M* (Range)	10	7–10
Days of work per week, *M* (Range)	5	5–7
Perceived exertion, *M* (Range)		
Current shift (6–20 Borg RPE Scale)	13	12–18

Table 2. Sociodemographic and work characteristics by type of pain.

	Pain in the Last 7 Days (n = 13)		Acute Pain (n = 19)		Chronic Pain (n = 5)	
Trade/Occupation, n (%)						
Carpenter	4	31	7	37	1	20
Framer	5	39	6	32	2	40
Laborer	4	31	5	26	2	40
Smoking, n (%)	5	39	6	32	2	40
BMI, M (Range)	27	19–36	27	19–37	26	24–36
Years of work, M (Range)	5	0–33	9	0–36	9	5–29
Perceived exertion (Borg RPE scale), M (Range)	13	12–18	13	12–18	13	13–18

3.2. Musculoskeletal Pain

Table 3 summarizes musculoskeletal pain, treatment, and its effects on work attendance and duties among participants. The proportion of participants reporting acute musculoskeletal pain in the last 12 months was 86%. This percentage was higher than those reporting chronic musculoskeletal pain in the same period, who had a proportion of 23%. Among participants with acute pain, the lower back (63%), knee (53%), and shoulder (47%) were the body areas more frequently associated with this type of pain. Likewise, participants with chronic pain reported the lower back (40%), shoulder (40%), and wrist or forearm (20%) as the body areas mainly associated with this type of pain (Table 3).

Table 3. Musculoskeletal pain, treatment, and its effects on work attendance and duties among participants (n = 23).

Musculoskeletal Symptoms and Treatment and Its Effects on Work during the Last 12 Months	n	%
Musculoskeletal pain		
Reported musculoskeletal pain in the last seven days *	13	62
Reported acute musculoskeletal pain in the last 12 months *	19	86
Body area:		
Lower back	12	63
Knee	10	53
Shoulder	9	47
Neck	6	32
Wrist or forearm	4	21
Ankle or feet	4	21
Reported chronic musculoskeletal pain in the last 12 months *	5	23
Body area:		
Lower back	2	40
Shoulder	2	40
Wrist or forearm	1	20
In the last 12 months		
Visited a health professional for musculoskeletal pain treatment	8	35
Reported musculoskeletal disorders diagnosed by a physician	6	26
Received medication for musculoskeletal pain	7	30
Reported days away from work due to musculoskeletal symptoms *	3	14
Reported change in work habits due to musculoskeletal symptoms	7	32
Reported sick leave due to musculoskeletal symptoms *	4	31

* Differences in subtotal population sample due to item nonresponse or missing.

In the previous 12 months, a physician diagnosed 26% of the participants with a MSD. Additionally, 35% of the workers visited a health professional such as a physician, chiropractor, or physiotherapist, to receive treatment. About 30% of them got a medication

prescribed for their MSD symptoms. About 63% of the workers experiencing musculoskeletal symptoms reported the need to implement changes in work intensity and job duties or use sick leave to handle the pain (Table 3).

About 60% of the participants experienced pain in the last seven days of the study (see Table 3). Among them, a significant proportion of the workers reported moderate pain in their legs or knees (46%), low back (30%), and severe pain in their arms, shoulders, or hands (23%). The reliability test reported a Cronbach alpha of 0.68, and the scale assessment reported a Loevinger H coefficient of 0.36 (Table 4).

Table 4. Pain location and severity among workers with musculoskeletal pain in the last 7 days (n = 13).

Pain Location	Pain Severity									
	None		Mild		Moderate		Severe		Extreme	
	n	%	n	%	n	%	n	%	n	%
Pain in your low back	3	23	5	38	4	31	1	8	-	-
Pain in your arm, shoulder, or hand	5	38	4	31	1	8	3	23	-	-
Tingling ("pins and needles") in your arm, shoulder, or hand	5	38	5	38	1	8	2	16	-	-
Pain in your legs or knees	2	16	5	38	6	46	-	-	-	-
Pain in your feet	11	84	-	-	2	16	-	-	-	-

Cronbach α: 0.68, Loevinger H: 0.36.

Table 5 summarizes functional limitations to performing activities of daily living (ADLs) among workers who reported musculoskeletal pain in the last 7 days. The results indicated that they experienced moderate to severe limitations in performing ADLs, such as recreational activities that involved some force or impact on the upper limb (moderate: 15%, severe: 8%), reaching objects on an overhead shelf (moderate: 15%, severe: 8%), and kneel or squatting (moderate: 23%). The reliability test reported a Cronbach alpha of 0.66, and the scale assessment reported a Loevinger H coefficient of 0.25 (Table 5).

Table 5. Functional limitations to perform activities of daily living among workers who reported musculoskeletal pain in the last 7 days (n = 13).

Activity	Difficulty Level									
	None		Mild		Moderate		Severe		Unable to Do	
	n	%	n	%	n	%	n	%	n	%
Do heavy household chores (some examples include washing walls or washing floors).	12	92	1	8	-	-	-	-	-	-
Carry a shopping bag or briefcase.	13	100	-	-	-	-	-	-	-	-
Recreational activities that involve some force or impact through your arm, shoulder, or hand (some examples include golf, hammering, or tennis).	7	54	3	23	2	15	1	8	-	-
Stand for one hour or more.	8	61	4	31	1	8	-	-	-	-
Reach for an object on an overhead shelf.	8	62	2	15	2	15	1	8	-	-
Put on your shoes or socks.	7	54	6	46	-	-	-	-	-	-
Get in or out of a car.	8	62	5	38	-	-	-	-	-	-
Stoop or bend towards the floor.	8	61	4	31	1	8	-	-	-	-
Kneel or squat.	7	54	3	23	3	23	-	-	-	-
Use any hand-held tool or equipment (some examples include a telephone, pen, keyboard, computer mouse, drill, hairdryer, or sander).	11	85	2	15	-	-	-	-	-	-

Cronbach α: 0.66, Loevinger H: 0.25.

3.3. Association between Musculoskeletal Pain and Different Predictors

Table 6 summarizes logistic regression models for different musculoskeletal outcomes of interest (musculoskeletal pain in the last seven days, acute musculoskeletal pain in the last 12 months, and chronic musculoskeletal pain in the last 12 months), including potential predictors and covariates such as years of work, BMI, smoking status, and perceived exertion of physical activity intensity level in the previous seven working days (Borg RPE scale).

Table 6. Logistic regression models for different musculoskeletal outcomes of interest.

Outcome: Musculoskeletal Pain in the Last Seven Days				
Parameter	Est. odds ratio	Standard error	95% confidence limits	*p* value
Borg Scale	1.28	0.34	0.76–2.16	0.36
BMI	1.10	0.16	0.83–1.45	0.51
Years of work	1.06	0.07	0.93–1.21	0.40
Smoke	0.66	0.69	0.09–5.08	0.69
Hosmer-Lemeshow: 10.17, *p*: 0.25; Log Likelihood: −12.35, *p*: 0.70				
Outcome: Acute musculoskeletal pain in the last 12 months				
Parameter	Est. odds ratio	Standard error	95% confidence limits	*p* value
Borg Scale	3.82	4.37	0.41–36.02	0.24
BMI	1.53	0.62	0.69–3.38	0.30
Years of work	1.22	0.23	0.85–1.76	0.27
Smoke	0.08	0.20	0.00–11.00	0.32
Hosmer-Lemeshow: 2.37, *p*: 0.97; Log Likelihood: −5.51, *p*: 0.19				
Outcome: Chronic musculoskeletal pain in the last 12 months				
Parameter	Est. odds ratio	Standard error	95% confidence limits	*p* value
Borg Scale	3.25	1.97	0.99–10.66	0.05
BMI	1.17	0.20	0.84–1.62	0.36
Years of work	0.93	0.12	0.72–1.20	0.57
Smoke	0.39	0.84	0.01–26.53	0.66
Hosmer-Lemeshow:14.68, *p*: 0.07; Log Likelihood: −5.82, *p*: 0.03				

The models indicated that for each 1 unit increase in the Borg RPE scale and the BMI, the odds of experiencing musculoskeletal pain also increased. The factors of this increase were particularly high among participants who reported acute and chronic musculoskeletal pain in the last 12 months than musculoskeletal pain in the last seven days. For each additional Borg RPE Scale unit, the odds of experiencing acute and chronic musculoskeletal pain in the last 12 months increased by 3.82 and 3.25, respectively. A one unit increase in the body mass index (BMI), was associated with an increased odds of experiencing acute and chronic musculoskeletal pain in the last 12 months of 1.53 and 1.17, respectively. Years of work had a different effect depending on the type of musculoskeletal pain reported. For each additional year of work, the odds of experiencing musculoskeletal pain in the last seven days and acute musculoskeletal pain during the previous 12 months increased by a factor of 1.06 and 1.22, respectively. However, the opposite effect was seen among participants reporting chronic pain. According to the model, the odds of experiencing chronic pain decreased by a factor of 0.93 on average for each additional year of work. In our study, smoking was associated with a decreased odds of experiencing musculoskeletal pain, indicated by an odds ratio below 1. The odds found were 0.66, 0.08, and 0.39 for musculoskeletal pain in the last seven days and acute and chronic musculoskeletal pain in the last 12 months, respectively (Table 6).

4. Discussion

This pilot study aimed to identify the presence of work-related acute and chronic musculoskeletal pain among construction workers, determine and quantify individual and

work-related factors associated with the occurrence of acute and chronic musculoskeletal pain, and learn how construction workers deal with their acute and chronic musculoskeletal pain. According to our knowledge, this is the first study done in Wisconsin addressing these topics. The tools used to characterize the factors associated with musculoskeletal pain can be easily applied in the field by EHS professionals in implementing and following interventions to reduce musculoskeletal pain among this working population.

Our study's findings concurred that workers in construction faced a high prevalence of musculoskeletal pain contributed by the poor work conditions, awkward body postures, and high levels of physical work activity (e.g., heavy manual materials handling) in the construction workplaces [5,7]. A significant number of respondents in the survey reported that they were seeking help from medical professionals or medications to alleviate their musculoskeletal pain, mostly in their low back, shoulders, and knees. The current study found that about 60% of the participants experienced pain in the last seven days. Among them, a substantial proportion of the workers reported moderate pain in their legs/knees, low back, and severe pain in their arms, shoulders, or hands. Furthermore, respondents who suffered from chronic musculoskeletal pain (> 3 months) [19] reported that the most affected body areas were their lower back, shoulder, and wrist/forearm. Moreover, it is essential to keep in mind that musculoskeletal pain has an impact on safety performance. The presence of musculoskeletal pain has been associated with the occurrence of work-related accidents. Workers who experience musculoskeletal pain reduce their movement in painful body areas. This cause an abnormal moving pattern that can compromise safety at work [20,21]. For example, individuals with low back pain have movement impairments that reduce trunk steadiness, making them prone to falls [22,23].

The findings from the logistic regression models indicated that Borg's ratings of perceived exertion (RPE) are associated with a higher probability of experiencing pain. The exertion levels suggested that the construction worker's odds of experiencing acute and chronic musculoskeletal pain in the last 12 months significantly increased by 3 to 4 times. The Borg's RPE is a good estimator of the physical activity intensity level. Perceived exertion is how hard one feels like one's body is working. It is based on the physical sensations a person experiences during physical activity, including increased heart rate, respiration or breathing rate, sweating, and muscle fatigue. Although this is a subjective measure, a worker's exertion rating based on a 6 to 20 rating scale may provide a fairly good estimate of the worker's actual heart rate during physical activity [15,24]. The respondents in the current study reported their Borg's perceived exertion, a median of 13 (i.e., moderate-intensity activity level of "somewhat hard") and ranging 12–18 (i.e., intensity levels of "somewhat hard" to between "very hard" and "extremely hard") [24]. The moderate intensity levels observed associated with musculoskeletal pain can lead to fatigue [25]. It is well known that fatigue decreases concentration and increases the probability of falls [25,26]. The combination of musculoskeletal pain, and moderate to high physical demands at work increase the likelihood of work-related injuries in the construction industry. The imbalance between job demands and workers' skills, increases the risk of MSDs [27]. For instance, continuous and excessive physical exertions, with or without repetitive body movements, could cause soft tissue damage and reduce the tolerance to make the same effort again [27].

Moreover, the "years of work" had a different effect depending on the type of musculoskeletal pain experienced by the respondents in the current study. For the last seven days and acute musculoskeletal pain in the last 12 months, each additional year of work increased, approximately 6% to 22% morelikely the odds of experiencing musculoskeletal pain. However, for chronic musculoskeletal pain in the last 12 months, the estimated odds ratio was 0.93, that means about 7% less likely to experience chronic musculoskeletal pain with an additional year of work. These findings can be interpreted as a result of the healthy worker survivor effect. According to it, a selection of unhealthy workers out of the workforce causes only healthy workers, survivors, to stay [28]. Workers with major MSDs might already quit their jobs and perform less demanding work. In an interview

study by Welch et al. [10] investigated the long-term consequences of construction worker musculoskeletal injuries, which required emergency room treatment, and found that about one-fourth of the construction workers with symptoms longer than two months were not employed at the time of interview [10]. Siebert [29] also demonstrated the healthy worker survivor effect among construction workers and reported the significant role of various chronic diseases in occupational mobility and early retirement due to permanent disability in the construction industry [29].

It is important to note that given the small sample size, the effect measure shown by the models can be overestimated. However, the purpose of these models was to identify associations between key recognized musculoskeletal pain risk factors and our outcomes of interest and not to develop prediction models for inference. The extrapolation of findings can only be done to construction workers' populations with similar demographic, ethnic, and sociodemographic characteristics. However, the factors identified such as the high physical demands of the job measured through the Borg (RPE) scale and the BMI have been previously identified and associated with the occurrence of musculoskeletal disorders and musculoskeletal pain by several studies [30–32].

Our study's findings indicated the need to implement intervention programs to reduce the effect of occupational and lifestyle risk factors. The integration of these two aspects may significantly reduce the exposure to occupational hazards and improve workers' health [33,34]. Understanding the relationship between musculoskeletal pain, physical work demands, and individual factors could inform the development of an integrated workplace intervention program. EHS and occupational health researchers and practitioners planning to develop a workplace program for the prevention of musculoskeletal pain in the construction industry may consider the effects of work demands and BMI in this working population. We believe an intervention addressing physical demands and promoting healthy lifestyles in the construction sector may have a significant impact on the reduction of musculoskeletal pain and will improve the quality of life of the workers. Moreover, stretch & flex (SF) exercise program interventions at the construction job sites can be beneficial not only reduction of recordable occupation injuries (e.g., fractures, sprains/strains), but also possibly in alleviating musculoskeletal pain or injury [34]. Furthermore, individually tailored interventions such as lifestyle counseling and physical activity behaviors coaching showed positive changes in vigorous physical activities and intake of sugar-sweetened beverages among construction workers [35].

"Decent work for all" was highlighted in the U.N.'s 2030 Agenda for *Sustainable Development Goals* [35]. Safe and healthy working conditions are a critical pointer for "decent work" [36]. Furthermore, occupational safety and health are indispensable for sustainable workplace and society where workers can enjoy healthy and prolific lives during and after work [37]. A study on construction workers and sustainability by Park & Jeong [38] stated that certain subgroups (e.g., older workers) are susceptible to musculoskeletal pain and are inclined to fatigue, sleep-related problems, and depression due to job uncertainty and deficiency of social support [38].

The U.S. National Institute for Occupational Safety and Health (NIOSH) defines Total Worker Health® as policies, programs, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness-prevention efforts to advance worker wellbeing [39]. The Total Worker Health (TWH) approach can improve the wellbeing of the workforce by protecting their safety and health while promoting benefits to workers, employers, and the community. The TWH program can enhance worker's wellbeing by informing the design of work and employment conditions to prioritize occupational safety & health, and improve physical and psychological outcomes [39]. For instance, Luckhaupt et al. [37] pointed out that work-related factors can contribute to the high prevalence of obesity in the U.S. working population. ESH professionals and employers should consider effective workplace interventions that target organization-level factors, such as scheduling and prevention of workplace hostility, along with individual-level factors (e.g., diet and exercise) [37,39]. The TWH approach also provides a scientific evidence base that can help

businesses and communities reduce the impact and cost of injuries and illness, thereby helping to control healthcare costs and disruption to family and community life. In deed, the TWH approach promotes research into patterns of work organization and emerging forms of employment, recognizing that both occupational and non-occupational exposures can act together to produce worker illness and injury. By integrating the traditional focus on work-specific factors with attention to health conditions and the quality of working life, the TWH approach provides a pathway to improve worker creativity, innovation, and productivity by creating work and work environments that are safe, health-enhancing, meaningful and fulfilling. By accentuating a TWH focus, employers can increase their competitive advantages related to employee recruitment, retention, satisfaction/morale, community engagement, reputation, and sustainable workforce [40,41].

Moreover, a discussion paper by Holtermann et al. [42] proposed the "Goldilocks Principle" for how productive work can be designed to promote worker's health and physical capacity. They claimed that designing work ensuing the "Goldilocks Principle" has the latent to scope all workers, including lower socioeconomic groups. As noted by Straker et al. [43], the "Goldilocks Principle" is inspired by the *Three Bears* fairytale, where Goldilocks tries the porridge, chairs, and beds, finding some too hot/large/hard, some too cold/small/soft, but some "just right" for her needs. Like the fairytale, the "Goldilocks Principle" aims to design or allocate productive work to be "just right" in regard to the worker's physical and health characteristics, while promoting workers' health and physical capacity [43]. The "Goldilocks Principle" could contribute to narrow the gaps in socioeconomic health disparities in many societies by protecting/promoting workers' health. Because the principle is also about making productive work "just right" for those with too much and too little physical demands, it can be seen as a potential tool for improving health/safety and physical capacity for white- and blue-collar workers. Due to its basis in productive and healthy work, the "Goldilocks Principle" may be effective for improving health/safety, physical capacity, work quality, and productivity, which means sustainable jobs [42].

Limitations of the current study included a relatively small sample size (number of participants), the population evaluated mainly included caucasian males (91% male vs. 9% female; 96% white vs. 4% black), and the lack of representation of construction trade/occupations such as carpenters, laborer, and framing (31–35% each). Furthermore, the survey participants were from a specific geographic region. We acknowledge that our small sample size may limit the generalizability of our findings to only construction workers with similar demographic characteristics and working practices. In the data analysis, it was noticed that some missing data from the survey questionnaire responses. Furthermore, there is potential "recall bias" in responding to the survey questionnaire questions (e.g., last 12 months), but we believe that musculoskeletal pain is a very significant symptom that most people would be able to recall and report. The study did not collect information on all the potential risk factors or confounders, such as psychosocial risk factors or diseases that could be associated with musculoskeletal pain. However, we know that the main factors identified by the models associated with musculoskeletal pain (Borg RPE scale, BMI, and years of work) are well recognized for their relation to the occurrence of musculoskeletal disorders and could be easily assessed to evaluate the efficacy of an intervention program aiming at reducing musculoskeletal pain in the construction industry.

5. Conclusions

This research paper effectively documented work-related acute and chronic musculoskeletal pain and how workers deal with musculoskeletal pain while identifying work-related and individual factors associated with musculoskeletal pain among commercial construction workers. The results can help occupational safety and health professionals in the region in order to recognize the significance of musculoskeletal pain at a much deeper level. Not only can the data provide the information necessary to understand how individuals deal with musculoskeletal discomfort/pain, but the data can also help further research

into finding solutions to prevent chronic and acute pain that construction workers would have readily available. This research may also be used to educate construction workers and employers and urge them to find a healthy way to mitigate or solve their musculoskeletal pain. Construction workers are dealing with acute and chronic pain at work that negatively impacts their work and activities of daily living (ADLs). Work-related and individual factors such as physical work exertion and BMI can play an important role in the presence of acute and chronic pain associated with MSDs. This study's findings can help guide sustainable ergonomic interventions to alleviate acute & chronic musculoskeletal pain and promote workers' health and wellbeing in the construction industry. Further studies with bigger sample sizes are warranted to fill the gap in the characterization of musculoskeletal pain among construction workers in Wisconsin and the U.S. Those studies will help to validate our findings, develop tailored interventions for health promotion and ergonomic programs essential to reduce musculoskeletal pain, and secure physical ergonomics and health for the sustainable work of construction workers in the industry.

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