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Assessment of Risk Factors Related to Body Pain Complaints in Tanzania Construction Industry

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ABSTRACT

The construction industry is associated with risks that can result in musculoskeletal diseases. Although young male workers who are presumed to be healthy dominate the industry in Tanzania, body pain complaints have been widely reported. The aim of this study is to assess the prevalence and causes of body pains in workers. A cross-sectional study involving 396 workers was conducted. A chi square test was used for testing association of independent categorical variables and binary logistic regression analysis was used to determine predictors for body pain complaints. The results show that all study participants complained of at least one form of body pain with back pain at 87.6%, shoulder pain at 62.9% and neck pain at 25.8%. Both sociodemographic factors as well as biomechanical risks factors were found to be determinants for pain in the neck and shoulder. However, none of the factors were found to be statistically significant for back pain.

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INTRODUCTION

Construction industry has been shown to have a very strong relationship with countries' gross domestic product (Alaloul et al., 2021; Musarat et al., 2020) and said to employ over 7% of the world's entire workforce (ILO, 2019; Kanchana et al., 2015). However, the industry is considered as one of the most hazardous industries for work-related musculoskeletal symptoms (Guo et al., 2004; Chen et al., 2005) where globally the prevalence of musculoskeletal disorder symptoms involving one or more body regions is higher in construction workers compared to other industries (Liang et al., 2019, Sousa et al., 2014). Seventy-seven per cent of the total construction workers are recognized to have musculoskeletal pain or disorder (Shirur et al., 2014) with the low back, neck, and upper extremities being the most commonly affected body parts (Umar et al., 2020; Umer et al., 2018; Alghadir and Anwer, 2015). Musculoskeletal disorders in the construction industry are mainly a factor of sociodemographic and ergonomic risk factors (Jaffar et al., 2011; Choi, 2010). *Sociodemographic risk factors associated with body pain:* Differences in perception of risks may lead to exposure that may in turn lead to accidents, injuries, body pain and musculoskeletal diseases. Studies show that workers perceive risks differently even when exposed to identical circumstances (Ricci et al., 2021; Trillo-Cabello et al., 2021) due to differences in their

influencing sociodemographic factors (Renault et al., 2021; Chaswa et al., 2020). Studies by Chen and Jin (2015) in United States of America, Idrees (2017) in Pakistan, Meng and Chan (2020) in China, have shown that age plays an important role in situational awareness and safety perception whilst a study by Han et al. (2019a) shows that there is a significant influence to safety perceptions in relation to difference in age, sex and educational level. The study found that young female workers with low-level education have lower safety perceptions compared to their peers on the same work environment. Han et al (2019b) also shows that workers' experience has a significant impact to the perception of safety in construction industry where entry-level employees tend to evaluate hazards with a higher degree of danger compared to early career employees and senior peers.

Other studies have shown that sociodemographic factors such as marital status (Berhanu et al., 2019; Fang et al., 2006) work role/type, work experience, education, employment status, and training also influence workers situational awareness (Meng and Chan, 2020; Mahboobi et al., 2020; Karimi and Taghaddos, 2019; Chan et al., 2017).

The construction industry involves variety of workers who perform activities in different environments such as at heights, on ground or underground (Ekpenyong and Inyang, 2014) facing chemical, biological, physical, psychological, biomechanical and ergonomic risks that might cause injuries to their bodies (Jaffar et al., 2011). Biomechanical risk is a physical, physiological, environmental factor within the workplace that harms the musculoskeletal system of the workers (Anwer et al., 2021; Liang et al., 2019; Shirur et al., 2014). Construction workers find themselves exposed to various biomechanical risk factors including lifting and carrying of heavy loads, prolonged vibration, bending, kneeling and other awkward postures (Antwi-Afari et al., 2017; Salas et al., 2016). A study by Lop et al. (2019) found that repetition movement, awkward posture, forceful exertion, vibration and contact stress are all risk factors to concrete workers in Malaysia where awkward posture was found to be one of the biggest contributing factors related to musculoskeletal injury. Occupational exposure to vibration and awkward posture were also associated with shoulder and neck musculoskeletal disease in a study by Charles et al. (2018). On the other hand, loading forces have been associated with risk of injury at the shoulder, neck, lower back, forearm, wrist and hand (Ray et al., 2012). In general, biomechanical risk factors are dependent on working procedures and methods used in the construction site and can lead to musculoskeletal diseases.

The construction industry in Tanzania contributed 13.8 percent of the total gross domestic product in 2021 with an annual growth rate of 2.3 percent (URT, 2021). As other developing countries, the industry is proliferated with unskilled parttime labour (at least 70 to 75 percent) with low engagement of female workers at 14.5 to 24.7 percent depending on the size of the construction company (URT, 2010). While studies have been conducted in different countries on the prevalence of body pain in the construction industry and their associated risk factors, it should be noted that the two are likely to be country specific since the construction industry in different countries is governed by different laws and procedures, has different levels of organizational maturity and employs workers with different skill set. Moreover, the impact of sociodemographic factors is not transversal to all construction industries, therefore there is a need to understand the impact of these factors specific to Tanzania construction industry.

METHODS AND MATERIALS

Study Design

Cross-sectional design was used to investigate exposure to biomechanical risk

factors and outcomes (neck, shoulder, and back pain) among construction workers in the economic capital of Tanzania – Dar es Salaam from 20th January 2020 to 30th May 2020. The study also investigated the effect of sociodemographic factors on pain complaints among workers.

Study Sample

The required sample size was determined by using the single population proportion formula (Israel,1992):

$$N = \frac{Z^2 \ x \ P \ x \ Q}{E^2} \qquad (1)$$

where N is the desired sample; P = Population proportional (0.533 – the proportion of workers who experienced body pain as reported by Jazari et al. (2018); Z = Confidence level (Z = 1.96 for 95%); E = Margin of error 5% (0.05); Q = (1-P).

Since the study used simple random sampling technique, a total of 10% anticipated non-respondents was added to give a total of 424 respondents needed in the study. The researchers visited eighty (80) registered construction sites having skilled and unskilled workers and selected five participants at random working at each site. Information was collected from 396 workers from a total of 424 workers that were selected (93.4% response rate) surpassing the required sample size of 385 workers. Ethical clearance was first obtained from the University of Dar es Salaam through the Department of Structural and Construction Engineering, Contractors Registration Board – that registers all construction projects, Construction companies' site management and oral informed consent was obtained from each respondent prior to answering the questionnaire.

Questionnaire design

A pre-tested and structured questionnaire and observational checklist were used to collect data on the prevalence of body pain complaints and its associated risk factors (Yang et al., 2020; Mekonnen et al., 2020; Reddy et al., 2016; Ekpenyong et al., 2014) using trained personnel. The anticipated sociodemographic and biomechanical risk data to be collected was referenced from literature review.

The first part of the questionnaire recorded detailed information on the socio-demographic condition of the participants including sex, age, education (no formal education, primary education, secondary education and higher education), marital status (single, married, divorced, cohabited, widower) employment status (temporary, permanent), and work experience (three to six months, six to twelve months and above twelve months). Due to a possibility of having a majority of temporary workers in the industry, work experience was defined in shorter periods of time in order to understand the working habits of these workers. The second part focused on information related to biomechanical risk factors. This information looked at the characteristics of the tasks performed by the workers (prolonged squatting, moving heavy loads manually, extension of arms, repetitive motion, bending and working with vibration tools) and the working method (work rotation). The third part of the questionnaire extracted information on the body regions where they have experienced pain in the last twelve months of working in the construction industry, whilst the fourth and final part of the questionnaire asked on the knowledge related to ergonomic risks and perceived measures to combat the risks.

Here, prolonged squatting was taken to mean working while squatting for more than thirty minutes without change of posture whilst moving the standard 20kg sandcrete block was used as reference when referring to moving of heavy loads manually. Repetition could be defined as performing a task that uses the same muscles over and over with little chance for rest or recovery (Jaffar et al., 2011); this includes task such as painting and moving buckets of water. On the other hand, neck

and back bents involves tasks that are performed while the neck and back are bent at an angle causing strain to the muscles. On the other hand, work rotation is defined as change of task to another discipline periodically.

Data analysis

Data collected were sorted and checked on daily basis to check their completeness and consistence. It was then statistically analyzed using SPSS version 22. Demographic data of the participants were calculated using descriptive statistics. Prevalence of body pain in different body regions was determined using cumulative frequency. Chi square tests were used for testing association of independent categorical variables (sociodemographic and biomechanical factors) and outcome variable (body pain complaints) using univariate analysis.

Binary logistic regression analysis was then used to determine predictors for body pain using odds ratio (OR) and confidence interval (CI) of 95%. P value <0.05 was considered statistically significant. The regression analysis included only the variables found to be significantly associated with body pain in the univariate analysis. Logistic regression analysis was chosen because it is well suited for describing and testing hypotheses about relationships between a categorical outcome and one or more categorical or continuous predictors (Peng et al., 2002). It has also been widely used in studies analyzing risk factors associated with occupational safety (Halabi et al., 2022; Makki and Mosly, 2021; Amoako et al., 2020; Chau et al., 2003). To investigate the reliability of the binary logistic regression, pre-estimate tests were performed to ensure there is linear relationship between continuous independent variable and the logit transformation of the dependent variable. The natural logarithm of the continuous independent variable was found not to be statistically significant and hence the data was assumed to be reliable.

Results

Participants socio-demographic information: In this study, the mean age of study participants was found to be 35.9 years. As a representative of the construction industry in Tanzania, the population was skewed to the male respondents (84.6%) with almost an equal distribution of respondents who were single (46.0%) and those who were married (42.9%). In addition, more than three quarters of respondents (77.5%) were temporarily employed. Workers who have lower-level education – primary school (37.1%) and secondary school (52.8%), dominate the industry whilst workers with higher education make only 8.1% of the study population. Moreover, the industry is made mostly of workers who have an experience of more than one year (76%) (Table 1).

The socio-demographic information collected in this study is consistent with the general characteristic of the construction industry in Tanzania as explained in Section 1.4 giving validity to the sampling method used in this study.

Prevalence of body pain complaints

The study participants reported three body pain complaints – back, shoulder and neck pain. All respondents reported pain at one or more body regions in the last twelve months. The most frequent body pain complaint was back pain at 87.6%, followed by shoulder pain at 62.9% and neck pain at 25.8% (Figure 1).

Table 1: Sociodemographic information

General Information	Value
Age	

Mean (SD)	35.9 (8.45)
Range	22 – 54
Sex (% sample)	
Male	84.6
Female	15.4
Education level (% sample)	
No formal education	2
Primary education	37.1
Secondary education	52.8
Tertiary education	8.1
Marital status (% sample)	
Single	46
Married	42.9
Divorced	3
Cohabited	8.1
Work experience	
3-12 months	24
>12 months	76
Job status (% sample)	
Temporary	77.5
Permanent	22.5

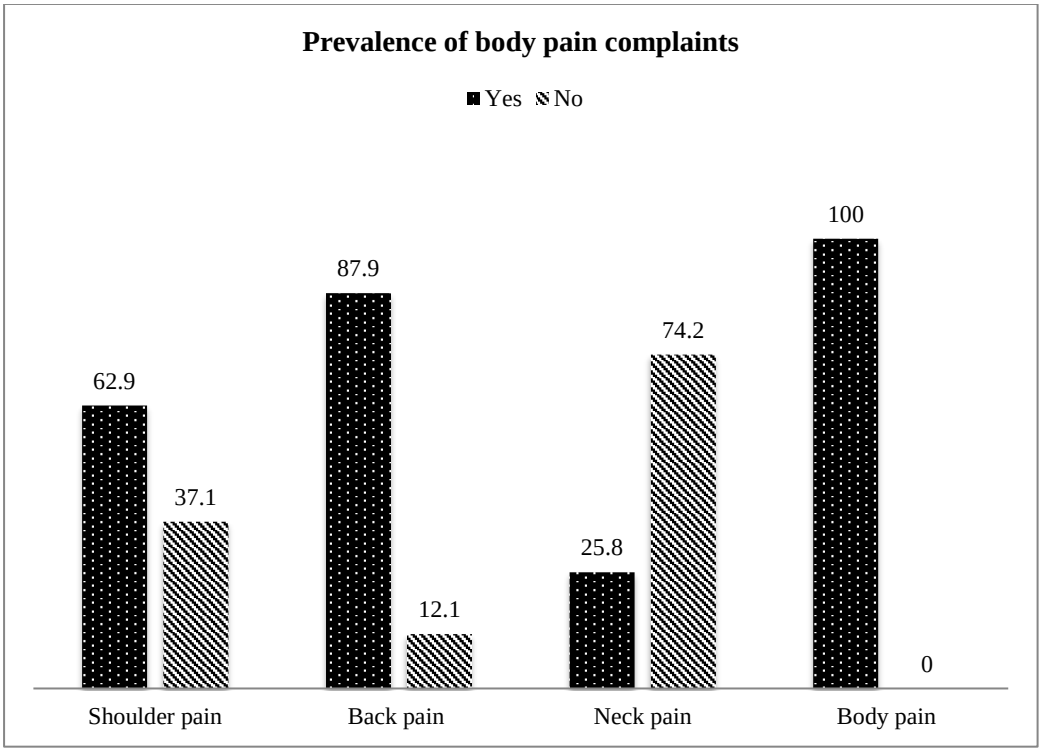

Figure 1: Prevalence of body pain complaints.

Risk factors in relation to body pain complaints

Risk factors associated with body pain complaints

The results in Table 2, Table 3 and Table 4 show association between risk factors and body pain complaints for neck, shoulders and back respectively. The results show strong association between all sociodemographic factors and neck, shoulder and back pain with the exception of employment status for back pain. On the other hand, only manual lifting, work rotation, extension of arms, prolonged squatting and moving more than 20kg load show an association with back pain amongst biomechanical factors. For the case of biomechanical risk factors on neck pain, work rotation, and bent back show no association whilst working with vibrating tools, repetitive motion and moving more than 5kg load show a strong association with $p<0.01$.

Contrarily, all biomechanical risk factors show an association with shoulder pain except for moving more than 20kg load. All factors that showed a strong degree of association with body pain (p-value <0.05) in this univariate analysis were inputted as covariates in the multiple regression analysis model that determined significant risk factors to body pain.

Table 2: Risk factors associated with neck pain using univariate analysis

			Neck pain			
Factors		**Count**	**Yes**	**No**	**Chi square**	**P value**
Age	≤30 years	117	19 (16.2%)	98 (83.8%)	7.867	0.005
	>30 years	279	83 (29.7%)	196 (70.3%)		
Sex	Male	335	67 (20%)	268 (80%)	37.699	< 0.05
	Female	61	35 (57.4%)	26 (42.6%)		
Marital status	Single	182	40 (22%)	142 (78%)	36.425	< 0.05
	Married	170	56 (32.9%)	114 (67.1%)		
	Divorced	12	0	12 (100%)		
	Cohabited	26	0	26 (100%)		
	Widow/widower	6	6 (100%)	0		
Education	No formal education	8	0	8 (100%)	62.182	< 0.05
	Primary education	147	23 (15.6%)	124 (84.4%)		
	Secondary education	209	53 (25.4%)	156 (74.6%)		
	Tertiary education	32	26 (81.3%)	6 (18.8%)		
Employment status	Temporary	307	65 (21.2%)	242 (78.8%)	15.016	< 0.05
	Permanent	89	37 (41.6%)	52 (58.4%)		
Experience	3 – 12 months	95	43 (45.3%)	52 (54.7%)	24.866	< 0.05
	> 12 months	301	59 (19.6%)	242 (80.4%)		
Manual lifting	Yes	357	102 (28.6%)	255 (71.4%)	15.009	< 0.05
	No	39	0	39 (100%)		
Work rotation	Yes	74	16 (21.6%)	58 (78.4%)	0.814	0.367
	No	322	86 (26.7%)	236 (73.3%)		
Extension of arms	Yes	242	92 (38%)	150 (62%)	48.903	< 0.05
	No	154	10 (6.5%)	144 (93.5%)		
Prolonged squatting	Yes	184	32 (17.4%)	152 (82.6%)	12.58	< 0.05
	No	212	70 (33%)	142 (67%)		
Moving >5kg	Yes	371	102 (27.5%)	269 (72.5%)	9.258	0.002
	No	25	0	25 (100%)		
Repetitive motion	Yes	207	43 (20.8%)	164 (79.2%)	5.635	0.018
	No	189	59 (31.2%)	130 (68.8%)		
Bent Neck/ Back	Yes	387	100 (25.8%)	287 (74.2%)	0.06	0.806
	No	9	2 (22.2%)	7 (77.8%)		
Moving >20kg	Yes	269	31 (11.5%)	238 (88.5%)	88.86	< 0.05
	No	127	71 (55.9%)	56 (44.1%)		
Working with vibrating tools	Yes	217	70 (32.3%)	147 (67.7%)	10.608	0.001
	No	179	32 (17.9%)	147 (82.1%)		

Table 3: Risk factors in relation to shoulder pain using univariate analysis

			Shoulder pain			
Factors		**Count**	**Yes**	**No**	**Chi square**	**P value**
Age	≤30 years	117	57 (48.7%)	60 (51.3%)	14.267	<0.05
	>30 years	279	192 (68.8%)	87 (31.2%)		
Sex	Male	335	188 (56.1%)	147 (43.9%)	42.569	<0.05
	Female	61	61 (100%)	0		
Marital status	Single	182	108 (59.3%)	74 (40.7%)	24.743	<0.05
	Married	170	115 (67.6%)	55 (32.4%)		
	Divorced	12	12 (100%)	0		
	Cohabited	26	8 (30.8%)	18 (69.2%)		
	Widow/widower	6	6 (100%)	0		
Education	No formal education	8	8 (100%)	0	30.938	<0.05
	Primary education	147	96 (65.3%)	51 (34.7%)		
	Secondary education	209	113 (54.1%)	96 (45.9%)		
	Tertiary education	32	32 (100%)	0		
Employment status	Temporary	307	178 (58%)	129 (42%)	14.042	<0.05
	Permanent	89	71 (79.8%)	18 (20.2%)		
Experience	3 – 12 months	95	74 (77.9%)	21 (22.1%)	12.073	<0.05
	> 12 months	301	175 (58.1%)	126 (41.9%)		
Manual lifting	Yes	357	233 (65.3%)	124 (34.7%)	8.851	0.003
	No	39	16 (41%)	23 (59%)		
Work rotation	Yes	74	31 (41.9%)	43 (58.1%)	17.173	<0.05
	No	322	218 (67.7%)	104 (32.3%)		
Extension of arms	Yes	242	207 (85.5%)	35 (14.5%)	136.874	<0.05
	No	154	42 (27.3%)	112 (72.7%)		
Prolonged squatting	Yes	184	86 (46.7%)	98 (53.3%)	38.357	<0.05
	No	212	163 (76.9%)	49 (23.1%)		
Moving >5kg	Yes	371	247 (66.6%)	124 (33.4%)	34.431	<0.05
	No	25	2 (8%)	23 (92%)		
Repetitive motion	Yes	207	150 (72.5%)	57 (27.5%)	17.071	<0.05
	No	189	99 (52.4%)	90 (47.6%)		
Bent Neck/Back	Yes	387	240 (62%)	147 (38%)	5.437	0.020
	No	9	9 (100%)	0		
Moving >20kg	Yes	269	176 (65.4%)	93 (34.6%)	2.334	0.127
	No	127	73 (57.5%)	54 (42.5%)		
Working with vibrating tools	Yes	217	121 (55.8%)	96 (44.2%)	10.422	0.001
	No	179	128 (71.5%)	51 (28.5%)		

Table 4: Risk factors in relation to back pain using univariate analysis

			Back pain			
Factors		**Count**	**Yes**	**No**	**Chi square**	**P value**
Age	≤30 years	117	116 (99.1%)	1 (0.9%)	19.789	< 0.05
	>30 years	279	232 (83.2%)	47 (16.8%)		
Sex	Male	335	327 (97.6%)	8 (2.4%)	193.414	< 0.05
	Female	61	21 (34.4%)	40 (65.6%)		
Marital status	Single	182	166 (91.2%)	16 (8.8%)	49.787	< 0.05
	Married	170	145 (85.3%)	25 (14.7%)		
	Divorced	12	12 (100%)	0		
	Cohabited	26	25 (96.2%)	1 (3.8%)		
	Widow/widower	6	0	6 (100%)		
Education	No formal education	8	8 (100%)	0	12.086	0.007
	Primary education	147	136 (92.5%)	11 (7.5%)		
	Secondary education	209	181 (86.6%)	28 (13.4%)		
	Tertiary education	32	23 (71.9%)	9 (28.1%)		
Employment status	Temporary	307	274 (89.3%)	33 (10.7%)	2.414	0.120
	Permanent	89	74 (83.1%)	15 (16.9%)		
Experience	3 – 12 months	95	70 (73.7%)	25 (26.3%)	23.641	< 0.05
	> 12 months	301	278 (92.4%)	23 (7.6%)		
Manual lifting	Yes	357	309 (86.6%)	48 (13.4%)	5.967	0.015
	No	39	39 (100%)	0		
Work rotation	Yes	74	74 (100%)	0	12.553	< 0.05
	No	322	274 (85.1%)	48 (14.9%)		
Extension of arms	Yes	242	194 (80.2%)	48 (19.8%)	34.759	< 0.05
	No	154	154 (100%)	0		
Prolonged squatting	Yes	184	182 (98.9%)	2 (1.1%)	39.286	< 0.05
	No	212	166 (78.3%)	46 (21.7%)		
Moving >5kg	Yes	371	323 (87.1%)	48 (12.9%)	3.681	0.055
	No	25	25 (100%)	0		
Repetitive motion	Yes	207	188 (90.8%)	19 (9.2%)	3.525	0.060

	No	189	160 (84.7%)	29 (15.3%)		
Bent Neck/Back	Yes	387	341 (88.1%)	46 (11.9%)	0.882	0.348
	No	9	7 (77.8%)	2 (22.2%)		
Moving >20kg	Yes	269	259 (96.3%)	10 (3.7%)	55.611	< 0.05
	No	127	89 (70.1%)	38 (29.9%)		
Working with vibrating tools	Yes	217	188 (86.6%)	29 (13.4%)	0.696	0.404
	No	179	160 (89.4%)	19 (10.6%)		

Significance of risk factors to body pain complaints

The results showing significant risk factors for neck pain are given in Table 5. Sociodemographic factors related to age, sex, education, employment status and work experience show a significant relationship with neck pain whilst extension of arms, repetitive motion and moving more than 20kg load are significant factors among biomechanical risk factors. In the case of shoulder pain, none of the sociodemographic factors are significant but extension of arms, prolonged squatting, works rotation, repetitive motion and working with vibration tools are all found to be significant among biomechanical risk factors (Table 6). Contrarily, all sociodemographic and biomechanical risk factors were found to be statistically non-significant for back pain (Table 7).

Additionally, in order to understand the relationship between age, experience and doing heavy manual jobs such as moving more than 20kg load, a correlation analysis was conducted between the three factors (Table 8). The same analysis was also conducted to elicit the relationship between education, experience and moving more than 20kg load (Table 9). The results show that there is an inverse correlation relationship between decreasing age of worker and experience, moving more than 20kg load and experience and moving more than 20kg load and decreasing age of worker. Moreover, the results in Table 9 show that there is an inverse relationship between education and experience and between moving more than 20kg and experience but a positive relationship between education and moving more than 20kg load.

RESULTS AND DISCUSSION

The present study was conducted in an attempt to investigate the working conditions of construction workers in Tanzania and evaluate the prevalence of musculoskeletal pain and their contributing risk factors. The study revealed that all workers investigated (100%) had experienced at least one form of body pain in the last twelve months of work with pain of the back being the most prevalent similar to previous findings amongst construction workers in other countries, albeit the findings in Tanzania show a significantly higher prevalence compared to Saudi Arabia (48.5%, self-reported, last 12months) (Alghadir et al., 2015), Iran (53.3%, self-reported, last 12months) (Jazari et al., 2018), Netherlands (67%, self-reported, last 6 months) (Boschman et al., 2012), and Nigeria (39.25%, self-reported, last 12months, Nordic scale) (Ekpenyong et al., 2015). The higher prevalence in Tanzania may be attributed to inadequate breaks and work rotations that would likely offer workers opportunity to work periodically in different fields. Survey results revealed that only 18.7% of study participants were doing work

rotation. Although slightly, work rotation has been shown in this study to decrease body pain with OR of 0.052 for shoulder pain.

Table 5: Significant risk factors for neck pain using multiple regression analysis

Factors		P value	OR	Lower limit	Upper limit	Significance
Age	>30 years	0.02	0.104	0.016	0.699	Significant
	≤30 years	Reference				
Sex	Male	0.019	7.701	1.391	42.643	Significant
	Female	Reference				
Marital status	**Group value**	**0.774**				
	Single	0.999	0.000	0.000		
	Married	0.999	0.000	0.000		
	Divorced	0.999	0.000	0.000		
	Cohabited	0.998	0.000	0.000		
	Widow/widower	Reference				
Education	Group value	0.001				Significant
	No formal education	0.998	0.000	0.000		
	Primary education	0.001	0.000	0.000	0.000	
	Secondary education	0.001	0.000	0.000	0.002	
	Tertiary education	Reference				
Employment status	Temporary	0.001	77.667	7.351	820.769	Significant
	Permanent	Reference				
Experience	Group value	0.041				Significant
	3 – 6 months	0.012	7.292	1.557	34.146	
	6 – 12 months	0.331	2.495	0.395	15.776	
	> 12 months	Reference				
Manual lifting	Yes	0.999	6.58E+04	0.000		
	No	Reference				
Extension of arms	Yes	0.001	48.743	5.974	397.727	Significant
	No	Reference				
Prolonged squatting	Yes	0.127	0.29	0.059	1.419	
	No	Reference				
Moving >5kg	Yes	0.999	9.85E+06	0.000		
	No	Reference				
Repetitive motion	Yes	0.001	416.303	28.903	6.00E+03	Significant
	No	Reference				
Moving >20kg	Yes	0.001	0.000	0.000	0.003	Significant
	No	Reference				
Working with vibrating tools	Yes	0.948	1.054	0.219	5.072	
	No	Reference				

Table 6: Significant risk factors for shoulder pain using multiple regression analysis

Factors	P value	OR	Lower limit	Upper limit	Significance

Age	>30 years ≤30 years	0.323 Reference	1.672	0.603	4.635	
Sex	Male Female	0.997 Reference	0.000	0.000		
Marital status	Group value Single Married Divorced Cohabited Widow/widower	0.927 0.999 0.999 0.999 0.999 Reference	 4.46E+08 3.50E+08 9.76E+14 6.73E+08	 0.000 0.000 0.000 0.000		
Education	Group value No formal education Primary education Secondary education Tertiary education	0.219 1.000 0.997 0.997 Reference	 1.375 0.000 0.000	 0.000 0.000 0.000		
Employment status	Temporary Permanent	0.234 Reference	2.185	0.604	7.907	
Experience	Group value 3 – 6 months 6 – 12 months > 12 months	0.526 0.257 0.997 Reference	 0.546 3.88E+08	 0.192 0.000	1.552	
Manual lifting	Yes No	0.998 Reference	0.000	0.000		
Work rotation	Yes No	0.001 Reference	0.052	0.012	0.228	Significant
Extension of hands	Yes No	0.001 Reference	8.706	2.795	27.116	Significant
Prolonged squatting	Yes No	0.001 Reference	0.059	0.017	0.198	significant
Moving >5kg	Yes No	0.998 Reference	4.09E+11	0.000		
Repetitive motion	Yes No	0.001 Reference	35.132	9.353	131.963	Significant
Neck/back bents	Yes No	0.999 Reference	0.000	0.000		
Working with vibrating tools	Yes No	0.001 Reference	21.433	4.065	113.007	Significant

Table 7: Significant risk factors for back pain using multiple regression analysis

Factors		P value	OR	Lower Limit	Upper Limit	Significance
Age	>30 years ≤30 years	0.990 Reference	1.48E+15	0.000		
Sex	Male Female	0.992 Reference	6.68E+21	0.000		
Marital status	Group value Single Married Divorced Cohabited Widow/widower	1 0.998 0.996 0.997 0.998 Reference	 0.000 0.000 0.000 0.000	 0.000 0.000 0.000 0.000		
Education	Group value No formal education Primary education Secondary education Tertiary education	1 0.992 0.987 0.988 Reference	 0.000 0.000 0.000	 0.000 0.000 0.000		
Experience	Group value 3 – 6 months 6 – 12 months > 12 months	1 0.998 0.997 Reference	 3.55E+08 4.68E+07	 0.000 0.000		
Manual lifting	Yes No	1 Reference	0.005	0.000		
Work rotation	Yes No	0.994 Reference	6.61E+21	0.000		
Extension of arms	Yes No	0.99 Reference	0.000	0.000		
Prolonged squatting	Yes No	0.982 Reference	3.10E+35	0.000		
Moving >20kg	Yes No	0.982 Reference	8.85E+28	0.000		

Moreover, the presence of high number of temporary workers (77.5%) may also be an attributing factor since temporary workers have been found to take less precaution on health and safety issues as they are not assured of employment (Lette et al, 2018). This study found that the relationship between neck complaint and employment status has an OR of 77.677 indicating the markedly increased likelihood for a temporary worker to experience neck pain compared to a permanent one.

Another contributing factor is the differences in activities performed. Studies

show that manual handling activities have significant impact on the body pain complaints (Jazari et al., 2018; Kisilu et al., 2017; Kincl et al., 2016; Ekpenyong and Inyang, 2014; Boschman et al., 2012). In this study, moving more than 20kg load was found to be a statistically significant risk factor for neck pain albeit with a very low odds ratio (p=0.001; OR=0.00). The study of Kisilu et al. (2017) that reported a 22% prevalence body pain complaint has 25.5% of its participants performing manual handling work while in this study it accounted for 90.2%. The implication of this finding is that even contractors with more resources registered in Class I to IV are working without utilization of mechanical tools in contrast to the recommendations of Contractors Registration Board.

Moreover, construction workers are predominately temporarily employed in the construction industry in Tanzania, and continue working under temporary conditions for at least over one year (76%); as a consequence, length of service is another significant risk factor to musculoskeletal diseases among construction workers (Jaiswal & Veerkumar, 2016; Purani et al., 2016) as supported in our results for neck pain (p=0.041).

By understanding the importance of safety training in reducing hazard risks in the construction industry (Tezel et al., 2021; Hasanzadeh et al., 2020; He et al., 2019), the Occupational Safety and Health (Building and Construction Industry) Rules of 2015 (URT, 2015) governing the construction industry in the country under the Occupational Safety and Health Act of 2003 (URT, 2003) requires that the contractor shall provide Occupational Health and Safely training for workers before commencement of the project and that no contractor shall allow or permit any employee or person to enter any site, unless such employee or person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry. Regardless of the available regulations, this study found that none of the 396 respondents (0%) working on eighty legally registered construction sites have undergone such a training and that only 3.5% of the participants were aware of ergonomic risks.

After adjusting for all associated variables, age (OR 0.104 for workers of above 30 years of age), sex (OR 7.701 for male workers), employment pattern (OR 77.677 for temporary employed), and work experience (OR 7.292 for duration of 3-6 months and OR 2.495 for duration of 6-12 months) all show a significant contribution to neck pain.

In general, the results show that young male workers under temporary employment with little experience have higher chances of experiencing neck pain since strong young male workers with shorter experience are considered more susceptible to be tasked with heavy manual jobs such as moving more than 20kg load. The results in this study that show that age of above 30 years is a protective factor to body pain are in contrast to the study by Bodhare (2011) and Holmstrom et al. (2005) which found that increasing age is significant risk factor that may be a reflection of the accumulation of repeated insults to the body. However, site procedures in Tanzania, supports the findings of this study. This is because as workers' age increases, their experience and seniority give them an opportunity to be assigned different tasks than doing heavy manual work. This is supported by interpretation of correlation analysis of age, experience and moving more than 20kg load as given in Table 8. Meaning that an experienced worker doing block walling might be tasked with setting of the mortar between blocks while an inexperienced worker is more likely to be tasked with carrying the blocks to the walling area.

Table 8: Correlation analysis for age, experience and moving >20kg load

Correlated Variable	Type of Correlational Relation	Pearson	Significance	Interpretation
Age (*reference category* - Below 30 yrs /Above 30 yrs) & **Experience** (*reference category* - Above 12 months / 3 to 12 months)	Inverse	-0.184	0.000	Persons above 30 years have experience of over 12 months. Persons of below 30 years have experience of between 3 to 12 months.
Moving >20kg load (*reference category* - No / Yes) & **Experience** *(reference category* - Above 12 months / 3 to 12 months*)*	Inverse	-0.119	0.018	Persons moving >20kg load have experience of over 12 months. Persons not moving >20kg load have experience of between 3 to 12 months.
Moving >20kg load (*reference category* - No / Yes) **&** **Age** *(reference category* - Below 30 yrs /Above 30 yrs*)*	Inverse	-0.020	0.691	Persons not moving >20kg load have age of over 30 years. Persons moving >20kg of load have age of below 30 years

Additionally, education was found to have aunderstanding of doing the task while also small yet significant protective effect for neckimproving on their muscle strength. This kind pain with $p<0.001$ (OR=0.00) for primaryof observation is supported by medical studies education and $p<0.001$ (OR=0.00) forof athletes including that of Suchomel et al., secondary education. Although much more2016; Lehance et al., 2009; Portero et al., 2001; detailed research is needed to conclude thisLehnhard, 1996 that show that neck muscles finding, workers with lower-level education aregain strength and ultimately reduced injuries more susceptible to be assigned the task ofafter prolonged neck exercises by athletes. The moving more than 20kg load and ultimatelyreason for the risk effect of higher education on gain experience of doing the same task for atneck pain was not able to be concluded in this least more than 12 months (Table 9). Longerstudy and further research is proposed experience improves on their ergonomic

Table 9: Correlation analysis for education, experience and moving >20kg load

Correlated Variable	Type of Correlational Relation	Pearson	Significance	Interpretation
Education (*reference category* - Tertiary Education / Secondary Education / Primary Education) & **Experience** (*reference category* - Above 12 months / 3 to 12 months)	Inverse	-0.64	0.205	Workers with primary education have experience of over 12 months. Workers of tertiary education have experience of between 3 to 12 months.
Moving 20kg load (*reference category* - No / Yes) &	Inverse	-0.119	0.018	Workers moving >20 kg load have experience of over 12 months. Workers not moving >20kg load have experience of between 3 to 12 months.

Experience (*reference category* - Above 12 months / 3 to 12 months)				
Education (*reference category* - Tertiary Education / Secondary Education / Primary Education) **&** **Moving 20kg load** (*reference category* - No / Yes)	Positive	0.175	0.000	Workers moving >20 kg load have primary education. Persons not moving >20kg load have tertiary education.

Looking at the biomechanical factors, results show that extension of arms (OR 48.742 for neck pain and OR 8.706 for shoulder pain), repetitive motion (OR 416.303 for neck pain and OR 35.142 for shoulder pain) and working with vibrating tools (OR 21.433 for shoulder pain) are significant factors to body pain. These findings are supported by the study done in Karimnagar, Andhra Pradesh and reported by Bodhare et al. (2011) as well as the one reported by Jaiswal and Veerkumar (2016). Their studies revealed a stronger association between body pain and work involving repetitive motion, force extension and working in vibration.

On the other hand, work rotations (OR 0.052 for shoulder pain) that involves change of tasks periodically and prolonged squatting (OR 0.059 for shoulder pain) are protective factors to body pain. These results indicate that workers who have opportunity to work in different fields within the site periodically such as tiling, roofing, walling and painting have lower risks of developing shoulder pain as compared to the ones who work throughout in the same channel that affect the shoulders. Although this is a protective factor to body pain, this study found that only 18.7% of workers studied undergo work rotations. On the other hand, prolonged squatting as a protector of shoulder pain indicates specialization of workers in the site. Workers who have to undergo prolonged squatting in works such as floor tiling specialize in the same tasks and will not be working in fields that can have an impact on the shoulders.

Although back pain is the most prevalent pain complaint (87.6%) among construction workers in this study, none of the identified risk factors showed a significant contribution. This might be an indication that back pain is a product of multiple statistically non-significant factors, yet to be identified factors or not an independent factor from neck and shoulder pain but may be a secondary pain complaint. Nature of doing work in the construction sites in Tanzania supports this hypothesis where heavy objects such as sandcrete blocks, cement sacks, sand and concrete mixing trays/pans within the site are carried on the head or shoulder.

These results show that although the industry is characterized by seemingly healthy young male workers (average age is 35.9; 84.6% male), the work culture and working conditions are major influences to body pain complaints and musculoskeletal diseases in construction workers in the country. Even workers under a work period of less than one year, have reported body pain complaints. Excessive manual handling of works, working under temporary status coupled with site procedural conditions such as extension of arms for long periods with no breaks or work rotations will eventually lead to more severe results adversely affecting the work force. Moreover, lack of enforcement of regulations by authorities has also been shown to be a contributing factor to risks of musculoskeletal disease in the construction industry in Tanzania.

Notwithstanding several limitations to be taken into consideration including the

cross-sectional design nature of the study that renders it difficult to draw a causal inference, recall bias arising from self-reported questionnaires with twelve months recall period and reporting bias of symptomatic workers, findings from this study confirm that musculoskeletal diseases are an occupational health hazard in the construction industry in Tanzania. It should be noted that this study was conducted on only registered construction sites that are periodically monitored by government authorities and the situation for unregistered construction work is unknown albeit expected to be in a more severe condition. The study affirms the need to reform the construction industry by enforcing the current regulations that require use of tools and machinery to reduce manual handling and safety training that includes ergonomic risks awareness. Preventive measures including work rotation and frequent breaks should also be reinforced in the regulations. The case of massive temporary employment condition within the industry should also be taken in consideration while devising policies to improve work conditions in the industry.

CONCLUSION

In conclusion, musculoskeletal pain complaints among construction workers in Dar es Salaam, Tanzania were found to be highly prevalent where all workers had endured at least one form of body pain throughout their employment. Higher odds of body pain were associated with extension of the arms, repetitive motion, working with vibration tools and moving load of more than 20kg as well as sex, age, work experience and temporary employment conditions. Conversely, work rotation was found to be protective against body pain complains. The study implies that there is a significant and serious risk to construction workers in Tanzania as a result of sociodemographic conditions and a number of biomechanical factors as a consequence of construction process and procedures involved in construction sites. Authorities have a responsibility to improve business environment that would enable contractors to employ on permanent basis and enforce laws and regulations.

Disclaimer

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publishing anywhere else.

Alaloul, W. S., Musarat, M. A., Rabbani, M. B. A., Iqbal, Q., Maqsoom, A., & Farooq, W. (2021). Construction Sector Contribution to Economic Stability: Malaysian GDP Distribution. *Sustainability*, 13(9), 5012.

Alghadir, A., & Anwer, S. (2015). Prevalence of musculoskeletal pain in construction workers in Saudi Arabia. *The Scientific World Journal*, *2015*.

Amoako, R., Buaba, J., & Brickey, A. (2020). Identifying Risk Factors from MSHA Accidents and Injury Data Using Logistic Regression. *Mining, Metallurgy & Exploration.*

Antwi-Afari, M. F., Li, H., Edwards, D. J., Pärn, E. A., Seo, J., & Wong, A. Y. L. (2017). Biomechanical analysis of risk factors for work-related musculoskeletal disorders during repetitive lifting task in construction workers. *Automation in Construction*, *83*, 41-47.

Anwer, S., Li, H., Antwi-Afari, M. F., & Wong, A. Y. L. (2021). Associations between physical or psychosocial risk factors and work-related musculoskeletal disorders in construction workers based on literature in the last 20 years: A systematic review. *International Journal of Industrial Ergonomics*, *83*

Berhanu, F., Gebrehiwot, M., & Gizaw, Z. (2019). Workplace injury and associated factors among construction workers in Gondar town, Northwest Ethiopia. *BMC musculoskeletal disorders*, *20*(1), 1-9.

Bodhare, T., Valsangkar, S., & Bele, S. (2011). An epidemiological study of work-related musculoskeletal disorders among construction workers in Karimnagar, Andhra Pradesh. *Indian journal of community medicine: official*

publication of Indian Association of Preventive & Social Medicine, *36*(4), 304.

Boschman, J. S., van der Molen, H. F., Sluiter, J. K., & Frings-Dresen, M. H. (2012). Musculoskeletal disorders among construction workers: a one-year follow-up study. *BMC musculoskeletal disorders*, *13*(1), 1-10.

Chan, A. P., Wong, F. K., Hon, C. K., Lyu, S., & Javed, A. A. (2017). Investigating ethnic minorities' perceptions of safety climate in the construction industry. *Journal of safety research*, **63**, 9-19.

Charles, L. E., Ma, C. C., Burchfiel, C. M., & Dong, R. G. (2018). Vibration and ergonomic exposures associated with musculoskeletal disorders of the shoulder and neck. *Safety and health at work*, **9**(2), 125-132.

Chaswa, E. N., Kosamu, I. B. M., Kumwenda, S., & Utembe, W. (2020). Risk perception and its influencing factors among construction workers in Malawi. *Safety*, **6**(2), 33.

Chau, N., Mur, J.-M., Benamghar, L., Siegfried, C., Dangelzer, J.-L., Français, M., … Sourdot, A. (2003). Relationships between certain individual characteristics and occupational injuries for various jobs in the construction industry: A case-control study. *American Journal of Industrial Medicine*, **45***(1), 84–92.*

Chen, Q., & Jin, R. (2015). A comparison of subgroup construction workers' perceptions of a safety program. *Safety Science*, **74**, *15–26.*

Chen, Y., Turner, S., Hussey, L., & Agius, R. (2005). A study of work-related musculoskeletal case reports to The Health and Occupation Reporting network (THOR) from 2002 to 2003. *Occupational Medicine*, **55**(4), 268-274.

Choi, S. D. (2010). Ergonomic assessment of musculoskeletal discomfort of iron workers in highway construction. *Work*, **36**(1), 47-53.

Ekpenyong, C. E., & Inyang, U. C. (2014). Associations between worker characteristics, workplace factors, and work-related musculoskeletal disorders: a cross-sectional study of male construction workers in Nigeria. *International Journal of Occupational Safety and Ergonomics*, *20*(3), 447-462.

Engholm G. and Holmström E. (2005). Dose-response associations between musculoskeletal disorders and physical and psychosocial factors among construction workers. Scand J Work Environ Health. **31**(2):57–67.

Fang, D., Chen, Y., & Wong, L. (2006). Safety climate in construction industry: A case study in Hong Kong. *Journal of construction engineering and management*, **132**(6), 573-584.

Guo, H. R., Chang, Y. C., Yeh, W. Y., Chen, C. W., & Guo, Y. L. (2004). Prevalence of musculoskeletal disorder among workers in Taiwan: a nationwide study. *Journal of occupational health*, *46*(1), 26-36.

Halabi, Y., Xu, H., Long, D., Chen, Y., Yu, Z., Alhaek, F., & Alhaddad, W. (2022). Causal factors and risk assessment of fall accidents in the US construction industry: A comprehensive data analysis (2000–2020). *Safety science*, *146*, 105537.

Han, Y., Feng, Z., Zhang, J., Jin, R., & Aboagye-Nimo, E. (2019b). Employees' Safety Perceptions of Site Hazard and Accident Scenes. *Journal of Construction Engineering and Management*, **145***(1), 04018117.*

Han, Y., Jin, R., Wood, H., & Yang, T. (2019a). Investigation of Demographic Factors in Construction Employees' Safety Perceptions. *KSCE Journal of Civil Engineering*, **23***(7), 2815–2828.*

Hasanzadeh, S., De La Garza, J. M., & Geller, E. S. (2020). Latent effect of safety interventions. *Journal of construction engineering and management*, **146**(5), 04020033.

He, C., Jia, G., McCabe, B., Chen, Y., & Sun, J. (2019). Impact of psychological capital on construction worker safety behavior: Communication competence as a mediator. *Journal of safety research*, **71**, 231-241.

Idrees, M. D., Hafeez, M., & Kim, J. Y. (2017). Workers' age and the impact of psychological factors on the perception of safety at construction sites. *Sustainability*, **9**(5), 745.

ILO. (2019). Developing the construction industry for employment-intensive infrastructure investments. ISBN: 978-92-2-133587-0 (Web PDF). Geneva.

Israel, G. D. (1992). Determining Sample Size 1 The Level Of Precision. *The Level Of Precision (Pp. 1–5).*, (November), 1–5.

Jaffar, N., Abdul-Tharim, A. H., Mohd-Kamar, I. F., & Lop, N. S. (2011). A literature review of ergonomics risk factors in construction industry. *Procedia engineering*, **20**, 89-97.

Jaiswal, N., & Veerkumar, V. (2016). Work related musculoskeletal disorders among construction workers of India. *Research Journal of Family, Community and Consumer Sciences*, **4**(2), 1-5.

Jazari, M. D., Jahangiri, M., Khaleghi, H., Abbasi, N., Hassanipour, S., Shakerian, M., & Kamalinia, M. (2018). Prevalence of self-reported work-related illness and injuries among building construction workers, Shiraz, Iran. *EXCLI journal*, *17*, 724.

Kanchana, S., Sivaprakash, P., & Joseph, S. (2015). Studies on labour safety in construction sites. *The Scientific World Journal*, *2015*.

Karimi, H., & Taghaddos, H. (2019). The influence of craft workers' educational attainment and experience level in fatal injuries prevention in construction projects. *Safety science*, **117**, 417-427.

Kincl, L. D., Anton, D., Hess, J. A., & Weeks, D. L. (2016). Safety voice for ergonomics (SAVE) project: protocol for a workplace cluster-randomized controlled trial to reduce musculoskeletal disorders in masonry apprentices. *BMC public health*, **16**(1), 1-9.

Kisilu, P., Gatebe, E., & Msanzu, J. (2017). Prevalence of Work-Related Musculoskeletal Disorders among Housing Construction Workers in Mombasa County, Kenya. *International Journal of Approximate Reasoning*. 5(Jun),1674-1684.

Lehance, C., Binet, J., Bury, T., & Croisier, J. L. (2009). Muscular strength, functional performances and injury risk in professional and junior elite soccer players. *Scandinavian journal of medicine & science in sports*, **19**(2), 243-251.

Lehnhard, R. A., Lehnhard, H. R., Young, R., & Butterfield, S. A. (1996). Monitoring injuries on a college soccer team: the effect of strength training. *Journal of Strength and Conditioning Research*, *10*, 115-119.

Lette, A., Kumbi, M., Hussen, A., & Nuriye, S. (2018). Determinants of occupational injury among building construction employees in southeastern Ethiopia. *IJ Tropic Dis Health*, **34**(4), 1-11.

Liang, K., Fung, I. W. H., Xiong, C., & Luo, H. (2019). Understanding the factors and the corresponding interactions that influence construction worker safety performance from a competency-model-based perspective: evidence from scaffolders in China. *International journal of environmental research and public health*, **16**(11), 1885.

Lop, N. S. B., Salleh, N. M., Zain, F. M. Y., & Saidin, M. T. (2019). Ergonomic Risk Factors (ERF) and their Association with Musculoskeletal Disorders (MSDs) among Malaysian construction trade workers: concreters. *International Journal of Academic Research in Business and Social Sciences*, **9**(9), 1269-1282.

Mahboobi, M., Taghipour, M., & Ali Azadeh, M. (2020). Assessing ergonomic risk factors using combined data envelopment analysis and conventional methods for an auto parts manufacturer. *Work*, *67*(1), 113-128.

Makki, A. A., & Mosly, I. (2021). Predicting the safety climate in construction sites of Saudi Arabia: A bootstrapped multiple ordinal logistic regression modeling approach. *Applied Sciences*, **11**(4), 1474.

Mekonnen, T. H., Kekeba, G. G., Azanaw, J., & Kabito, G. G. (2020). Prevalence and healthcare seeking practice of work-related musculoskeletal disorders among informal sectors of hairdressers in Ethiopia, 2019: findings from a cross-sectional study. *BMC Public Health*, *20*, 1-10.

Meng, X., & Chan, A. H. S. (2020). Demographic influences on safety consciousness and safety citizenship behavior of construction workers. *Safety Science*, **129**, *104835*.

Musarat, M. A., Alaloul, W. S., & Liew, M. S. (2020). Impact of inflation rate on construction projects budget: A review. *Ain Shams Engineering Journal*.

Peng CYJ, Lee KL, Ingersoll GM. (2002). An introduction to logistic regression analysis and reporting. J Educ Res 96:3–14

Portero, P., Bigard, A. X., Gamet, D., Flageat, J. R., & Guézennec, C. Y. (2001). Effects of resistance training in humans on neck muscle performance, and electromyogram power spectrum changes. *European journal of applied physiology*, **84**(6), 540-546.

Purani, R., & Sharma, S. (2017). Prevalence of musculoskeletal disorders in construction workers in Gujarat: A cross sectional survey. *International Journal of Therapies and Rehabilitation Research*, **63**, 52-57.

Ray, S. J., & Teizer, J. (2012). Real-time construction worker posture analysis for ergonomics training. *Advanced Engineering Informatics*, *26*(2), 439-455.

Reddy, G. M., Nisha, B., Prabhushankar, T. G., & Vishwambhar, V. (2016). Musculoskeletal morbidity among construction workers: A cross-sectional community-based study. *Indian journal of occupational and environmental medicine*, **20**(3), 144.

Ricci, F., Bravo, G., Modenese, A., De Pasquale, F., Ferrari, D., Bello, M., ... & Gobba, F. (2021). Risk perception and ethnic background in construction workers: results of a cross-sectional study in a group of trainees of a vocational school in Italy. *European journal of investigation in health, psychology and education*, **11**(1), 96-109.

Salas, E. A., Vi, P., Reider, V. L., & Moore, A. E. (2016). *Factors affecting the risk of developing lower back musculoskeletal disorders (MSDs) in experienced and inexperienced rodworkers. Applied Ergonomics*, **52**, *62–68*.

Shirur, S., & Torgal, S. (2014). Enhancing safety and health management techniques in Indian construction industry. *International Journal of Engineering and Technical Research*, **2**(4), 52-56.

Sousa, V., Almeida, N. M., & Dias, L. A. (2014). Risk-based management of occupational safety and health in the construction industry–Part 1: Background knowledge. *Safety science*, **66**, 75-86.

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2016). The importance of muscular strength in athletic performance. *Sports medicine*, **46**(10), 1419-1449.

Tezel, A., Dobrucali, E., Demirkesen, S., & Kiral, I. A. (2021). Critical success factors for safety training in the construction industry. *Buildings*, *11*(4), 139.

Trillo-Cabello, A. F., Carrillo-Castrillo, J. A., & Rubio-Romero, J. C. (2021). Perception of risk in construction. Exploring the factors that influence experts in occupational health and safety. *Safety Science*, **133**, 104990.

Umar, T., Egbu, C., Honnurvali, M. S., Saidani, M., & Al-Mutairi, M. (2020, September). An assessment of health profile and body pain among construction workers. In *Proceedings of the Institution of Civil Engineers-Municipal Engineer* (Vol. 173, No. 3, pp. 125-135). Thomas Telford Ltd.

Umer, W., Antwi-Afari, M. F., Li, H., Szeto, G. P., & Wong, A. Y. (2018). The prevalence of musculoskeletal symptoms in the construction industry: a systematic review and meta-analysis. *International archives of occupational and environmental health*, **91**(2), 125-144.

URT. (2010). Integrated Business Survey – Construction Industry Analytical Report. National Bureau of Statistics (Tanzania).

URT. (2021). Basic Statistics and Information in Construction Industry. Ministry of Works and Transport (Works Section).

URT. 2003. Occupational Safety and Health Act of 2003. United Republic of Tanzania.

URT. 2015. Occupational Safety and Health (Building and Construction Industry) Rules of 2015. United Republic of Tanzania.

Yang, S., Li, L., Wang, L., Zeng, J., & Li, Y. (2020). Risk factors for work-related musculoskeletal disorders among intensive care unit nurses in China: A structural equation model

approach. *Asian nursing research*, **14**(4), 241-248.

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