

Work-related Musculoskeletal Disorders among Workers at Gold Mine Industry in Ghana: Prevalence and Patterns of Occurrence

Andrews Kwabena Tawiah^{1*}, Bertha Oppong-Yeboah² and Ajediran Idowu Bello²

¹Faculty of Health Sciences, University of Southampton, England.

²Department of Physiotherapy, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana, Ghana.

Authors' contributions

This work was carried out in collaboration between all authors. Author AKT designed the study protocol and wrote the first draft of the manuscript. Authors AKT and BOY involved in data collection and analysis. Author AIB transformed the manuscript into intellectual context. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2015/18747

Editor(s):

- (1) Bodur Hatice, Department of Physical Medicine and Rehabilitation, Ankara Numune Training and Research Hospital, Turkey.
(2) Masahiro Hasegawa, Department of Orthopaedic Surgery, Mie University Graduate School of Medicine, 2-174 Edobashi, Tsu City, Mie, 514-8507, Japan.

Reviewers:

- (1) Anonymous, Dr. D. Y. Patil University, India.
(2) Anonymous, University of Zambia, Zambia.
(3) Oyewole O. Olufemi, Physiotherapy, Olabisi Onabanjo University Teaching Hospital, Nigeria.
(4) Ting Xia, Palmer Center for Chiropractic Research, Palmer College of Chiropractic, USA.
Complete Peer review History: <http://sciencedomain.org/review-history/10171>

Original Research Article

Received 8th May 2015
Accepted 25th June 2015
Published 14th July 2015

ABSTRACT

Background: Work-related Musculoskeletal Disorders (WRMSDs) constitutes major constraint to optimal performance among workers. However, information about its prevalence and pattern of occurrence among Ghanaians working in gold mine industries remain insufficient.
Objective: To determine the prevalence of WRMSDs among workers of AngloGold Ashanti (AGA)-Obuasi mine.
Materials and Methods: A cross-sectional survey was conducted with 28-point self-administered questionnaire modified from the Standardized Nordic Musculoskeletal Questionnaire. Quota sampling was applied using ratios according to the number of workers in each department. Data

*Corresponding author: Email: akt1g14@soton.ac.uk;

were analysed with descriptive and inferential statistics at alpha level of .05.

Results: Two hundred and five (205) workers participated in the cross-sectional survey. 12-month prevalence of WRMSD was 85.5% and low-back had the highest percentage 178 (30.0%) as regards the affected body segments. Fifty seven (30.7%) reported that pain or discomfort had prevented them from working optimally and 28 (13.7%) of the respondents have had to change the area or specialty of their work as a result of WRMSDs. Seventy six (23.1%) and 51 (24.9%) of the respondents indicated accidental falls from a height and working in the same position for long periods as moderate and severe risk factors respectively. Nature of work engagement was significantly associated ($\chi^2=27.73$ $P<.001$) with the incidence of WRMSDs.

Conclusion: There was a high prevalence of WRMSDs among workers in AGA-Obuasi mine industry. Occurrence of the disorders was observed to be closely linked with the nature of service rendered by the workers. This outcome should therefore inform the preventive strategies required to curtail its occurrence.

Keywords: Gold mine; work related disorders; prevalence; patterns.

1. INTRODUCTION

Musculoskeletal disorders (MSDs) are generally described as disorders of the soft tissues and their surrounding structures that are not related to an acute or instantaneous event (such as slips or falls) and mostly occur in the neck, shoulder, elbow hand / wrist and low-back [1]. Musculoskeletal disorders are ranked highest among other work-related injuries with concomitant appalling healthcare costs in industries and firms [2]. Work-related musculoskeletal disorders (WRMSDs), are specifically defined as impairments of bodily structures such as muscles, joints, tendons, ligaments, nerves or the localised blood circulation system that are caused or aggravated primarily by the performance of work and by the effects of the immediate environment in which work is carried out [3]. WRMSDs have been found to be associated with numerous occupational risk factors including physical work load factors such as disproportionate force, awkward posture, abnormal movement and vibration, psychological stressors and individual factors [3-4]. The classification of WRMSDs can be based on the anatomical regions involved (e.g. shoulder, elbow, hand etc.) or by the main tissue type affected (e.g. tendons, muscles, ligaments, etc.) [5].

Musculoskeletal disorders are the most common self-reported work-related hazards, with high costs incurred from long-term disability [6]. They impose huge financial burden on the individual, business organizations and health service providers. In the USA, WRMSDs account for between 56% and 65% of all occupational injuries [6]. Overall, the estimated prevalence of MSDs is 75% for males and 74-77% for females

[7]. Accurate data on the incidence and the prevalence of musculoskeletal disorders are difficult to obtain, and the official statistics are difficult to compare across countries. Nevertheless, WRMSDs are the single largest category of the work-related illness, representing a third or more of all registered occupational diseases in the United States of America (USA), the Nordic countries and Japan [6].

A study by Van Vuuren et al. [8] on WRMSDs amongst workers in a steel industry in South Africa revealed reports of pain or discomfort arising from work, with low-back being the most affected body part. The respondents also consistently identified frequent twisting and bending of the trunk as the main cause of pain or discomfort. Gold mining remains the major source of foreign exchange in Ghana and the venture has attracted the interest of many investors to the country. Although, modern mining involves the use of machines and equipment, the associated work injuries and disorders cannot be over-ruled. Most mining companies in the developing countries such as Ghana do not have data regarding the incidence of WRMSDs for referencing. This leaves much to be desired given the enormity of the demands for physical exertions in the industry. Typically, mining involves heavy physical workload which has been recognized to be the prominent risk factor contributing to the prevalence of their occupational LBP [9].

In view of the seemingly barren literature on the prevalence and pattern of occurrence of WRMSDs among mining workers in Ghana, this study was designed to provide preliminary data about the disorders at the AngloGold Ashanti (AGA) - Obuasi mines in Ghana. The aim of this

study was to determine the prevalence of WRMSDs among miners at the AGA- Obuasi mines.

2. MATERIALS AND METHODS

2.1 Sampling and Study Site

The project was carried out at the AGA-Obuasi mines in the Ashanti region of Southern Ghana. The company remains one of the largest mines in Ghana and it is primarily an underground mining site with some surface mining activities. A total attributable production of 357,000 ounces, equivalent to approximately 7.1% of group production for AGA was recorded in 2008, by the company [10]. The company comprised a total of 5,722 workers across various departments as follows: Mining (2,237); Engineering (1,116); Human resources (561); Processing (555); Safety; Health and Environment-SHE (836); Sustainable Development (137); Transportation (280) [10].

This study was a cross-sectional survey in which the prevalence of WRMSDs among workers at the AGA-Obuasi mines was the focal point. The workers were included in this study if they had worked with the company for at least one year. Newly recruited workers and those with WRMSDs prior to their employment at the company were excluded. Quota sampling method was adopted in recruiting the participants for the study using population-based ratio from each department.

Workers in each department performed different tasks. Mining department is responsible for drilling, blasting, and extraction of gold ore which puts demands for high efforts. Engineering department is involved in ensuring maintenance of equipment used for mining and also involved in construction thus demanding high impact efforts. Processing department refining and processing gold ore into pure gold with moderate effort requirements while Safety, Health and Environment (SHE) deals with planning, educating and maintain health and safety for the company with minimal efforts requirements. Sustainable development was involved in the reclamation of land and area already mined to ensure they are viable and involved in community health. Transportation department is involved in the transport of staff and goods to and from the mining sites while the human resource department manage all the administrative duties of the company. The latter

three departments demand moderate efforts of workers as well.

The sample size of the study population was calculated using the formula: $N = [Z_{1-\alpha/2}^2 \times p (1-p)] / d^2$. Confidence level =95%, Standard normal variate ($Z_{1-\alpha/2}$) =1.96, Estimated proportion (p) =0.5 and margin of error (d) =0.05 [11]. Calculated sample size was 384.

2.2 Instrument

An adapted questionnaire to the Standardized Nordic Questionnaire was used to record work-related musculoskeletal symptoms in working populations [12]. This is a self-administered questionnaire and consists of closed and open-ended items that target issues unique to the development of WRMSDs, lifestyle of workers, job satisfaction and the number of days off-work as a result of WRMSDs. Section A sought information on the workers demographic data including age, sex, marital status, educational level and duration of work as well as information on frequent working patterns. Section B contains items that described the musculoskeletal injury, its onset, most significant WRMSDs and the body part affected.

Section C contains items on possible risk factors on a three point scale (mild, moderate and severe) and the information on the participant's lifestyle.

Palmer et al. [13] evaluated the reliability and specificity of Nordic questionnaire and found it to be highly reliable ($\alpha=0.63 - 0.90$), with the specificity index ranging from 0.73 to 0.94. The adopted questionnaire was pilot studied and its reliability was tested and found to be $\alpha=0.79$.

2.3 Procedure

Prior to the distribution of the questionnaire, the initial draft of the questionnaire was sent to physiotherapy educators from the University of Ghana and one experienced physiotherapy clinician, for perusal. The questionnaire was piloted thereafter on seven workers of the AGA-Obuasi mines, to ensure that the questions were clearly understood by the respondents so as to make amendments should the needs arise.

Questionnaires were deposited in each department and also at the Company Clinic. This ensured a generalised covering of the sampled population. The researchers with the assistance

of the Safety Control officers of the various departments administered the questionnaires. The completed questionnaires were retrieved after the appointed period of approximately three weeks.

Ethical approval was obtained from the Ethical Review Committee of the School of Allied Health Sciences, College of Health Sciences, University of Ghana before commencing the study (Ethics identification number: ET/022007033/AA/26A/2010-2011).

2.4 Statistical Analysis

The data collected were collated and analysed using the statistical software SPSS version 16 for windows manufactured by SPSS incorporated, Chicago. The descriptive statistics of mean, standard deviation and percentages as well as inferential statistics of chi-square was used to analyse the data. Alpha level at $p < 0.05$ was considered significant for any statistical tests.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Socio-demographic information

Two hundred and five (205) workers responded to the questionnaire giving a response rate of 53.4% and decline rate of 46.6%. The study sample comprised 197 (96.1%) male and 8 (3.9%) females. The Mean age of the mine workers was 43.4 years $\pm$ 6.4. The Demographics of all participants are summarized in Table 1.

3.1.2 Self-reported discomfort or pain

During the last 12 months, 186 (90.7%) of the respondents reported pain or discomfort in some parts of their body that lasted for more than 3 days compared to 19 (9.3%) who did not report any complaints of pain or discomfort in any part of their body within the same period. One hundred and fifty nine (85.5%) of the respondents reported that their pain or discomfort was due to the nature of work they performed in each department. Results are presented in Fig. 1 based on the department in which participants work.

3.1.3 Nature of injuries

One hundred and thirty six (66.3%) of the total respondents did not link any on-the-spot injury to

their work while 69 (33.7%) reported various forms of on-the-spot injuries due to their work.

3.1.4 Body distribution of WRMSDs

Low-back presented the highest percentage of body distribution 178 (30%) followed by the wrist 96 (16%) whilst the ankle, thigh and forearm presented with the lowest distribution of 5 (1%) each. Results are shown in Fig. 2. Also, 57 (30.7%) complained of pain or discomfort preventing them from working whilst 23 (12.4%) reported pain or discomfort being the barrier preventing them from doing their normal activities of daily living.

Table 1. Demographic information of the participants

	Variable	n	%
Sex	Male	197	96.1
	Female	8	3.9
	Total	205	100
Department	Mining Dept.	80	39.0
	Engineering Dept.	40	19.5
	Human Resources Dept.	20	9.8
	S.H.E	20	9.8
	Processing division	30	14.6
	Transport	10	4.9
	Sustainable Dev.	5	2.4
	Total	205	100
Age	21-30yrs	24	11.7
	31-40yrs	58	28.3
	41-50yrs	95	46.3
	50+	28	13.7
	Total	205	100

3.1.5 Risk factors associated with WRMSDs

Mining department recorded the highest value for the severe 33 (41.3%) and moderate 21 (26.3%) risk factors for WRMSDs and the engineering department recorded the highest mild risk factors 14 (35%). Some of the risk factors are repetitive performance of a particular task, bending / twisting of the back in awkward way and lifting or carrying of heavy objects.

3.1.6 Effects of WRMSDs

Twenty eight (13.7%) of the respondents changed the specialty of their work as a result of developing WRMSDs whilst 64 (31.2%) of the respondents would consider changing the specialty of their work because of the risk of developing WRMSDs. On the issue of job satisfaction, 199 (97.1%) of the respondents'

reports of having job satisfaction and 45 (22.0%) reported not being satisfied with the task they perform. Financial benefit was mostly reported by the respondents, 79 (49.4%) as an acceptable compensation for developing WRMSDs.

3.1.7 Association between the prevalence of WRMSDs and socio-demographics of the participants

Chi square analysis showed no significant association ($\chi^2 = 5.67$; $P=.13$) between the number of years participants had worked and the prevalence of WRMSDs. Contrarily, the prevalence of WRMSDs was significantly associated ($\chi^2 = 27.73$ $P<.001$) with specific

department of participants. Chi square tables are presented in Table 2.

3.2 Discussion

The current study found the 12-month prevalence of WRMSD to be 85.5% and low-back was mostly reported 178 (30%) as the affected body segment. The incidence was mostly recorded in mining department of the company. The outcome of our study bears similarity to the previously reported prevalence (83.3%) among quarry workers in south East Nigeria [14]. Although, a 12-month prevalence of low-back pain (67.2%) had already been documented in Ghana among Gold miners [9]

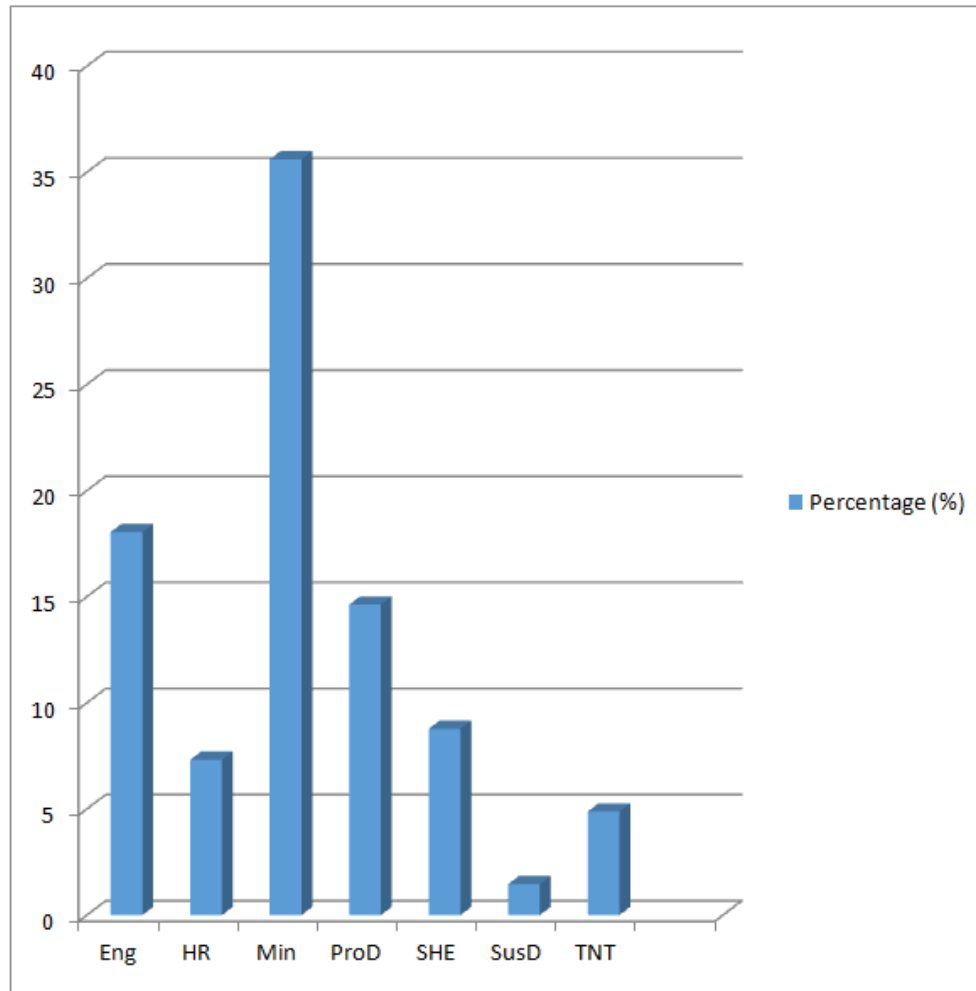


Fig. 1. Percentage of respondents who complained of pain or discomfort in relation to the nature of work

Key: Eng-Engineering Department, HR-Human Resources Department, Min-Mining Department, ProD-Processing Department, SHE-Safety Health and Environment, SusD-Sustainable Development, TNT-Transport Department.

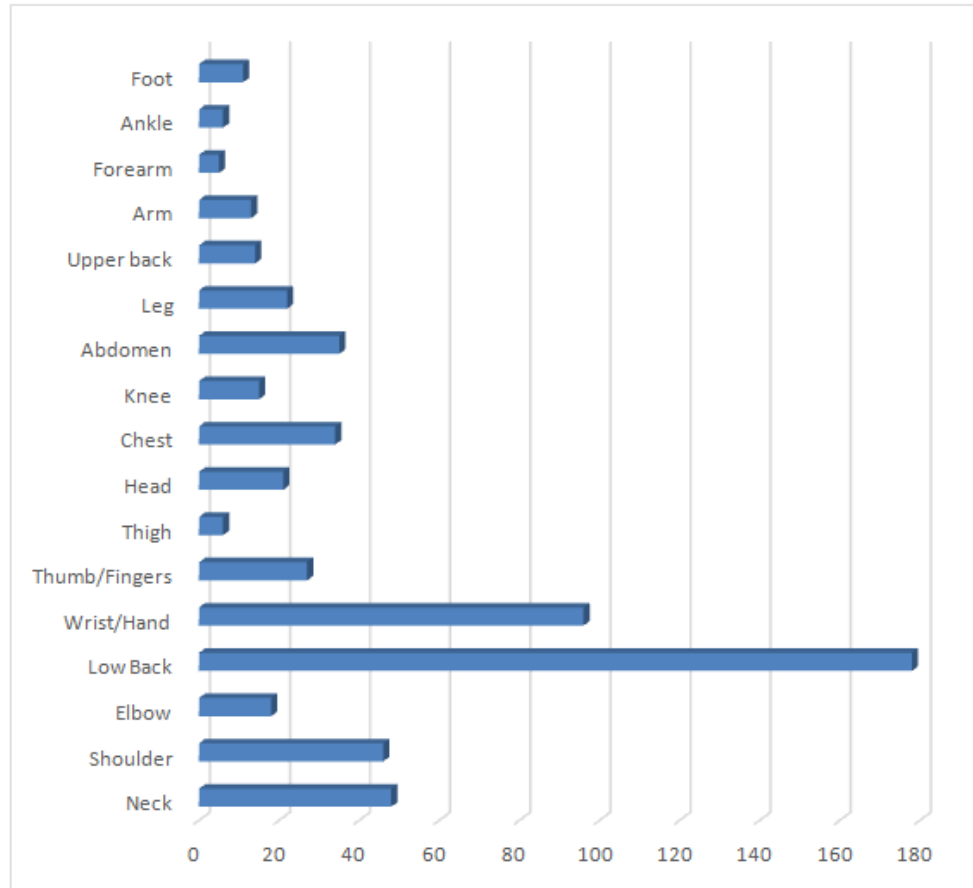


Fig. 2. Percentage of anatomical area distribution of WRMSD

Table 2. Chi square analysis showing the association of the number of years worked and the department of the workers with prevalence of WRMSDs

Work duration (years)	Yes	No	df	χ^2	P-value
1 - 9	38	33	3	5.67	0.13
10 - 19	33	37			
20 - 29	36	18			
30+	7	3			
Department	Yes	No	6	27.73	0.001
Engineering	28	12			
Human Resources	11	9			
Production	27	3			
Mining	71	9			
Safety Health and Environment	13	7			
Sustainable Development	1	4			
Transport	6	4			

our results have lent credence to the enormous physical components of mining activities which remain potential sources of WRMSDs. Logically, it could be assumed that the apparent upsurge in the prevalence as obtained in all the studies suggests the availability of improved health care

service provided by employers lately, which appears to compel most workers to report any form of musculoskeletal complaints without any fear of reprisal. In addition, the seemingly rise in the prevalence could also be traced to better awareness among workers and the readiness of

most employers to be more responsive to the issues relating to the healthcare needs of their employees.

The results show no significant association between the number of years spent as a worker in the company and the prevalence of WRMSDs. This is contrary to the findings by Egwuonwu et al. [14], who reported that WRMSDs were highest in the longer serving staff (age 45 to retirement) than those with lesser years. The difference in the findings might be due to the possibility of other predisposing factors such as depression and anxiety, psychological distress and family problems [4,15]. The impacts of these factors were not considered in our study. Indeed, the longer one works, the more experienced the person becomes in the application of better safety methods when working. An almost equal number of respondents have worked for 1-9 years and 10-19 years (34.6% and 34.2% respectively). This result is quite similar to Bio et al. [9] who found out that, the miners had been in service for a mean duration of 15 years (± 6.4 , ranging from 1 to 32 years). On the contrary, there was a significant association between the nature of work engagement and prevalence of WRMSDs. Departments that demand more manual and task oriented jobs like the mining and engineering departments are bound to predispose workers to developing WRMSDs as compared to the other departments that are more concerned with administrative and "light-weight" duties such as the sustainable development and processing departments. The mining department recorded the highest percentage of injuries and this is similar to a study in the United States of America [16] in which the authors found that 60% of injuries occur in the surface mining facilities in most mining industries.

From the present result, the low-back showed the highest percentage (30%) of body segment affected. This finding is supported by previous studies which highlighted low-back pain as the most frequent WRMSD complaint in any industry [9,17,18]. The high incidence rate of low-back pain is mostly owed to working pattern among most workers which includes twisting and bending of back in an awkward way, while working. Improper lifting, sitting and handling of materials technique are also factors contributing to the high rate of low-back pain in the mining industry. Additionally, 32% of the total respondents reported experiencing various forms of on-the-spot injuries due to their work. This is

similar to a study conducted by Vazirinejad et al. [19] on a five-year follow up of job-related injuries among Sarcheshme Copper Mine Complex workers. It was reported that out of 5,600 workers, a total of 735 injuries were reported giving an overall five-year incidence rate of 131 per 1000 Person-years-at-risk. The high rate reported was anchored on occupational hazards encountered including improper working techniques.

Ergonomically, manual material handling is one of the recognized risk factors for back problems, with other factors such as bending and/or twisting [20]. This finding is consistent with the report of Chung et al. [21], which indicated that 78.6% of the workers performing task requiring trunk twisting were reported to have experienced low-back pain. Other identified risk factors associated with low-back pain include: Heavy physical work such as lifting and forceful movements; awkward postures; whole body vibration, as well as psychosocial risk factors [17]. The findings of this study were consistent with other studies [22,23] in which drilling and mining, were pin-pointed as being among the highest risk groups, including blasting and supervisory work that make up the mining team. Owing to the intense labour requirement, 13.7% of the respondents had changed the specialty of their work on account of WRMSDs affliction and 31.2% of the respondents would consider changing the specialty of their work due to the risk of developing WRMSDs. Open wounds were reported as the highest (39.4%) of the on-the-spot work-related injuries followed by fracture (19.7%) and muscular strain (15.2%) which was similar to the findings of Olaogun et al. [18]. More et al. [16] however reported a higher prevalence (60%) of fracture and sprains/strains among miners. Open wound, fracture and muscle strain occurs more frequently due to the physical nature of the work and this often caused by rock and accidental falls.

3.3 Limitations

There are some limitations associated with this study. The cross-sectional design adopted might not have revealed all the important variables that could influence the incidence of WRMSDs among the sampled workers. A longitudinal study in which workers could be monitored at the time of entry into the mining company would have been more appropriate to highlight the risk and predictive factors related to leaving or staying in the work. Also, there are variations in the number

of staff recruited from each department of the company occasioned by varying population of workers which has reduced the statistical power appreciably.

4. CONCLUSION

A cross-sectional survey conducted among staff of the AGA-Obuasi Mine has revealed a high prevalence of WRMSDs particularly among the workers at the mining department and the low-back was found to be most frequent affected body part. In addition, a section of the workers were made to modify their work activities due to afflictions of WRMSDs. The study also found an association between the individual task and the risk of developing WRMSDs. However, the age of the workers has no bearing on the risk of developing WRMSDs. This outcome calls for awareness campaign among the workers and employers about the necessity for ergonomic use of their body. Further research could also be undertaken to consider the psychosocial and financial impact of WRMSDs in the mining industry as these factors are known to predict morbidity in MSDs.

CONSENT

All authors declare that 'written informed consent was obtained from the participants (or other approved parties) for publication of this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Punnett L, Wegman DH. Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. *J Electromyogr Kines*. 2004;14(1):13-23.
2. Carroll C, Rick J, Pilgrim H, Cameron J, Hillage J. Workplace involvement improves return to work rates among employees with back pain on long-term sick leave: A systematic review of the effectiveness and cost-effectiveness of interventions. *Disabil Rehabil*. 2010;32(8):607-21.
3. European Agency for Safety and Health at Work. Work-related musculoskeletal disorders: Back to work report. Magazine of the European Agency for Safety and Health at Work. 2007;3. Available: <https://osha.europa.eu/en/publications/reports/7807300> (Accessed 20th April 2009).
4. Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. *Bull World Health Organ*. 2003;81(9):646-56.
5. Kenyon J, Kenyon K. Musculoskeletal pathologies. The physiotherapist's pocket book: Essential facts at your finger tips. London, Churchill Livingstone. 2004;73-81.
6. National Research Council. Panel on musculoskeletal disorders and the workplace, commission on behavioral and social sciences and education, musculoskeletal disorders and the workplace: Low back and upper extremities. National Academy Press. Washington DC; 2001.
7. Jordan K, Clarke AM, Symmons DM, Fleming D, Porcheret M, Kadam UT, Croft P. Measuring disease prevalence: A comparison of musculoskeletal disease using four general practice consultation databases. *Brit J Gen Pract*. 2007;534:7-14.
8. Van Vuuren BJ, Becker PJ, Van Heerden HJ, Zinzen E, Meeusen R. Lower back problems and occupational risk factors in a South African steel industry. *American Journal of Industrial Medicine*. 2005; 47(5):451-7.
9. Bio FY, Sathra S, Jackson C, Burge PS. Low back pain in underground gold miners in Ghana. *Ghana Med J*. 2007;41(1):21-25.
10. AngloGold Ashanti. Ghana country report; Obuasi Report; 2008. Available: http://www.anglogold.co.za/NR/rdonlyres/EC62C8CA-4F9A-4D74-B33F-322DF7137EF4/0/obuasi_report.pdf (Accessed on 18th April 2009).
11. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med*. 2013;35(2):121-126.
12. Kuorinka I, Jonsson B, Kilbom A. Standardized nordic questionnaire for the analysis of musculoskeletal symptoms. *Appl. Ergon*. 1987;18:233-237.
13. Palmer K, Walker-bone K, Linaker C, Reading I, Kellingray S, Coggon D, Cooper C. The southampton examination schedule for the diagnosis of musculoskeletal disorders of the upper limb. *Ann Rheum Dis*. 2000;59:5-11.
14. Egwuonwu VA, Abidemi TB, Aiyejunsunle CB, Ezeukwu OA, Auwal A, Okoye CE. A

- cross-sectional survey of work related musculoskeletal disorders prevalence and associated risk factors among quarry workers in a South Eastern Nigerian community. *Int J. Epidemiol.* 2013;11(2). Available:<https://ispub.com/IJE/11/2/1598#> (Accessed on 20th April 2009).
15. Bongers P, Ijmker S, Van den Heuvel S, Blatter B. Epidemiology of work related neck and upper limb problems: Psychosocial and personal risk factors (part I) and effective interventions from a bio behavioural perspective (part II). *J Occup Rehabil.* 2006;16(3):272-95.
 16. Moore SM, Porter LW, Dempsey PG. Fall from equipment injuries in U.S. mining: Identification of specific research areas for future investigation. *J. Safety Res.* 2009;40(6):455-460.
 17. Dias B, Schutte. Work-related musculoskeletal disorders in the South African mining industry. Proceedings of 30th International Conference of Safety in Mines Research Institutes, South African Institute of Mining and Metallurgy; 2003.
 18. Olaogun MOB, Oladimeji BY, Adedoyin RA, Olaogun AAE, Akinloye AA, Egwu MO, Oyelese BO, Folorunso TJ. Patterns of musculoskeletal pain in selected occupations. *J. Nig. Soc. Physiother.* 2002;14(1):24-29.
 19. Vazirinejad R, Esmaeili A. Five year follow up of job-related injuries among sarcheshme copper mine complex workers. *Pak. J. Med. Sci.* 2009;25(3): 418-423.
 20. Kinkade S. Evaluation and treatment of acute low back pain. *Am Fam Physician.* 2007;75(8):1181-8.
 21. Chung MK, Kee D. Evaluation of lifting task frequently performed during fire brick manufacturing process using NIOSH lifting equations. *Int. J. Ind. Ergonom.* 2000;25: 423-433.
 22. Mandal B, Srivastava A. Musculoskeletal disorders in dumper operators exposed to whole body vibration at Indian mines. *Int J Min Reclam Env.* 2010;24(3):233-43.
 23. Naidoo RN, Haq SA. Occupational use syndromes. *Best Pract Res Clin Rheumatol.* 2008;22(4):677-91.

© 2015 Tawiah et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://sciencedomain.org/review-history/10171>