International Journal of Occupational Safety and Health

ISSN: 2091-0878 (Online) ISSN: 2738-9707 (Print)

Original Article

Study on effects of hand-arm vibration syndrome on construction workers in Oman

Palathoti SR[1], Al-Qaidi M[1], Otitolaiye VO[1]

[1]Department of Health Safety and Environmental Management, International College of Engineering and Management, Al-Seeb, Sultanate of Oman

Corresponding author:
Suvarna Raju Palathoti,
Assistant Professor,
Department of Health and Safety Environmental Management, International College of Engineering and Management, Seeb, Muscat, Sultanate of Oman,
Email: suvarnarajup2008@gmail.com
Orcid: https://orcid.org/0000-0003-1713-6943

Date of submission: 24.03.2023
Date of acceptance: 08.08.2024
Date of publication: 01.10.2024

Conflicts of interest: None
Supporting agencies: None
DOI:https://doi.org/10.3126/ijosh.v14i4.50328

Copyright: This work is licensed under a CreativeCommons Attribution-NonCommercial 4.0 International License

ABSTRACT

Introduction: The prolonged exposure of construction industry workers to various vibrating equipment gives rise to hand-arm vibration syndrome (HVS). Due to its growing prevalence among construction workers, scientists around the world have sought to examine its presence, prevalence, and potential impacts in various locations across the world. Therefore, the main objective of this paper is to examine the effects of HVS on construction workers in the Sultanate of Oman.

Methods: The quantitative cross-sectional design approach employed in the study involved the administering of a Google form questionnaire comprising 18 questions to collect, analyze, and sample the opinions of 40 respondents on the topic.

Results: The workers at the selected construction site were largely young and able-bodied males who displayed full knowledge and awareness of the nature, symptoms, and effects of HVS. The most common symptoms of HVS were white fingers, painful numbness in hands and arms, and musculoskeletal pains, whereas pain and sleep disturbance, reduced or inability to do work safely in cold conditions were termed the most prominent effects of HVS. Hence, some preventive measures proposed to address the problems of HVS were examined in the study.

Conclusion: The study demonstrated that HVS could be effectively reduced or eliminated at construction sites by establishing good personal health and occupational safety measures.

Keywords: Construction Safety, Hand-arm Accidents, Vibration Syndrome, Construction Safety, Workplace

Introduction

The process of construction involves the use of numerous types of tools that largely operate on the principle of vibration to accomplish various tasks.[1,2] Vibration, derived from the Latin word *vibrationem* (shaking or wielding), refers to the oscillatory motion of single or multiple bodies around an equilibrium point.[3] In principle, it is a mechanical process in which multiple oscillations take place at a fixed point. Globally, it is estimated that over 9 million workers are exposed to various kinds of tools or equipment that expose them to multiple and continuous vibrations.[4] For example, construction site workers utilize numerous types of hand tools that undergo several vibrations

during operations. As a result, these workers are prone to the multiple and continued oscillations of such equipment, which poses severe risks to their personal health and occupational safety.[5,6] The risks typically arise from the so-called hand-transmitted or hard-arm vibrations which over time could result in hand-arm vibration syndrome (HVS).[7-8] The HVS refers to the various kinds of damage caused by the vibration ranging from white fingers to muscular and neurological damage that can lead to numbness or tingling of hands and fingers.

Typically, the factors that contribute to the risk of developing HVS depend on the vibration magnitude and exposure frequency.[9] According to Poole et.al., the most essential factors responsible for the occurrence of HVS are the grip, as well as the push and essential forces used for guiding the vibrating tools used in construction.[10] A tight grip is used in case of ground vibration which is why more vibration energy is passed on to the hand. It was noted that the exposure pattern, as well as frequency of work and rest periods, are critical accountable factors for the occurrence of HVS.[11] However, there are a set of standards associated with a vibration like ISO standard 2349 (2001) for hand-transmitted vibrations.[12] Despite this, the lack of appropriate knowledge about the situation on the ground makes it difficult to decide what standards can be adhered to.[13-14]

The general construction industry as well as the heavy engineering and concrete product manufacturing industry also recruit numerous workers affected by HVS. Likewise, ancillary construction industry workers in mine/quarry, motor vehicle manufacturing, and public utility (i.e., water and electric facilities) companies are also affected by HVS.[15] However, the construction industry workers are particularly prone to HVS due to exposure to various vibrating equipment during high-end and sustained construction projects as typically witnessed in the Middle East. For example, in countries like Oman construction work requires the use of heavy vibration tools which results in chronic and sustainable exposure to high-magnitude vibration particularly among the largely migrant workforce.[16,17] It is estimated that ~57% of the people associated with construction projects are non-native immigrant workers employed by construction companies.[18] Hence, it is generally believed that the concept and knowledge of local regulations and associated engineering factors among immigrant or migrant workers are generally lacking. Likewise, noted that the safety norms among migrant workers are considered highly volatile when compared to that of native workers.[19]

According to Qamruddin et. al., the dynamic nature of the construction project in Middle Eastern countries like Oman requires significant knowledge of the ground situation to critically address health, safety, and other work site-related issues such as HVS among the workers.[20] This is one of the primary factors for the lack or absence of any evidence of a comprehensive survey conducted by construction companies to execute a localized topographical study about vibration in its complete form with emphasis on a specific geographical typology. Therefore, this study aims to examine the effects of the hand-arm vibration syndrome (HVS) on the overall personal health and occupational safety of construction workers in the Sultanate of Oman.

Methods

The study adopted a quantitative cross-sectional design for the data collection, analysis, and sampling.

The sample size for administering the questionnaire was based on workers who work with hand power tools or other operators who work with other equipment that could cause vibration at the selected construction site. The sample size of this study was 40, whereas the gender was men aged between 25 to 35 years of age.

This part of the study involved the use of a questionnaire to collect primary data on the impact of Hand-arm Vibration Syndrome (HVS) on construction workers in Oman. Hence, a

Google form-based questionnaire consisting of 18 questions was administered via email to workers whose tasks involved the use of hand power tools to obtain information about the worker's knowledge of the risk of vibration exposure and the HVS. The questionnaire was also aimed at examining the symptoms and consequences of the HVS disease and safety measures to avoid contraction. The questionnaire was focused on the worker's age, gender, nature of work, and the frequency of using HV tools at construction sites. The questionnaire was structured with specific questions that provided answers between the knowledge scale and yes or no questions on a Google form administered to the workers.

The questionnaire was analyzed depending on the high or low scale. It aimed to examine each worker's knowledge of the nature of their work and the HVS disease if any. The analysis was performed through Microsoft Excel and Chart analysis of the percentages and the number of workers.

Results

The questionnaires were distributed to 40 workers at the selected construction site in Oman. The total number of returned questionnaires was 32 with all respondents being male aged between 20 and 35 years of age. The results also showed that respondents aged between 20-25 accounted for the largest percentage (37.50%) of workers at the site, whereas the aged groups 26-30 and 31-35 accounted for 34.38% and 28.13% of the respondents, as highlighted in Figure 1.

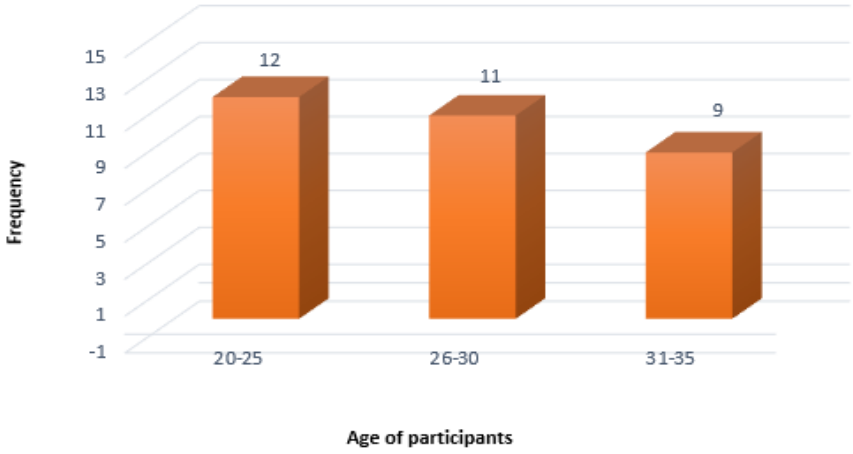

Figure 1: Age distribution of study respondents

The nature of the tasks/jobs on the selected construction site was also examined in the study. Based on the findings of the questionnaire, it was observed that the tasks include drilling, demolishing, operating heavy equipment, maintenance, loading materials, removing debris, and cutting, as shown in Figure 2. As observed, 4 out of 8 tasks/jobs at the construction site involve the use of vibration equipment, namely drilling, demolishing, operating heavy equipment, and cutting. However, the analysis of the total number of workers assigned tasks showed that drilling accounts for the highest share with 31.25% (10 workers), followed by demolishing at 25% (8 workers), operating heavy equipment at 12.50% (4 workers), and lastly, cutting at 6.25% (2 workers). The findings showed that 75% (24 workers) at the construction site operate vibrating equipment, which suggests that this group is more prone to HVS than other workers.

Further analysis showed that 23 workers (71.88%) are aware of or have experienced one or more symptoms of HVS ranging from white fingers, painful numbness in hands and arms, and musculoskeletal pains. The symptom with the highest prevalence among the workers was white fingers (37.5%) followed by painful numbness in

hands and arms (25%), and lastly, musculoskeletal pains (9.38%) as shown in Figure 3. The high prevalence of white fingers (37.5%) in workers is because it is the onset symptom or most common feature of HVS. The disease typically begins with numbness before progressing tothe white fingers hence workers have sufficient knowledge about the HAVS symptoms.

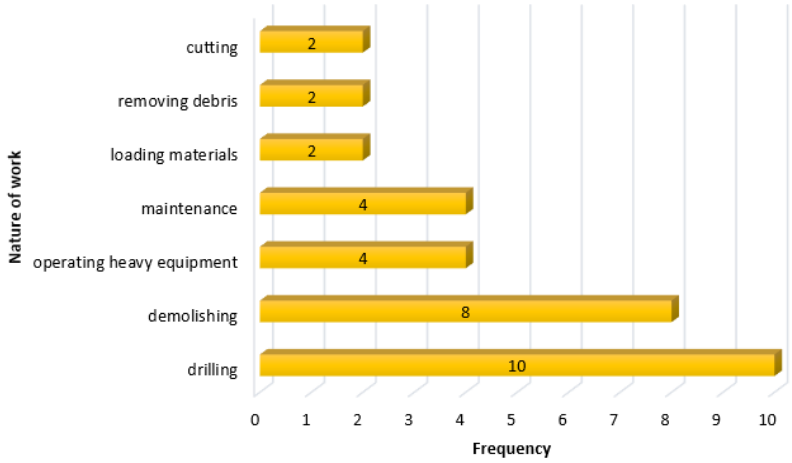

Figure 2: Nature of work of study respondents

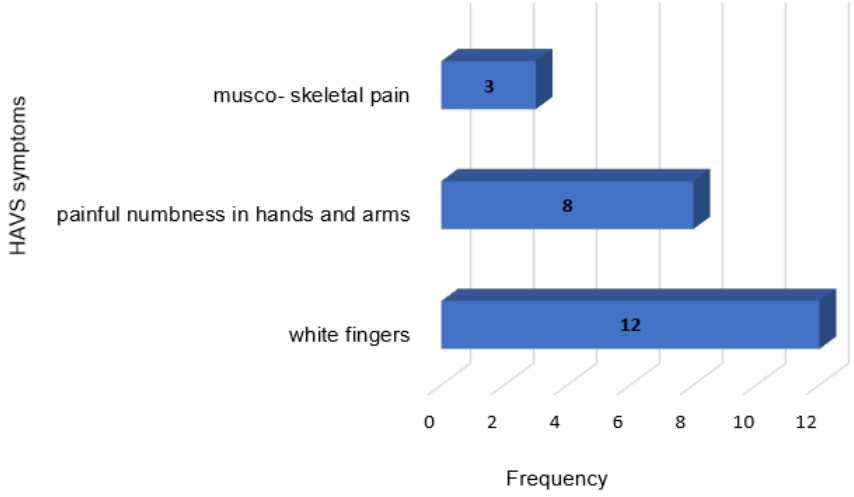

Figure 3: Distribution of HAVS symptoms among respondents

The consequences of HVS among construction site workers were also examined in this study. In this study, it was observed that the most notable consequences of HVS are the inability to do your work safely, pain and sleep disturbance, and reduced ability to do work in cold conditions, as illustrated in Figure 4. The distribution of the detected consequences showed that the inability to do your work safely was the most common consequence of HVS disease, which is to be expected since this is the primary effect of HVS, whereas sleep disruption and working in cold conditions are secondary effects or reactions to HVS. Further analysis revealed that workers also experienced other symptoms, termed after-work consequences, particularly in the fingers, arms, and hands as well as discomfort while working, and tingling feeling.

Given its short- and long-term impacts on workflow, there is an important need to address the challenges of HVS. Hence, the respondents were asked to evaluate selected precautionary or

preventive measures to address the problems of HVS onsite, as depicted in Figure 5. The questionnaire responses showed that changing work methods that reduce vibration, keeping hand tools always good and maintained, and encouraging workers to report early symptoms were the most common responses. Further analysis showed that changing work methods that reduce vibration was the selected response by 71.88% of the respondents. This response is to be expected as it is the most logical response to HVS accidents.

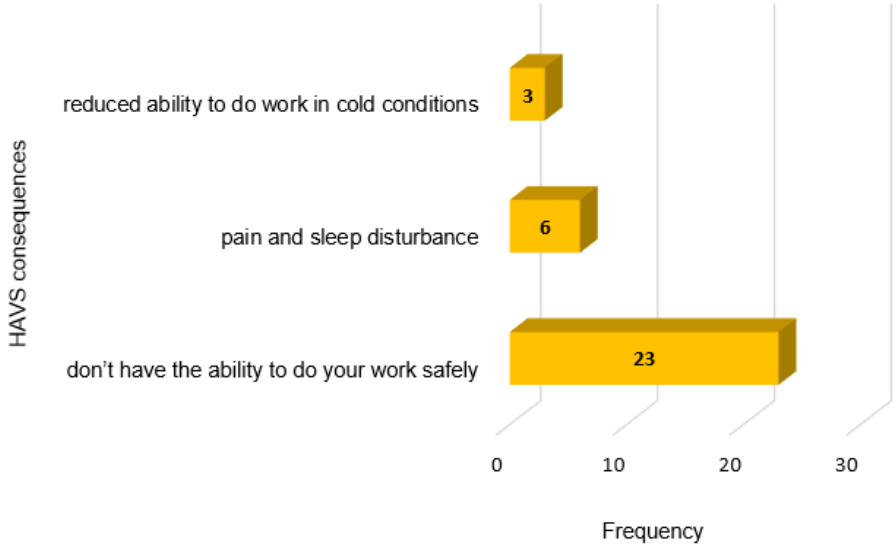

Figure 4: Consequences of HVS among construction workers

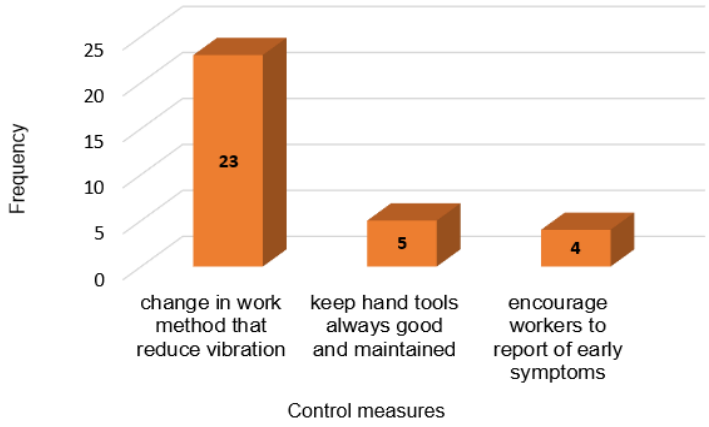

Figure 5: Control measures for preventing vibration exposure

Discussion

The first part of the questionnaire obtained data on the respondent's demographic information such as the worker's age, gender, and nature of work. All the workers at the selected construction site are male and fall within the age brackets of 20 to 35. Further analysis showed that the most significant number of workers (i.e. 12) fall within the age bracket from 20 to 25, whereas the age brackets 36-30 and 31-35 each have 11 and 9 workers, respectively. Analysis of the nature of the work shows that drilling is the most common type of work at the site due to the numerous workers performing this activity.

The second part of the questionnaire aimed to examine the workers' general knowledge of HVS. The findings showed that the workers are largely knowledgeable about HVS, and the risks associated with exposure to the syndrome. This observation is largely beneficial as knowledge of the syndrome and its underlying risks will ensure caution and serve as a preventive measure against future occurrences. The respondents also showed their awareness of the chronic and acute symptoms of HVS such as white fingers, which is in fact the most significant symptom of the syndrome. Other symptoms of HVS depend on the period of exposure to hand-arm vibration as well as tools and the nature of work.

The ability to do your work safely was deduced as the most significant consequence of HVS as confirmed by 23 workers at the construction site. Hence, some control measures were proposed to reduce or limit the consequences of HVS such as changing the work methods as deduced from the frequency of workers' responses to this measure. In addition, the findings revealed that good knowledge of the nature of vibration work and tools can enhance overall health and safety as well as prevent future cases of HVS among workers.

Based on the results, it can be reasonably expected that the prevalence of the male gender among the study respondents is due to the nature of the construction work. Typically, the long hours, drudgery, and potential risks of construction sites require that workers are male, young, healthy, and able-bodied to effectively function. In addition, the use of hand tools typically characterized by high noise and vibration levels requires men in the age groups deduced from the study.

Conclusions

The study investigated the effects of the Hand-arm Vibration Syndrome (HVS) on the overall health and safety of construction workers in Oman. The results showed that the workers at the selected construction company are generally informed about HVS, its symptoms and the risks associated with exposure to the disease. Furthermore, the findings showed that the most common symptoms of HVS experienced by the workers are white fingers, painful numbness in hands and arms, and musculoskeletal pains. Based on their responses, it was also observed that the most prominent effects of HVS are pain and sleep disturbance, as well as reduced or inability to do work in cold conditions or work safely. Given the immediate and potential impacts of HVS, the workers' opinions on selected precautionary or preventive measures to address the problems of HVS were examined in the study. The questionnaire responses showed that adjusting working procedures that reduce vibration, maintaining work tools, and early reporting of symptoms were considered the most critical to addressing HVS among workers. Overall, the results showed that with proper measures in place, HVS can be significantly reduced or eliminated at construction sites.

References

1. Edwards DJ, Holt GD. Hand-arm vibration exposure from construction tools: results of a field study. Construction Management and Economics. 2007;24(2):209-17. Available from: https://doi.org/10.1080/01446190500310643
2. Jing X, Zhang L, Feng X, Sun B, Li Q. A novel bio-inspired anti-vibration structure for operating hand-held jackhammers. Mechanical systems and signal processing. 2019;118:317-39. Available from: https://doi.org/10.1016/j.ymssp.2018.09.004
3. Abeykoon AHS, Wijewardhana W, Senevirathne EH, Jayawardhana K. Vibration suppression of force controllers using disturbance observers. Vibration Control and Actuation of Large-Scale Systems. 2020:57-89. Available from: https://doi.org/10.1016/B978-0-12-821194-6.00003-2
4. Mansfield NJ. Human response to vibration: CRC press; 2005. Available from: https://docs.wind-watch.org/Mansfield-human-response-vibration.pdf
5. Eyayo F. Evaluation of occupational health hazards among oil industry workers: A case study of refinery workers. IOSR J Environ Sci. 2014;8(12):22-53. Available from: http://dx.doi.org/10.9790/2402-081212253

6. Debela M, Taferi G, Assefa M. Occupational Exposure to Hand-arm Vibration and Associated Factors among Metehara Sugar Industry Workers: East-shoa, Ethiopia. J Environ Hazard. 2019;2(1). Available from : https://www.researchgate.net/publication/330651634_occupational-exposure-to-handarm-vibration-and-associated-factorsamong-metehara-sugar-industry-workers-eastshoa-ethiopia
7. Fakhory MVG. Knowledge, Attitude, And Practice of Electrical and Metal Workers toward Occupational Health and Safety, Tolan Electrical and Metal Factory. 2020.
8. Roseiro L, Neto M, Amaro A, Alcobia C, Paulino M. Hand-arm and whole-body vibrations induced in cross motorcycle and bicycle drivers. International journal of industrial ergonomics. 2016;56:150-60. Available from: https://doi.org/10.1016/j.ergon.2016.10.008
9. Vihlborg P, Bryngelsson L, Lindgren B, Gunnarsson LG, Graff P. Association between vibration exposure and hand-arm vibration symptoms in a Swedish mechanical industry. International Journal of Industrial Ergonomics. 2017;62:77-81. Available from : https://doi.org/10.1016/j.ergon.2017.02.010
10. Poole C, Bovenzi M, Nilsson T, Lawson I, House R, Thompson A, Youakim S. International consensus criteria for diagnosing and staging hand-arm vibration syndrome. Int Arch Occup Environ Health. 2019;92:117-27. Available from: https://doi.org/10.1007/s00420-018-1359-7
11. Aarhus L, Veiersted K, Nordby K, Bast-Pettersen R. Neurosensory component of hand-arm vibration syndrome: a 22-year follow-up study. Occupational Medicine. 2019;69(3):215-8. Available from: https://doi.org/10.1093/occmed/kqz029
12. Baghel S, Vyas J. Literature Survey on Comparative analysis of RC & Steel Chimney. International Research Journal of Engineering and Technology. 2019;6(7):44-7. Available from: https://www.irjet.net/archives/V6/i7/IRJET-V6I708.pdf
13. Krajnak K, Waugh S. Systemic effects of segmental vibration in an animal model of hand-arm vibration syndrome. Journal of occupational and environmental medicine. 2018;60(10):886-95. Available from: https://doi.org/10.1097/jom.0000000000001396
14. Krajnak K, Miller G, Waugh S. Contact area affects frequency-dependent responses to vibration in the peripheral vascular and sensorineural systems. Journal of Toxicology and Environmental Health, Part A. 2018;81(1-3):6-19. Available from: https://doi.org/10.1080/15287394.2017.1401022
15. Charles LE, Ma CC, Burchfiel CM, Dong RG. Vibration and ergonomic exposures associated with musculoskeletal disorders of the shoulder and neck. Safe health work. 2018;9(2):125-32. Available from: https://doi.org/10.1016/j.shaw.2017.10.003
16. Umar T, Wamuziri SC. A review of construction safety, challenges and opportunities-Oman perspective. 2016:14-22. Available from: https://uwe-repository.worktribe.com/output/8661954/a-review-of-construction-safety-challenges-and-opportunities-oman-perspective
17. Umar T, Egbu C. Perceptions on safety climate: a case study in the Omani construction industry. Proceedings of the Institution of Civil Engineers-Management, Procurement and Law. 2018;171(6):251-63. Available from: https://doi.org/10.1680/jmapl.18.00001
18. Umar T, Egbu C, Honnurvali MS, Saidani M, Al-Mutairi M. An assessment of health profile and body pain among construction workers. Proceedings of the Institution of Civil Engineers-Municipal Engineer; 2020;173(3):125-35. Thomas Telford Ltd. Available from: https://doi.org/10.1680/jmuen.18.00019
19. Roseiro LM, Paulino MF, Neto MA, Amaro AM. Analysis of hand-arm vibration syndrome in drummers. International Journal of Industrial Ergonomics. 2018;66:110-8. Available from: https://doi.org/10.1016/j.ergon.2018.02.014
20. Qamruddin AA, Husain NRN, Sidek MY, Hanafi MH, Ripin ZM, Ali N. Prevalence of hand-arm vibration syndrome among tyre shop workers in Kelantan, Malaysia. Journal of occupational health. 2019;61(6):498-507.Available from: https://doi.org/10.1002/1348-9585.12078