OCCUPATIONAL INJURIES AMONG ROAD CONSTRUCTION WORKERS IN GHANA: BURDEN, MECHANISM AND SEVERITY

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Abstract

Objective: Road construction work involves diverse activities relying on the use of both skilled and unskilled manpower, posing serious risks to workers. This study sought to determine the burden, mechanism and severity of occupational injuries among road construction workers.

Methodology: The study design was institution-based descriptive cross-sectional using a questionnaire with closed- and open-ended questions. From Ashanti, Ahafo and Western North regions, 353 road workers reported on work-related injuries, types of injury, body parts injured, day(s) lost to activity and cause of injury from 27th January, 2020 to 4th March, 2020.

Results: The workers were primarily young (mean age 32.4 years) and male (97.7%). Most (70.2%) workers were contract/casual staff. Nearly 88% experienced injury the past year with 67.5% experiencing multiple injuries. The body parts most affected included waist/low back (29.9%), forearm/palm (18.9%), leg/foot (17.5%), chest (8.9%) and joints (7.1%). Mechanism of injury included slips/trips (18.5%), use of tools/equipment (13.8%) and overexertion during lifting (10.2%). For injury severity, 88.0% of workers had minor injuries, 8.8% moderate and 3.2% severe injuries.

Conclusion: There is high burden of injury among road construction workers in Ghana. Most experienced injury during the past year, with over 4-in-5 having minor injuries. Leading mechanisms were slips/trips, use of tools/equipment and overexertion during lifting. Limitations include biases like memory decay, purposive selection of construction sites and driver over-representation. Hence, recommendations deriving from this study include enforcement of personal protective equipment use, proficiency training in use of tools/equipment and inter-lacing manual handling-related activities with activities that vary worker-postures.

Key words: *Occupational injury, mechanism of injury, road construction workers, injury severity.*

Introduction

Work affords economic and other benefits to workers who may at some point, be faced with a variety of hazards which could predispose them to injury, disease, disability or death. These hazards may be attributable to chemicals, biological agents, physical factors, adverse ergonomic conditions, allergens, a complex network of safety risks and varied psychosocial factors. Occupational accidents and diseases not only cause great pain, suffering and death to victims, but also threaten the lives of other workers and their dependants. The diverse activities of the construction industry make it very dependent on the use of manpower (skilled and unskilled) which makes the issue of health and safety key. Based on the world's statistics, the accident rate in the construction industry is almost three times higher than that of the manufacturing sector.[1] Construction work involves serious occupational risks, such as work at heights (use of scaffolding, gangways and ladders), excavation works (use of explosives, earth moving machines), lifting of materials (use of cranes, hoists) and others which are specific to the sector. Thus, construction is often classified as a high-risk industry as it has historically been plagued with much higher and unacceptable injury rates compared to other industries.[2,3]

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About 350 million workers currently work in this industry around the world.[4] In developed countries, approximately 6-10% of the workers are employed in the construction industry and 20-40% of work-related deaths are attributed to this industry.[5] For example, despite the fact that 7.7% of the workers in the United States are employed in the construction industry, 22.2% of work-related mortalities occur in this industry.[6] According to the statistics presented by the Hong Kong Labour department, the highest work-related fatality rate over the past decade has been related to the construction industry so that in 2015, 32.4% of industrial accidents and 79.2% of total work-related deaths occurred in the construction industry.[7] It seems that injuries among

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construction workers happen more frequently in developing countries compared with developed countries.[8] For example, in Turkey, annual work-related accidents have reached the threat level and 400 deaths as well as 400 total disabilities have emerged out of 6,000-9,000 work-related accidents.[9] In Iran, almost 37% of industrial accidents occur in the construction industry, while only 14% of the workers work in this industry [8]. Gebremeskel and Yimer found a high annual prevalence of injury among construction workers in Ethiopia (33%).[10.] The Ghanaian construction industry represents a major economic force as it creates job opportunities for both literates and non-literates in the society.

In the year 2000, the Labour Department of the Ministry of Employment and Labour Relations reported that the construction industry in Ghana accounted for the highest rate of occupational deaths as compared to other industrial sectors, with 56 out of a total of 902 occupational accidents that occurred in construction being fatal.[11,12] A study on building construction workers in Ghana found that the proximal factors (age, sex of worker, income) and distal factors (e.g. work structure, trade specialisation, working hours, job/task location, and monthly off days) were risk factors for occupational injuries among frontline construction workers.[13] In Ghana, the available information is about injuries to workers involved in building construction. However, there is currently no empirical data specific to road construction work-related injuries. In order to address the gap in knowledge, this study sought to determine the burden, mechanism and severity of occupational injuries among road construction workers and body parts affected.

Materials and Method

Methods for this study have been previously reported [14,15] and summarised below.

The Setting

The 18 road construction firms working actively on 19 roads (one firm worked on two different roads) were purposively selected from three middle zone regions of Ghana, namely, Ashanti, Ahafo and Western North for the study. Eight firms were excluded due to having only skeletal (the work camp had closed with no road construction-related activity going on and only the security men and less than five workers were idling about) work crew[3], being on break[3] or did not allow the study to be conducted at all[2].

Profile of Study Participants

At each firm's site, workers working in any of the following crafts were selected: excavation, site supervision, steel bending, masonry, carpentry, welding, driving, automechanics, daily labourership, safety officers, architecture, land surveying, quantity surveying and civil engineering. Every worker in each craft who gave consent was included in the study.

Study Design

The study, which was carried out between 27th January, 2020 and 4th March, 2020 was institution-based cross-sectional.

Sample Size Determination and Sampling Technique

The desired sample size, n, was estimated based on the following assumptions: *Population size*: This refers to the denominator or population from which the sample was drawn. Total number of road construction workers working actively on site in Ghana between January and March, 2020 was approximately 1000 (based on the staff strength of the firms that were busy on site at the time, according to the Ministry of Roads and Highways). Anticipated percentage of workers who have had an injury in the past year: 3% (Based on prior study of occupational injuries in Ghana by Mock *et al.*).[16] *Acceptable margin of error*: 1.5 %. The estimated minimum sample size needed to detect the anticipated proportion at 95% confidence was determined to be 333, using Raosoft (Raosoft Inc., 2004). Overall, 353 road construction workers were studied using structured questionnaire survey.

Data Collection Procedure

All data collected were anonymised without names or identifiers of participants. The data was collected using a semi-structured questionnaire with both closed- and open-ended questions and was administered in either English or Asante Twi (a widely spoken Ghanaian local dialect), depending on the preference of the participants. Part one of the data collection tool consisted of unidentifiable demographic data such as age, sex, education level, marital status, profession/designation, years of experience in the construction sector, status of employment (permanent or casual), shift workers, in-service or on-the-job training received, working hours per day, working days per week and number of projects in which each interviewee had been involved. Part two had questions on burden of injury, comprising any injury sustained in the prior year, pain or discomfort, types of injuries, part of body where injury occurred, cause of injury and day(s) of lost activity. Other questions concerned. Injury here included abrasions, blisters, bruises, splinters, open wounds, open and closed fractures, dislocations, ruptures, tears, penetrating injuries, burns, repetitive strain injuries, lower back and waist pain, crushing injuries and spinal cord injuries. The Open Data Kit (ODK) app and hard copies of the questionnaire were used to collect the data. Information from the hard copies, used at places where internet connectivity was poor, were entered into the ODK app after collection.

Data Quality Assurance

Data collection assistants and field supervisors received three days intensive training by the principal investigator. Data collected were checked for accuracy, completeness and uniformity at the end of each day's activity.

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Data Analysis

Data analysis was done using Stata/SE version16.0. Descriptive statistics such as means, frequency distribution, and percentage were used for a number of variables. Statistical significance was set at $p<0.05$. Relationship of dependent and independent variables was assessed using Chi-square test.

Ethical Approval

The Committee on Human Research, Publications and Ethics (CHRPE) of the Kwame Nkrumah University of Science and Technology, Kumasi – Ghana, approved the study (Ref. CHRPE/AP/510/20). Agencies under the Ministry of Roads and Highways (MRH), namely, Ghana Highway Authority (GHA), Department of Urban Roads (DUR) and Department of Feeder Roads (DFR) as well as construction companies also gave approval for the conduct of the study at the construction sites. Verbal consent was obtained from study participants.

Table 1: Profession, Employment Status, Education and Age (n=353)

Profession	Frequency	Percentage (%)
Labourers	111	31.5
Drivers/Heavy duty equipment operators	55	15.6
Carpenters	41	11.6
Masons	28	7.9
Steel benders	22	6.2
Site supervisors	21	6.0
Civil/Materials engineers	16	4.5
Others	14	4.0
Flagsmen	10	2.8
Surveyor/Surveyor assistants	8	2.3
Mechanic	7	2.0
Safety officers	7	2.0
Concrete mixer operators	6	1.7
Quantity surveyors	4	1.1
Welders	2	0.6
Electrician	1	0.3
Status of Employment		
On contract	155	43.9
Permanent	105	29.8
Casual	93	26.3
Gender		
Male	342	96.9
Female	11	3.1
Education		
JHS/Middle	169	47.9
Secondary / SHS / Technical	100	28.3
Tertiary	38	10.8
No schooling	24	6.8
Primary	22	6.2
Age Distribution		
26 -35	144	40.8
16 - 25	94	26.6
36 -45	72	20.4
46 - 55	36	10.2
≥ 56	7	2.0
Marital Status		
Single	220	62.3
Married	126	35.7
Divorced	7	2

***Work experience, working hours, working days per week, in-service training and number of projects*.**

Results

Characteristics of the study sample

The 353 road construction workers interviewed were aged between 16 and 66 years with the mean, median and modal ages being 32.4, 30.0 and 27.0 years respectively. Majority of the workers were male (96.9%). The leading category of workers was labourers (31.5%) followed by drivers operating trucks and other construction equipment such as excavators, dumpers, bulldozers or pavers (15.6%), carpenters (11.6%) and masons (7.9%). About a third (29.8%) of respondents were permanent staff while the rest (70.2%) were either contract or casual workers. Junior High/Middle School education was the most common education level; 47.9% of the respondents had this level of education. Almost 2 out of 3 workers were unmarried (Table 1). Out of a total of 353 respondents, 51.3% (181) had practiced their trade in the construction sub-sector for more than 5 years, while 13.9% had 1-3 years of experience. About 57% of the respondents had a daily work schedule ranging from 8 to 10 hours and nearly 83% working 6 days per week. Approximately 86% of the respondents had at least one day off-work per week with nearly 80% having been involved in between 1 and 5 construction projects. A little over half (52.4%) of the respondents had ever received training on-the-job (Table 2).

Table 2: Work experience, working hours, working days per week, in-service training and participated number of projects (n=353)

Variable	Frequency	Percentage (%)
Construction Work Experience		
> 5years	181	51.3
< 6 months	65	18.4
1 – 3 years	49	13.9
3 – 5 years	41	11.6
6 months – 1 year	17	4.8
Working Hours		
8 -10	200	56.7
11 - 13	149	42.1
<8	2	0.6
>13	2	0.6
Working Days per Week		
6 days	292	82.7
7 days	45	12.8
< 6 days	16	4.5
In-Service/On-the-Job Training		
Yes	185	52.4
No	168	47.6
Number of Projects Participated		
1 – 5	282	79.9
6 – 10	50	14.2
11 – 15	11	3.1
>16	10	2.8
Day Off Work		
Yes	302	85.5
No	51	14.5

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Burden of Injury

Nearly 88% experienced work-related injury. Among those who had been injured, 32.5% sustained single injuries with 67.5% experiencing multiple injuries (i.e., those involving two or more body regions) (Table 3).

Table 3: Burden of Injury

Characteristic	Frequency	Percentage
Injury Sustained/Burden of Injury* (n=352)		
Yes	308	87.5
No	44	12.5
Number of Injuries Sustained (n=308)**		
2	101	32.8
1	100	32.5
3	58	18.8
≥5	32	10.4
4	17	5.5

***missing data = 1**

****More than one injury sustained implies either more than one body part injured during one injury event or multiple injury events or both.**

Injury by mechanism, type, severity and body parts affected.

The mechanism of injury included slips/trips (18.5%), use of tools/equipment (13.8%), overexertion during lifting (10.2%) and hit object on road (8.9%). The "other" category included stress, sitting for long hours, too much work load, standing for long hours, dust inhalation, vibrations from roller, hit by a car door on site, carrying bags of cement, cutting of iron rods, repetitive lifting of materials, stepped on nails, driving for long hours, vibrations from grader, use of grader, hit by hammer, physical abuse, steel bending, concrete mixer prick, hurt by spanner, faulty headpan and poor posture (Table 4).

Lower/upper back musculoskeletal strain constituted the predominant type of injury (41%) followed by repetitive strain injury (21.1%), lacerations/cuts (17%), superficial injury (6%), fracture (3%), among others. The category, "other", included twisted wrist, hit by object, injury from physical abuse by expatriate superiors, injury from iron rods and binding wires, among others. The body parts affected by the injuries included waist/lower back (29.9%), forearm/palm (18.9%), leg/foot (17.5%), chest (8.9%), generalised pain in multiple joints (7.1%), forehead (4.1%), ribs (3.8%), head (1.8), nose (1.8%) and knee (4.7%). The wrist, lips, ear, eye and back constitute the "other" category. The number of working days lost was used as a measure of the injury severity.[15] Out of the 308 injured workers, 88.0% were considered to have had minor injuries (i.e. "no day lost" up to six days of absence from work), 8.8% were moderate (7–29 days of absence from work) and 3.2% were severe (absence from work for more than 30 days) (Table 4).

Table 4: Injury by mechanism, type, severity and body parts affected

Variable*	Frequency	Percentage (%)**
Mechanism of Injury (mentioned 384 times)		
Slips/trips	71	18.5
Use of tools/equipment	53	13.8
Overexertion during lifting	39	10.2
Hit object on road	34	8.9
Road traffic incidents	12	3.1
Fall from ground level	9	2.3
Fall from height	4	1
Others	162	42.2
Type of Injury Sustained (mentioned 596 times)	**Frequency**	**Percentage (%)**
Lower/upper back musculoskeletal strains	242	40.6
Repetitive Strain Injury	126	21.1
Cuts/Laceration	103	17.3
Superficial Injury	34	5.7
Fracture	16	2.7
Open Wound	9	1.5
Hammer Injury	9	1.5
Nail Injury	6	1.0
Other	51	8.6
Body Parts Affected (mentioned 338 times)	**Frequency**	**Percentage (%)**
Waist/lower back	101	29.9
Forearm/Palm/Finger	64	18.9
Leg	59	17.5
Chest	30	8.9
Generalised pain in multiple joints	24	7.1
Forehead	14	4.1
Ribs	13	3.8
Head	6	1.8
Nose	6	1.8
Knee	5	1.5
Other	16	4.7
Severity of Injury***	**Frequency**	**Percentage (%)**
Minor	271	88.0
Moderate	27	8.8
Severe	10	3.2

*** As workers could report multiple injuries arising from multiple injury events, the variables mechanism of injury, type of injury and body parts affected have different numbers of entries.**

****Percentages based on denominator of total number of responses in a given category.**

***** Severity based on outcome of most severe single injury, if more than one injury.**

Discussion

This study sought to determine the proportion of road construction workers who were injured at work in Ghana and the details of those injuries, including mechanism, type and severity. We found that most (88%) of the workers had been injured during the prior year. The leading mechanisms of injury were slips/trips, use of tools/equipment and overexertion during lifting. The main types of injuries sustained were back strains, repetitive strain injury and lacerations. Although most (88%) injuries were minor, a significant number of

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workers (12%) had injuries from which they lost more than a week of work.

A high rate of injuries to road construction workers has been found in other countries. For example, roughly 20,000 construction workers are injured each year in highway and road construction accidents in the United States. Transportation incidents accounted for over 65% roadway worksite fatalities. The US's Census of Fatal Occupational Injuries (CFOI) data indicated that 55% of fatalities occurred within the work zone itself.[18] The scientific literature on road construction worker injuries is fairly limited, but there is more information about injuries among general construction workers, especially injuries during building construction. Wong found that in Hong Kong, 63.1% of construction workers had been involved in one or more injuries at work.[19] Amissah and others found that more than half (57.9%) of Ghanaian housing construction workers had experienced occupational injuries.[13] In Gondar City, Ethiopia, Adane and colleagues found the prevalence of construction injuries to be 38.7%.[20] Even though, these are injuries suffered during housing construction, the proportion of workers sustaining injuries, are smaller than those of road construction workers, pointing to the hazardous nature of the construction industry and the need for pragmatic interventions to reduce the numbers. In the current study, most workers (67.5%) had multiple injuries. In contrast, Wong found in Hong Kong that 80.3% sustained single injuries, while 19.7% had multiple injuries.[19]

The contrast, in terms of higher multiple injuries could be attributed to the poor safety regulation and enforcement in Ghana, a developing country. The leading types of injury in the current study were back strains and repetitive strain injuries, with lacerations being third. In their study in Ghana, Amissah *et al.* found that the type of injuries sustained by building construction workers were open wounds and superficial contusions.[13] The difference in the injury types in Ghana could be due to the dissimilar activities performed by the two construction worker groups, even though, some of them are similar. The leading mechanisms of injury were slips/trips, use of tools/equipment and overexertion during lifting. Yilmaz studied occupational accidents in the general construction sector in Turkey and found that the main causes of accidents were being hit by objects and 'being stung by something'. The most important reason of occupational accidents was 'unsafe behaviours' with a rate of 67%, which was defined as not obeying the rules, although the necessary occupational safety measures were provided.[9] According to Choi *et al.*, the leading causes of fatal occupational injuries in the United States from 2011 to 2015 were falls/slips/trips (36.2%), transportation incidents (28.6%) and contact with objects and equipment (16.0%). Similarly, in other countries, falls were often the leading cause of fatal accidents in construction. For example, falls from heights accounted for 50.4% of construction deaths in South Korea and 53.5% in China.[21]

In the case of the other research, road, housing and other types of construction were involved whereas this current study only involved road construction, which may have accounted for the differences in the mechanisms of injury. Information specific to road construction is more limited. In the United States, between 1995 and 2002, 844 workers were killed while at work at road construction sites. Approximately 93% of the total were male. More than four-fifths (693) of occupational fatalities that occurred were caused by transportation incidents. Most prevalent were workers who were struck by a vehicle or mobile equipment, accounting for approximately 60% (509). Other fatal events of note included highway collisions between vehicles or mobile equipment (10%), being struck by an object (5%) and falls (3%) (US Bureau of Labour Statistics, 2004).[6]

More recently, from the perspective of the US Federal Highway Administration (2010), each year, over 20,000 workers are injured in road construction work zones. Between 2003 and 2008, these injuries were caused by contact with objects or equipment (35%), slips/trips/falls (20%), overexertion (15%), and transportation incidents (12%).[22] The proportion of injured road construction workers in the US is smaller than what was found in this study. This may be as a result of the enforcement of safety regulations such as the use of personal protective equipment, proper housekeeping, safety training for workers and strict sanctions regimes on construction sites, among others, in developed than in developing countries like Ghana.[15,24]

In the current study, the body parts most affected by injury were the waist/lower back, forearm/palm, and leg/foot. In Turkey, Yilmaz found that in the construction sector, eye, finger, foot and hand were the most common body parts affected. The eyes were affected most (14%) by the metal burrs produced as a result of exposure to heat, such as metal cutting and welding processes. The fingers (11%), hands (8%) and face (5%) were mostly effected by frequent use of drilling and cutting tools as against the feet which were mostly affected by falling objects.[9] The differences in activities, environment and worker attitudes may be responsible for the different body parts affected by injuries.

The number of days lost from work was used as a measure of the severity of injury sustained.[17] In the current study, most (88.0%) injuries were minor ("no day lost" up to six days of absence from work), but a significant number (12.0%) resulted in a week or more of lost work time. The UK Labour Force Survey estimated that in construction, there were 61,000 cases of non-fatal work-related injury with 27% resulting in an over seven days absence from work.[23] This high percentage of severe injuries in the UK study may be

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because it was in respect of both building and road construction activities.

The current study is one of the first studies to report injuries for construction workers specific to road construction in sub-Saharan Africa. In one of the few other studies on this topic, Nyende-Byakika reported on road construction injuries in Uganda, showing that 56%-85% of workers (depending on the specific site) had sustained injuries at the current work sites, although a time frame was not given. The leading injuries were lacerations and bruises. The injuries mainly arose during the activities of clearing, grading and drainage.[24] The current study focused on injuries sustained by workers involved in road construction-related activities, which include but not limited to excavation, grading, compaction, steel cutting and bending, carpentry, masonry, civil works, concrete mixing and bituminous surfacing, among others. These numerous activities involved in road construction are hazardous and increase the workers' exposure to injuries, accounting in part for the high injury prevalence, type, mechanism and severity in this current study. The other studies in sub-Saharan Africa either involved only housing construction or both housing and road construction.

For the types of injuries found in the current study, several countermeasures can be considered. First is increased use of personal protective equipment. The effectiveness of personal protective equipment in occupational safety is well documented.[25] It is also notable that one study from Ethiopia reported a high annual prevalence of injury of 32.6% in construction. This was cut in half by both personal protective equipment use and safety training.[10] Second, the second leading mechanism of injury was due to use of tools and equipment. Such injuries could be decreased by proficiency training in the use of these tools and equipment. Third, the leading types of injuries were back strains and repetitive strain injury. Ensuring that worker postures are varied can lower the risk of such injuries, such as ensuring that manual handling activities are interlaced with other activities.

Limitations

This study has some limitations. First, the recall period was one year, and there could be some memory decay or forgetting of injuries that occurred earlier during that period. This memory decay would bias the study to under-estimate the actual burden of injury. Second, construction sites were selected purposively in three middle-belt regions of Ghana. The findings may not be generalisable to other areas of Ghana. Third, drivers were over-represented among workers, in part because on-site supervisors were more likely to release drivers to be interviewed (while waiting to drive or while driving) than other workers.

Conclusion

Most road construction workers in this study had been injured during the prior year. Leading mechanisms were slips/trips, use of tools/equipment and overexertion during lifting. The main types of injuries sustained were back strains, repetitive strain injury and lacerations. A significant number of workers had injuries from which they lost more than a week of work. Possible areas for safety improvement include enforcement of the use personal protective equipment over the body parts most affected, proficiency training in the use of tools/equipment and ensuring that manual handling-related activities are inter-laced with other activities that vary worker postures.

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