

**ORIGINAL RESEARCH ARTICLE****Assessment of ergonomics hazards and associated health effects in selected food and beverage industries Nairobi Kenya.****Ayaga Odiwuor Francis¹, Mburu Charles^{1, 2} , Karanja Benson¹**¹*Institute of Energy and Environmental Technology, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya*²*Department of Occupational Safety & Health, IEET, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya*Corresponding author email: princef254@gmail.com**ABSTRACT**

In the food and beverage industries, ergonomic risk factors, including awkward postures, excessive force, and repetitive tasks, have a significant impact on exacerbating work-related musculoskeletal disorders (MSDs). Repetitive tasks involving manual lifting or carrying are associated with work-related musculoskeletal disorders. This cross-sectional descriptive study aimed to profile ergonomic hazards, assess health effects among employees, and identify existing control measures implemented in the food and beverage industries in Nairobi County. The study was conducted among a population of 1821 workers in five selected facilities from October 2022 to January 2023. A systematic random sampling technique, following the Yamane (1967:886) statistical method as cited in Leon Mystica (2020), was employed to obtain a representative sample of 328 voluntary participants. Primary data was collected through self-administered structured questionnaires, observations, and taking measurements in the facilities. The study confirmed the literature's theory that most activities performed by employees in the sector are manual, repetitive, and physically demanding, primarily in the manufacturing (56.0%) and warehousing (24.0%) departments. The most prevalent factors contributing to ergonomic hazards and MSDs include excessive force exertion during manual handling, the adoption of awkward body postures, prolonged periods of static positions, and exposure to vibrations. The health effects of ergonomic hazards are further aggravated by the manual handling of heavy material loads and the mismatch between job requirements and employees' physical capabilities. The high occurrence of pain or discomfort among workers is significantly influenced by the poor posture they adopt when performing tasks. Despite a satisfactory combination of control measures implemented in the selected workplaces, their prioritization does not align with the risk control hierarchy described in existing literature. The majority of implemented control measures in the sector are administrative, and there is a lack of adherence and consistency in enforcing safety regulations regarding the maximum load limits for manual lifting.

Keywords: ergonomic hazards, hierarchy, musculoskeletal disorder, control measures, machinery safety,



1.0 Introduction

Musculoskeletal disorders are commonly associated with ergonomic risk factors such as awkward postures, excessive force, and repetitive tasks. The Health and Safety Authority (HSA, 2019) defines musculoskeletal disorders as injuries and disorders that affect the skeletal system. Ergonomics, as explained by the authority, involves designing tasks to improve human comfort, health, and performance. Given the prevalence of repetitive tasks in material handling processes within the food and beverage industries, which is one of the largest economic sectors, the researcher is interested in conducting a study in this area.

Managing ergonomic risk factors in the workplace is crucial to protecting workers' health, enhancing performance, and ensuring compliance with applicable laws (HSA, 2019). A hazard is defined as any source that has the potential to cause harm, ill health, damage to property, the environment, or a combination of these factors (Rout & Sikdar, 2017). Material handling processes are common across various sectors, and workers engaged in these processes are frequently exposed to repetitive tasks such as loading, unloading, lifting, pushing, carrying, and more. These repetitive activities can lead to work-related musculoskeletal disorders (Chaiklieng, 2019). Therefore, the researcher aims to gain a better understanding of the ergonomic hazards, applied controls, and health risk factors associated with such hazards.

Davidson et al. (2018) identified ergonomic hazards as the top risk factors in performing industrial tasks, highlighting low back strain and pinched fingers as the most affected areas during manual handling of various weights. Rout & Sikdar (2017) suggested that routine risk assessments and the application of control measures can significantly reduce the risk levels of identified hazards to as low as reasonably practicable (ALARP).

Kanda & Chirengendure (2019) emphasized that employees involved in lifting or other material handling work may be at risk of back or other injuries. Brown, Shore, Dyke, Scott, & Smith (2020) concluded that ergonomic risk assessment provides an opportunity to reduce the risk of work-related musculoskeletal disorders (WMSDs) associated with the weights of the load being handled. Ahmed, Raut, and Sharma (2017) stated that tasks involving lifting, lowering, pushing, pulling, carrying, or restraining individuals are considered hazardous. Similarly, HSA (2019) supports the assertion that these hazardous tasks, such as repetitive movements, sudden force, awkward postures, and exposure to vibrations, directly impose stress on the body and can consequently lead to work-related musculoskeletal disorders (WRMD).

In manufacturing industries, workers often manually carry various material loads without assessing the associated risk factors. An assessment report by Gardner, Reed, and Davidson (2020) revealed that workers transport, load, and unload materials weighing as much as 363.0 kg in metallic or plastic containers, exceeding the recommended limit of 50.0 kg per adult male worker according to recommendation 1967 no. 128 (Mugford, Gibbs, & Boylestein, 2017).

According to Tee et al. (2017), workplaces should establish, implement, and maintain a process for eliminating and reducing occupational health and safety (OH&S) risks. The hierarchy of controls should always consider elimination, substitution, engineering controls, reorganization

of work, administrative controls, and the use of adequate personal protective equipment as a last resort. The researchers emphasized that the inefficiency of resources is noted as a key challenge, especially regarding the investigation of occupational accidents and diseases in all workplaces.

2.0 Materials and methods

2.1 Study design

In this study, the choice of research design was determined by the research questions being investigated. The aim of the study was to gather information, and therefore, a descriptive research study design was employed. Goel et al. (2019) emphasize the importance of selecting suitable strategies, methods, and techniques to effectively address the research questions.

2.2 Study area and population

Primary data for the study was collected from five selected industries in Nairobi County, namely Nestle Kenya Limited, Nairobi Bottlers Limited, Unga Limited, C. Dorman Limited, and Artcaffe Coffee & Bakery Limited. These industries were purposely chosen to represent the broader population in the food and beverage sector. According to data obtained from the Directorate of Occupational Safety and Health Services (DOSHS, 2019), there are a total of 10,302 registered workplaces in the Republic of Kenya, with 4,393 (42.6%) of them located in Nairobi County. Moreover, the records showed that there were 13,803 workers employed in the food and beverage sector of the economy. The report further revealed that the majority of the workforce in this sector is female, accounting for 9,968 (72.2%), while the male workforce accounts for 3,835 (27.8%) (DOSHS, 2019).

Table 1: Selected food and beverage facilities in Nairobi County.

No.	Workplace	Address	County	Nature of work	Approximate No. of workers
	Unga ltd	30386	Nairobi	Flour milling	400
	Nestle kenya ltd	30265	Nairobi	Manufacturing of cereals & beverages	150
	Nairobi bottlers ltd	18034	Nairobi	Storage, warehousing, engineering & distribution	1000
	Artcaffe coffee & bakery ltd	14510	Nairobi	Restaurant	188
	C. Dorman ltd	30147	Nairobi	Processing & Packaging	83

Source: Directorate of occupational safety and health institute registry, 2019.

2.3 Sampling method

In this study, a systematic random sampling technique was applied to obtain a representative sample of workers from the food and beverage sector. As alluded to by Goel et al. (2019), sampling helps save time and resources, so the researcher made a decision to focus on only

five specific industries within the food and beverage sector due to limited financial resources and time constraints.

2.4 Sample size determination

To ensure a representative sample of workers from the population of 1821 in the five selected food and beverage industries, the Yamane (1967:886) statistical method of sample size determination (as cited in [Leon Mystica, 2020](#)) was employed. The formula used in this method is: $n = N / (1 + N(e)^2)$, where N represents the population under study, n is the sample size for the study, and e is the marginal error (0.05). By applying this method, the calculated sample size for the study was determined as follows: $n = 1821 / (1 + 1821 (0.05)^2) = 328$.

To ensure representation from each workplace in the five selected industries, a proportionate distribution of the population was considered. The representative sample size of respondents in each selected industry who participated in the study was determined using the formula: $n_i = (n_x/N) \times n$. In this formula, n_i represents the representative sample size of respondents in each selected industry, n_x denotes the population of workers in each selected industry, and N represents the total population of workers available in all five selected industries under study.

Table 2: Sampled respondents in the selected facilities.

#	Facility	Population (nx)	Proportionate distribution.	Representative sample size (ni)
1	Unga Ltd	400	21.97%	72
2	Nestle Kenya Ltd	150	8.24%	27
3	Nairobi Bottlers Ltd	1000	54.91%	180
4	Artcaffe Coffee & Bakery Ltd	188	10.32%	34
5	C. Dorman Ltd	83	4.56%	15

Source: Directorate of Occupational Safety Health Institute Registry. (2019 February,19)

2.5 Research instruments

To gather information about the respondents' experiences, a structured questionnaire was employed. Additionally, a camera and a notebook were utilized to record observations during interactions with the workers. Furthermore, a tape measure was applied to confirm measurements in the workplace, all of which were done to achieve the objectives of the study.

3.0 Results and Discussion

The study aimed to assess ergonomic hazards and associated health effects in selected food and beverage industries. The specific objectives were to profile ergonomic hazards, evaluate health effects among employees, and identify existing control measures as applied in the selected food and beverage industries.

3.1 Existing and applied Control measures in the food and beverage industries.

Table 3: Applied Control Measures in Percent by Respondent.

Indicators of Applied Existing Controls	1	2	3	4	5
I have been trained and issued with instruction before given a new task	4.8	17.6	19.2	20.4	38.0
Proper arrangements and organization are maintained	2.4	16.8	18.4	27.2	35.2
Material safety data sheets have been made readily available when handling hazardous chemicals.	12.9	12.1	9.7	26.2	39.5
Weight of material load carried whole by worker exceeds set maximum.	31.9	20.2	11.3	11.7	25.0
Rest, break, or rotation is allowed on doing loading, offloading tasks or working with hazardous chemicals.	9.6	15.2	14.4	32.4	28.4
Machines are maintained in good working conditions with safety guards	7.3	12.9	20.2	21.4	38.3

(Where: 5 -atleast four times, 4- three times, 3-two times, 2-once and 1- zero).

Table 3 presents a summary of participants' responses to interactions with implemented controls for minimizing the risk of injuries or illness in the workplace. The responses were collected using a 5-point Likert scale.

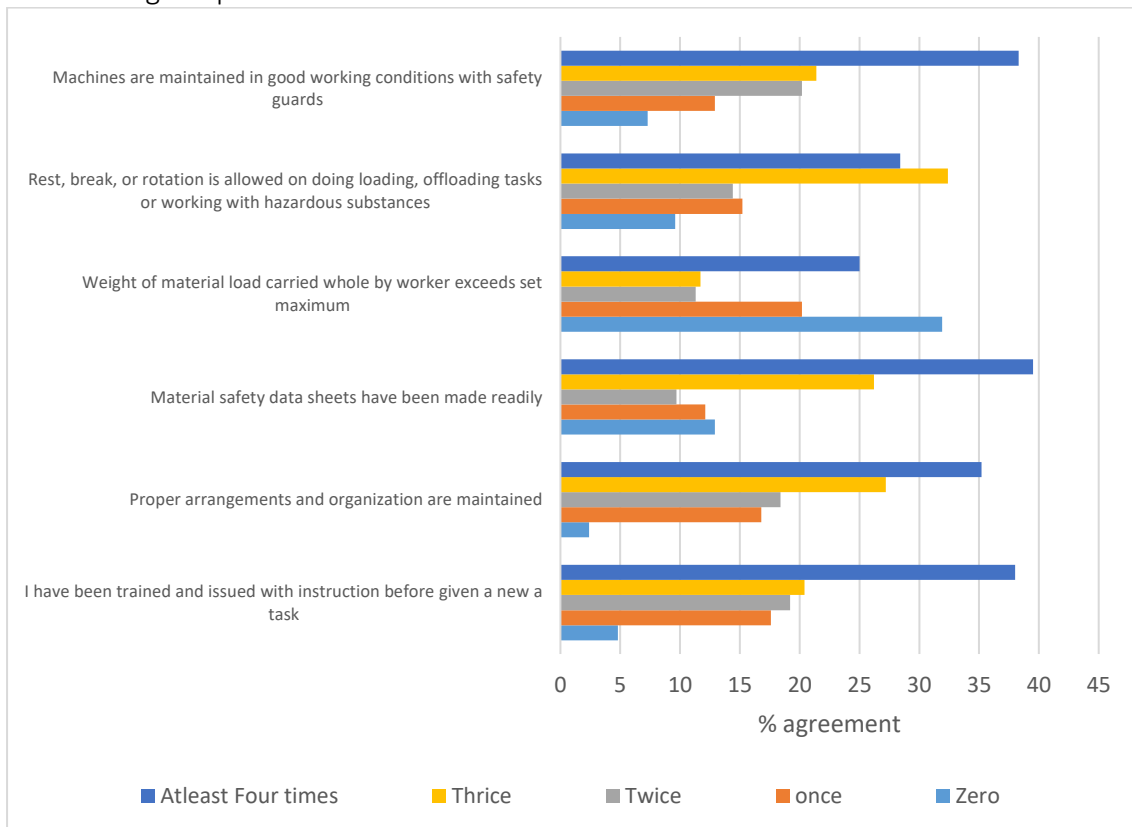


Figure 1: Participants' Responses on applied control measures in the Workplace



As illustrated in Figure 1, a substantial majority of workers (38.0%) have received extensive training and instruction on their assigned tasks more than four times, with 20.4% receiving training three times, 19.2% receiving it twice, and only 4.8% reporting a lack of instruction or training. These findings indicate that management has made significant investments in training initiatives for workers in the food and beverage industries. Results indicate that 35.2% of respondents have consistently experienced proper arrangements and organisation in the workplace on four or more occasions. Additionally, 27.2% reported encountering it three times, 18.4% encountered it twice, and only 2.4% reported a lack of proper workplace arrangements. These findings suggest that safety requirements were fairly considered during the planning and design stages of the facilities, thus promoting good housekeeping practices.

In terms of the accessibility of Material Safety Data Sheets (MSDS), 39.5% of respondents have encountered them at least four times when handling hazardous substances. Furthermore, 26.2% encountered them three times, 12.9% reported no encounters, and 9.7% reported encountering them twice. These results suggest that management has made considerable efforts to ensure the availability of MSDS and has provided training to workers on their proper use. This demonstrates a commendable commitment to prioritizing safety and equipping workers with the necessary information to handle hazardous substances effectively.

A significant majority (31.9%) of respondents reported that they have never observed violations regarding workers carrying materials beyond the set load limits in their workplace. However, 25.0% reported more than four encounters, 20.2% reported one encounter, and 11.3% reported encountering it twice. These findings suggest that while most workers adhere to the recommended weight limits or may occasionally engage in team lifting, a notable proportion of workers continue to manually carry heavy material loads that surpass the organization's established thresholds. This highlights the importance of further attention and the implementation of control measures to address this issue and ensure the safety and well-being of workers.

The study further revealed that a significant proportion of respondents (32.4%) reported that rest, breaks, or rotation are allowed three times, while 28.4% reported at least four times. However, 14.4% reported twice, but 9.6% reported that employees work continuously without breaks when performing repetitive tasks. These results suggest that workers in food and beverage facilities frequently engage in physically demanding and repetitive tasks. However, management recognizes the importance of allowing workers to rest and recover from fatigue, thereby minimizing their exposure to ergonomic hazards. By providing opportunities for rest and breaks, management demonstrates a commitment to promoting worker well-being and reducing the risk of injuries associated with repetitive tasks. Similarly, 38.3% of respondents reported encountering machines maintained in safe working conditions more than four times; 21.4% recorded three times; 15.2% indicated once; and only 7.3% reported unpleasant experiences with unsafe machines or poorly guarded equipment. These findings suggest that most facilities in the sector have implemented a combination of various control measures to minimize machine-related injuries. Overall, control measures, such as machine guarding, training and instructions, safety rules, and inter-task breaks or rotation, are suitably applied in

the sector. The institution alludes to the idea that workplaces should have adequate storage spaces, use appropriate equipment for material handling, and maintain clear and unobstructed pathways to reduce repetitive handling of materials. According to the International Labour Organisation (ILO, 2017), there should be adequate controls, including breaks and worker rotation, training and instructions, the use of suitable technical devices, and good workplace organisation.

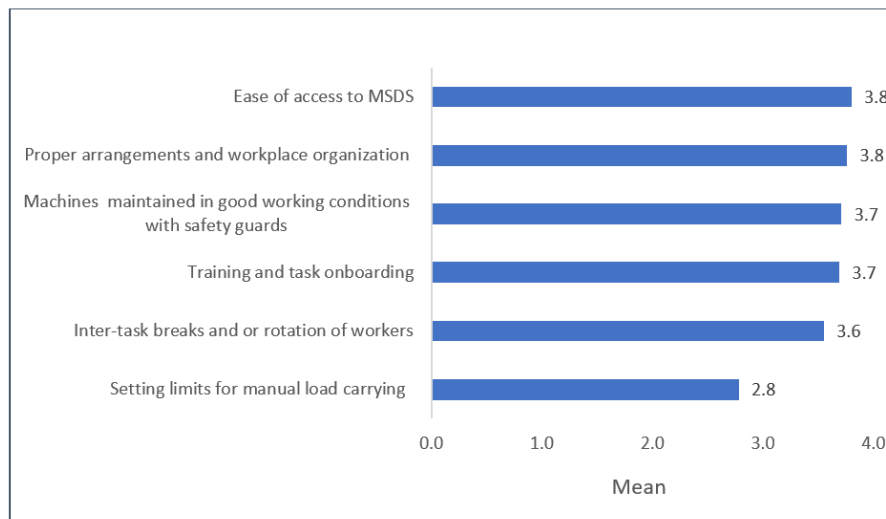


Figure 2: Hierarchy of Existing Control Measures as Applied in the Workplace

As shown by Figure 2, the most effective control measures implemented in the food and beverage industries include access to workplace information, proper organization and workplace layout, machine guarding, and training and onboarding for tasks. Conversely, the least applied control measures were found to be adherence to safety rules regarding maximum material load limits and the implementation of inter-task breaks or rotation of workers.

These findings are consistent with the research conducted by Cunningham and Jacobson (2018), who emphasized the use of transmission devices to minimize worker overexertion and the importance of following established ergonomic rules to reduce the risk of injury during material handling operations. The results also highlight the need for improvement in terms of adherence to safety rules and the promotion of inter-task breaks or the rotation of workers in the food and beverage industries. By addressing these areas, organizations can further enhance workplace safety and reduce the risk of injuries associated with overexertion and repetitive tasks.

Table 4: Width of internal transport routes (metre)

	N	Minimum	Maximum	Mean	Std. Deviation
Width (m)	24	0.5	5.2	2.1	1.1

Based on the data presented in Table 4. The results indicate that the average width of the transport routes in the workplace was 2.1 metres, with a standard deviation of 1.1. The maximum width observed was 5.2 metres, while the minimum width recorded was 0.5 metres. These findings suggest that most transport routes in the studied workplaces are designed to facilitate the safe transfer of materials and the movement of individuals, thereby reducing the risk of collisions. These results align with the recommendations of the International Labour Organisation (ILO, 2017), which emphasizes the importance of ensuring that main transport routes are wide enough to enable the safe movement of both materials and individuals. The findings from this analysis highlight the efforts made by the selected food and beverage industries in Nairobi County to maintain adequately sized transport routes that promote safety and efficient operations within the workplace.

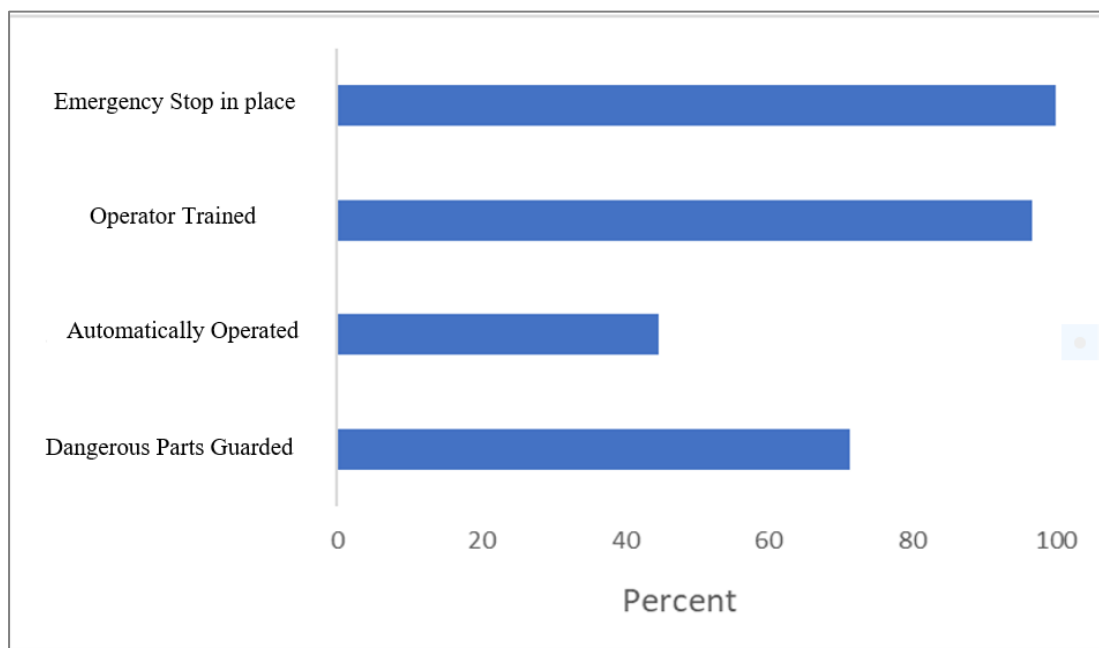


Figure 3: Machinery safety Measures implemented in the workplace.

From Figure 3, 71.4% of the examined machines have their dangerous parts properly guarded, 44.8% of the machines are operated automatically with minimal human interaction, and 96.6% of the operations are performed by trained employees. Additionally, all observed machines during the workplace walk around were equipped with emergency stop buttons.

These findings suggest that management has allocated adequate resources to prioritize worker safety and prevent machinery-related accidents in the food and beverage facilities. There is also evidence of good adherence to maintenance plans and the training of operators in the sector. However, it is important to note that a significant portion of operations in these industries still involve manual and repetitive handling of tasks, which can increase the risk of work-related musculoskeletal disorders (MSDs) due to regular physical motions.

These findings align with a study conducted by Chaiklieng (2019), who argued that working with automated machinery and performing packaging tasks in the food processing industry involves



regular physical motion. Such conditions expose workers to high ergonomic risk levels, particularly when tasks are performed in repetitive postures with exertion at regular intervals. The findings highlight the efforts made by management to ensure worker safety through the implementation of control measures. However, there is a need to address the ergonomic risks associated with manual and repetitive tasks to further enhance worker well-being and reduce the risk of work-related MSDs.

4.0 Conclusions and recommendations

Despite the presence of relatively good combination of existing and applied control measures in the selected industries to address the risks posed by ergonomic hazards, their prioritization does not align with the risk control hierarchy described in existing literature. The majority of implemented control measures are predominantly administrative in nature, and there is a lack of adherence and consistency in enforcing safety regulations regarding the carrying of material loads that exceed the maximum limits set by organizations. The food and beverage industries in Nairobi County face various ergonomic hazards, particularly those related to repetitive activities performed by workers in awkward postures. Therefore, it is crucial that tasks assigned to workers are designed to suit their capabilities, rather than expecting workers to adjust their bodies to fit the tasks.

- i. The study recommends that management in the food and beverage industries in Kenya prioritize the use of material handling devices in material handling operations, with manual handling considered a last resort. This approach will make work safer, easier, and more attractive to all genders, including female workers.
- ii. Management focuses on deploying additional engineering control solutions to reduce the risk of work-related illnesses associated with the manual handling of materials. Work tasks should be matched to workers' abilities, and pre-task assessments conducted to protect young or underage workers from exposure to hazardous work conditions.
- iii. Occupational health and safety enforcement authorities should ensure compliance with minimum regulatory safety standards, and regular workplace health risk assessments should be conducted and associated actions implemented.
- iv. Prioritization of resources in implementing control measures should consider the hierarchy of risk controls to address the significant ergonomic risks associated with manual and repetitive tasks to enhance worker well-being and reduce the risk of work-related MSDs.
- v. Further research is recommended to conduct similar studies in other counties outside of Nairobi, while also considering other potential hazards such as chemical and biological hazards in the food and beverage industries.

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5.1 Funding

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5.2 General

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5.3 Ethical consideration

The JKUAT ethical review committee and the National Commission of Science and Technology for granting me the research clearance permit number- NACOSTI/P/22/20920.

5.4 Conflict of interest

None.

6.0 References

- Ahmed, R., Raut, L., & A.S. Sharma. (2017). Review Paper of Various Industrial Material Handling Systems. *International Journal of Innovations in Engineering and Science*, 2(10), 28-31. <https://www.ijies.net/>
- Brown, C. E., Shore, E., Dyke, M. V. V., Scott, J., & Smith, R. (2020). Evaluation of an Occupational Safety and Health Training for Cannabis Cultivation Workers. *Ann Work Expo Health*, 64(7), 765-769. doi: DOI: 10.1093/annweh/wxaa026
- Chaiklieng, S. (2019). Health risk assessment on musculoskeletal disorders among potato-chip processing workers. *PLoS ONE*, 14(12), 1-8. doi: 10.1371/journal.pone.0224980
- Cunningham, T. R., & Jacobson, C. J. (2018). Safety Talk and Safety Culture: Discursive Repertoires as Indicators of Workplace Safety and Health Practice and Readiness to Change. *Ann Work Expo Health*, 13(62), S55-S64. doi:10.1093/annweh/wxy035
- Davidson, M., Reed, S., Oosthuizen, J., O'Donnell, G., Gaur, P., Cross, M., & Dennis, G. (2018). Occupational health and safety in cannabis production: an Australian perspective. *Int J Occup Environ Health*, 24(3-4), 75-85. doi:10.1080/10773525.2018.1517234
- Directorate of Occupational Safety and Health Services. (2019). Retrieved from Directorate of Occupational Safety Health Institute Registry.(2019 February,19)
- Gardner, M., Reed, S., & Davidson, M. (2020). Assessment of Worker Exposure to Occupational Organic Dust in a Hemp Processing Facility. *Annals of Work Exposures & Health*, 64(7), 745-753. doi:10.1093/annweh/wxaa065 https://pubmed.ncbi.nlm.nih.gov/?term=Gardner+M&cauthor_id=32607533
- Goel, A., Ganesh, L. S., & Kaur, A. (2019). Deductive content analysis of research on sustainable construction in India: current progress and future directions. *Journal of Cleaner Production*, 222, 142-158. <https://doi.org/10.1016/j.jclepro.2019.03.314>
- Health Safety Authority. (2019). Risk assessment for managing ergonomic risks. Retrieved from The Metropolitan Building, James Joyce Street, Dublin1: Retrieved from https://www.hsa.ie/eng/publications_and_forms/publications/manual_handling_and_musculoskeletal_disorders/managing_ergonomic_risk_-_abridged.pdf
- International Labour Organization. (2017). *Work Improvements in Small Enterprises* International Labour Office, Geneva, 2017. ISBN 978-922-129884-7 (web pdf). https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/instructionalmaterial/wcms_621054.pdf



- Leon, Mystica. (2020): Barriers to environmentally sustainable initiatives in oral health care clinical settings.
- Mugford, C., Gibbs, J. L., & Boylstein, R. (2017). Elemental properties of copper slag and measured airborne exposures at a copper slag processing facility. *J Occup Environ Hygiene*, 14(8), D120-D129. doi:10.1080/15459624.2017.1316388
<https://pubmed.ncbi.nlm.nih.gov/?term=Mugford%20C%5BAuthor%5D>
- Occupational Safety and Health Act 2007. (2007, October 6).
<https://www.kenyalaw.org/8181/exist/rest//db/kenyalex/Kenya...>
- Rout, B. K., & Sikdar, B. K. (2017). Hazard Identification, Risk Assessment, and Control Measures as an Effective Tool of Occupational Health Assessment of Hazardous Process in an Iron Ore Pelletizing Industry. *Indian J Occupational & Environmental Medicine*, 21(2), 56–76. doi: 10.4103/ijoem.IJOEM_19_16
- Tee, K. S., Low, E., Saim, H., Zakaria, W. N. W., Khialdin, S. B. M., Isa, H., . . . Soon, C. F. (2017). A study on ergonomic assessment in the workplace. *American Institute of Physics*, 1883(020034), 1-11. <https://doi.org/10.1063/1.5002052>