VIBRATION LEVELS AND REPORTED HEALTH EFFECTSAMONG WORKERS IN UBUNGO 1 POWER PLANT INDAR ES SALAAM, TANZANIA

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A Dissertation Submitted In Partial Fulfillment of the Requirements for the Degree of Master of Science in Environmental and Occupational Health of

Muhimbili University of Health and Allied Sciences
October, 2019

CERTIFICATION

The undersigned, certify that they have read this work and hereby recommend for acceptance by the Muhimbili University of Health and Allied Sciences, a dissertation entitled, **"*Vibration levels and reported WBV health effects among workers in Ubungo 1 Power Plant, Dar es Salaam, Tanzania*"** in partial fulfillment of the requirements for the award of the Master of science in Environmental and Occupational Health of the Muhimbili University of Health and Allied Science.

_____

Dr. Stephen S. Kishinhi

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Date: _____

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Prof. Sullivan Michael

(Supervisor)

Date: _____

DECLARATION AND COPYRIGHT

I, **Evamary Ludovick**, hereby declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature_____ **Date** _____

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DEDICATION

I humbly dedicate this dissertation report to my lovely husband Adrian Irongo, my children Ariannh Adrian Irongo and Ande Adrian Irongo together with all who were closed to me in any way during my study period.

ABSTRACT

Background: Vibration is a common occupational hazard produced by gas fired combustion engines in power plants. Workers especially in production area (maintenance workers and Operators) are occupationally exposed to high vibration levels when performing their duties. Therefore, they are at risk of develop WBV health effects.

Objective: This study aimed at assessing vibration levels and reported health effects among workers in Ubungo 1 power plant in Dar es Salaam, Tanzania

Material and Methods: A cross section study was conducted among 70 workers exposed to vibrations in Ubungo 1 Power Plant in Dar es Salaam. Vibro-meter connected to accelerometer (SD-8205) was used to measure vibrations magnitude on engines and walk-through floor. Distances were measured using Meter rule. Structured questionnaire were used to elicit information on WBV health effects among workers. Data were analyzed using SPSS version 20, and Chi Square used to prove the association between variables.

Results: Among workers participated in the study, women were 13(18.6%) and men were 57(81.4%). Workers in production area reported experience WBV health effects such as 68.2% abdominal rumbling, 63.6% abdominal pain, 52.3% low back pain, 52.3% fatigue and 43.2% headache. Vibration produced by engines were within the recommended levels 27m/s^2, while vibration measured on top walk-through 1 meter from engines were high above the recommended ELV of 1.15m/s^2. Chi square analysis has shown association between vibration levels and WBV health effects experience by workers, such as low back pain 13(52%), abdominal pain 20(80%), sleep disturbances 7(27%), loss of balance 13(52%) and chest pain 14(56%) with statistical significant of p value <0.05.

Conclusions and recommendations: Majority of workers reported experience WBV health effects they used to perform their duties in high vibration workplace. Therefore, Occupational health and safety department should conduct periodic monitoring of vibration in the workplace and communicate with workers through different safety signs.

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LIST OF ABBREVIATIONS

ANSI	American National Standard institute
EAV	Exposure action value
ELV	Exposure Limit Value
EWCS	Fifth European Working Condition Survey (2010)
ILO	International Labor Organization
ISO	International Organization for Standardization
HGCZ	Health Caution Guideline Zone
MSD	Musculoskeletal Disorder
PPE	People Protective Equipment
$_{w}$RMS	Weighted Root Mean Square
Aw	Accelerated Weight
VM	Vibration meter
WBV	Whole body vibration

OPERATIONAL DEFINITIONS OF TERM

Vibration is means an oscillatory motion of solid bodies of deterministic or random nature described by displacement, velocity or acceleration with respect to a given reference point.

Whole-body vibration (WBV) Vibration transmitted to the body as a whole through the supporting surface, namely the feet of a standing man, the buttocks of a seated man or the supporting area of a reclining man. This kind of vibration is usual in vehicles, in vibrating buildings and in the vicinity of working machinery.

Acceleration is the rate of change in speed of an object. The units used are "meters of distance per second per second".

Whole body Vibration Health effects This is the symptoms reported among workers regularly exposed to vibration include Low Back pain, Fatigue, Sleep disturbance, Loss of balance, Chest pains, Headache , Visual Dysfunction , Digestive disorders (Abdominal pain, abdominal rumbling, heartburn, nausea) and Circulatory problems (Hypertension)

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Tanzania electricity production was dominated by large hydro power plants, due to extensive droughts in the country it resulted into power supply shortages; the situation led to an active promotion of utilization of natural gas in production of electricity(1). Power plants have been one of the industries which utilize the modern technological machineries, designed and operating under automatic control systems, thus increasing its efficient and safeguarding workers against occupational risks. However, mostly installed machineries in power plant accompanied by different hazards including vibrations (2). Vibration produced by machinery can be transferred to the floors or work platforms, through supporting surfaces and reach individual to cause whole body vibration.

WBV refers to the situation where the whole body is exposed to vibration through contact by the buttocks or feet; whole body vibration occurs commonly in off-road work such as in construction (3)and on the road haul drivers (4)**.** To improve the health and safety of workers, Tanzania Environmental Management (Standards for the Control of Noise and Vibrations Pollution) (5) and European directive union (2002/44/EC) have establish the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibrations). The recommended permissible vibration action value should be less than $0.5 m/s^2$ and exposure action limit should not exceed $1.15 m/s^2$(6)**.**

Regular exposure to WBV is associated with development of a number of adverse health consequences including low back pain (7), abdominal pain, fatigue, cardiovascular disease (8), heartburn, loss of balance, chest pain and sleep disturbance (9)**.**But also, workers exposed to WBV are often subjected to a number of other risk factors that may contribute to the development of these adverse health effects. These risk factors include age(10)**,** maintaining a static posture for a long period of time, or twisting of the abdomen and heavy lifting (11)**.**

Ubungo 1 power plant as one of electricity producers in Tanzania, it utilizes gas fired combustions engines in electricity generation. The combustion engines convert a natural gas into electricity through mechanical processes(12), the mechanical movement of part produced a certain vibration levels which can easily transferred to the floor surfaces. Workers in production area (maintenance and operators) mostly were exposed to WBV due to its nature of their work as a result their at risk of injury from Whole Body Vibration exposure (13).

Currently the proportional of workers in Ubungo power plant experience WBV health effects is not known, while workers are still continue working in vibratory surface.

Therefore this study will assess vibration levels and reported WBV health effect among workers in Ubungo 1 power plant in Dar es salaam, Tanzania.

1.2 Statement of the problem

There are an increase number of machines in industrial world, although modern machines engineered to produce low vibration levels but still operators are exposed to WBV. Globally, 29 million U.S. workers have occupational WBV exposure and more than 7.2 million men and 1.8 million women in Great Britain were exposed to WBV at work in a one week period (14). In Africa no clear documentation has been made concern magnitude of WBV problem, but some of studies have shown the health effects incurred by the workers exposed to vibration even at low level(13)(15)

Ubungo 1 power plant uses gas fired combustion engines that produce vibrations through mechanical movement of its parts(12). Currently there is 12 gas fired combustion engines installed at Ubungo 1, but only nine were working. The engines are attached one meter to the top walkthrough that used by maintenance workers or operators during regular repair after breakdown occurred.

Maintenance workers and operators used to repair and fix the engines parts while in operational; these activities exposes them to vibrations that might lead to Whole body vibration health effects such as low back pain, fatigue, abdominal pain, loss of balance, chest pains, headache, visual dysfunction, digestive disorders and circulatory problems like hypertension. Current the proportion of workers experience WBV health effects in Ubungo 1 power plant is not known.

Therefore this study quantifies the vibration levels and proves the association with the reported WBV health effects among the worker in Ubungo 1 power plant.

1.3 Rationale of the study

The knowledge on WBV health effects experience by workers such as low back pain, chest pain and other illness generated from this study will create awareness to the employers and employees which might influence the changes through taking precaution and improvement on safety measures in the workplace.

The study findings added valuable information to the existing body of knowledge on whole body vibration exposure and risk factors associated with illness among workers in electrical power plants so as to improve their internal regulations on safety and health.

Findings are useful to Occupational Health and Safety Authority (OSHA) which aims at ensuring the creation and maintenance of ideal work environments which are free from occupational hazards that may cause injuries or illness to all employees in work environment. (Occupational Safety and Health Act no. 5, 2003).

1.4 Research Questions

1.4.1 Broad research question

The broad research question governed this study was what are the vibration levels and associated whole body vibration symptoms among workers in Ubungo 1 power plant?

1.4.2 Specific Questions

1. What are the proportions of workers experiencing whole body vibration health effects in Ubungo 1 power plant?
2. What is the magnitude of vibrations produced by gas fired combustion engines in Ubungo 1 power plant?
3. What is the WBV exposure (wRMS) at the top walkthrough (1meter) and on ground floor (2 and 4 meters) from the gas fired combustion engines?
4. Is their association between vibration exposure, breakdown attended by worker, time taken for repair/fixing of the engines and whole body vibration Health effects experience by workers in Ubungo 1 power plant?

1.5 Conceptual Framework

WBV health effects among workers in power plant can be contributed by working in vibration surface. Distance from machines and time taken for doing maintenance can increase the chance of worker exposed to vibrations and led to health effect

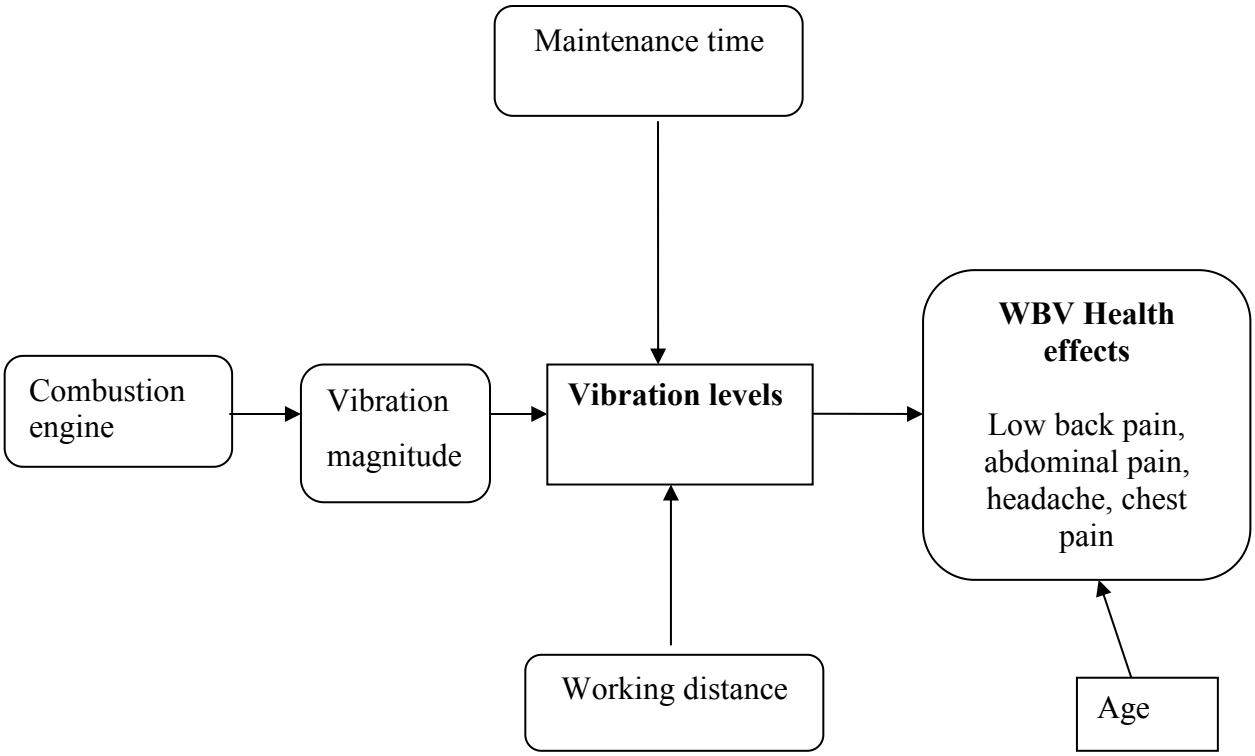


Figure 1.1: Conceptual framework of vibration level and associated health effects among workers in Ubungo 1 Power Plant in Dar es salaam, Tanzania.

1.6 Objectives of the study

1.6.1 Broad objective

The main objective of this study was to assess vibration levels and reported health effects among workers in Ubungo 1 power plant

1.6.2 Specific Objectives

1. To assess the proportional of workers experiencing whole body vibration health effects in Ubungo 1 power plant
2. To measure the magnitude of vibrations produced by gas fired combustion engines in Ubungo 1 power plant
3. To measure WBV exposure (wRMS) at the top walkthrough (1meter) and on ground floor (2 and 4 meters) from the gas fired combustion engines
4. To determine the association between vibration exposure, breakdown attended by worker, time taken for maintenance of the engines and whole body vibration Health effects experience by workers in Ubungo 1 power plant

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Whole Body Vibration Health effects

Low back pain (LBP) is a symptom frequently experienced by people over their lifetime. Low Back Pain was one of the WBV health effects(7), it defined as pain without specific underlined cause localized between the lower angle of the scapulae and above the buttocks. LBP most time affect the performance of individual at work, depending on disability individual incurred, it may be higher in such away worker can get difficult in even performing some small duties such as daily activities including personal care, lifting, walking, sitting, standing, sleeping, social life, travelling or home making.

Also There is an increased prevalence of gastrointestinal symptoms in workers with whole-body vibration (WBV) exposure, research done by Ishitake et al, investigate the mechanism of gastric motility suppression by exposure to whole-body vibration and found at a certain level of acceleration, a short-term exposure to WBV could suppress the gastric myoelectric activity, the responses on which might mediate by neuron humoral effects as well as the mechanical effect of WBV(16).

Occupational fatigue, reduced performance and concentration are the direct consequences of working under these conditions (17).Headache and eye strain have been a problem to the workers working near vibratory surface(18).

Furthermore there other adverse health effects linked to whole body vibration are chest pain and abdominal pain. Another study done in Nigeria, showed workers were exposed to WBV experience many health problems such as fatigue, abdominal pain, low back pain (19).

2.2 Magnitude of vibration produced by combustion engines

Natural machines vibrate when it is on the best of operating condition this is because some small, minor defects. Therefore, each machine has a level of vibration that may be regarded as normal or inherent(20). However, when machinery vibration increases or becomes excessive because of the mechanical trouble such as unbalance, misalignment, worn gears or bearings, looseness and it end up to machine fails or breaks down(21). The consequences of vibration can be on the machine itself, environment and might also cause a health effects to workers around the area(22).

The magnitude of vibration can be expressed by its vibration amplitude and can be measured as Acceleration (23). Therefore Acceleration produced by engine were measured and compared to recommended vibration from manufacturer to check diversity which might rich an individual or environment and cause some problems.

2.3 Vibration levels in a workplace

According to the Health guidance zones specified by ISO 2631-1, 1997 the impact of the vibration on the health of a worker depends on weighted root mean square acceleration and exposure duration/day (6).

Workers in electrical power plant used to be exposed to vibration of different ranges, knowing that ILO No. 148, 1977 held the convention concerning the protection of workers against Occupational hazards in the working environment and focus on protection of workers from vibration (24). And according to the European Directive 2002/44/EC on mechanical vibration, daily vibration exposure is expressed in terms of 8-hour energy-equivalent frequency weighted acceleration magnitude (A(8) in m/s^2) or A_{RMS} (RMS average acceleration(m/s^2), calculated as A(8)=Aw(T/T8), where T is the total daily duration of vibration exposure (hours), and T8 is the reference duration of 8 hours. Then, daily exposure to vibration will be evaluated and compared with the occupational exposure limits defined by national regulation standard, with measurement procedures defined by occupational hygiene standards, and the European Parliament Directive 2002/44/EC.

The Crest Factor (CF) is the ratio of the maximum (peak) weighted acceleration value to the weighted RMS. It is given as: CF= a_wPeak/A_{RMS} where CF = crest factor; Maximum a_w = highest value of acceleration in each axis (m/s^2); and A_{RMS} = RMS average acceleration (m/s^2). Weighted root mean square CF should be less than 9 (25). It is an evaluation of human perception use RMS.

The R.M.S. magnitude is related to the vibration energy and thereby gives a measure of the vibration injury potential. According to ILO, The exposure magnitude of the work place should range with in 0.5 m/s^2 for WBV as EAV and 1.15m/s^2 as ELV for whole body vibration (24).

The vibration produced by normal operation machine during electricity production may be so high that can to cause a disturbance to the building and other environment surrounding (26). In power plants, electricity production involves many machines which produced high vibration; workers get exposed to WBV when performing different duties such as maintenance or repairing some machine parts. Depending on the time, frequency and distance a worker is exposed to vibration may lead to health effects.

Literature reported that, workers in electrical power plant are vulnerable to illness especial those who working nearby sources of vibration (15). Distance from the vibration sources affect most the health of individual. Study done in Nigeria for generator users show that people who were performing their duties up to three meters they were suffering with both acute and chronic heath symptoms.

The mean magnitude of RMS acceleration along z - axis was 1.63 m/s^2 (range: 0.57 - 3.34 m/s^2). The risk assessment of operators based on daily exposure of RMS acceleration shows that 93.3% of operators were venerable to likely health risk (27).

Furthermore, vibration exposure level contribute much on increase the illness among the workers, study done in India shows that Whole-body vibration at range of 0.06 to 0.4m/s^2 driver sitting in three wheeler feels fairly uncomfortable.

On another side vibration measured in road vehicles, in Barents show that at the mean daily exposure between 0.2 and 1.0 m/s^2, and time between 1.9 and 6.7 h could cause impact to the passengers(28).

2.4 Association between vibration exposure and WBV health effects experience by workers in electrical power plants

Most literature reported that, workers in electrical power plants are vulnerable to illness especial those who are working nearby sources of vibration. Distance from the vibration sources affect most the health of individual. Workers who were performing their duties up to four meter they were suffering with both acute and chronic heath symptoms(19)(15).

Long-term occupational exposure to WBV was associated with an increased health effects among workers, Researchers investigating the association between exposure to occupational whole-body vibration and MSDs among 9,798 Swedish workers significantly associated with MSDs in the neck and shoulder/arm in addition to other locations (14).

Human body responds different when exposed to vibration, each parts of the body are most likely to be injured during exposure to whole-body vibration. According to Shehap et al, the whole body vibration level of $0.46m/s^2$ were measure in individual exposes to vibration and workers were suffer with chest and stomach pain(13).

Whole body vibration could cause cochlear damage, some study have been conducted in male rabbit through vibration induced auditory function effects, they have exposed to $1m/s^2$, vertical Whole body vibration at 4-8hz per day for 5 consecutive day and found cochlea damage (29), explain the effect of whole body vibration exposure, hearing loss show a statistical significance, and it might be due to combine effect of vibration and noise.

Whole-body vibration and at range of 0.06 to $0.4m/s^2$ driver sitting in three wheeler feels fairly uncomfortable and road maintenance workers that workers who exposed to machine with 1.23 m/s^2 for 6 hrs develop a back pain(3).

Vibration measurements performed according to ISO 2631-1 showed that vibration magnitude varied from 0.25 to 0.67 m/s^2 in cranes, 0.36 to 0.56 m/s^2 in busses, 0.35 to 1.45 m/s^2 in tractors, and 0.79 to 1.04 m/s^2 in fork-lift trucks and freight container tractors and this studies suggested an increased risk for Low Back Pain among occupational groups exposed to WBV when compared to unexposed control groups including either sedentary workers such as administrative officers or manual workers(7).

Gastro intestine effects are often observed in persons exposed to whole-body vibration over a long period of time. This is associated with the resonance movement of the stomach at frequencies between 4 and 5Hz and cardiovascular system effects resulting from prolonged exposure to whole-body vibration at frequencies below 20Hz (16).

Fatigue in industrial view, is the condition of workers to feel tired; Muscle fatigue also occurs as the muscles try to react to the vibration energy to maintain balance, protect and support the spinal column. But these are often too slow as muscular and nervous system cannot react fast enough to the shocks and loads being applied to the body(30).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study design

A cross-sectional study design was conducted to 70 participants at Ubungo 1 power plant from July to August of 2019.

3.2 Study population

The study involved all workers in Ubungo 1 power plant; operation, maintenance workers and other workers include (managers, administrative officers, supply officers, store, security and cleaners. Operation workers and maintenance workers were mostly involved in maintenance and mechanical repair of the gas fired combustion engines.

3.3 Description of study areas

This study was conducted in Ubungo 1 power plant area, located in Dar es Salaam. The plant is located at Ubungo in Dar es Salaam. Coordinate $6^0$47'40"S$39^0$12'30.5"E. It is a Gas powered Plant (Gas-fired plant) and it has started its operation since 2008, using locally available Songosongo natural gas as a source of fuel. The plant is installed with twelve (12) generating units (gas fired combustion engines) each with capacity of 8.73 MW making an average of 104 MW produced in case all the engines are in good working. The plant is interconnected with the national grid through Ubungo National grid.

3.4 Sampling procedure

3.4.1 Sample size and selection

Convenience sampling was used; all workers who were available in Ubungo 1 Power plant were allowed to participate in the study. This was done due to small number of workers present in each section in the power plant. The study involved 44 workers from production section (13 operators and 31 maintenance workers) and 26 other office workers, making a total of 70 workers in the plant.

3.4.2 Inclusion criteria

All workers at least one year of working experience in Ubungo 1 power plant were included in the study. One year was the latency period for the effect to manifest.

3.4.3 Exclusion criteria

Workers undergone surgery was not included in the study and those working less than a year were also excluded.

3.5 Study variables

3.5.1 Dependent variable

Whole body Vibration health effects

3.5.2 Independent variables

Independent variables were distance from machines, time taken for fixing machine, vibration exposure at workplace and breakdown attended by workers.

3.6 Data collection methods

3.6.1 Questionnaire

A semi structured questionnaire Swahili version and English version were distributed to workers for the purpose of filling some individual information such as age, profession, working experiences, health status and exposure duration, number of breakdown attended in machines and working distance from machines.

The health effects included were; Low Back pain, Sleep disturbance, Loss of balance, Chest pains, Headache, Visual Dysfunction , abdominal pain, stomach rumbling, heartburn, high blood pressure and fatigue.

3.6.2 Checklist

The observational checklist were also used to examine the availability of the selected items, including usage of PPEs, working activities performed in the workplace, type of engine used and its description, Number of engine present in each work station will be recorded, Design of equipment technology, old or new.

3.7 Recruitment and training of research assistant

A research assistant was recruited under the criteria of understanding of vibration concept. This help during the measurement activities which were conducted in Ubungo 1 power plant. After recruitment, research assistant were trained for one day by emphasizing the importance of confidentiality and ethical procedures. Objective of the study, identification of respondents and data collection procedures were also be included in the training.

3.8 Pre Testing of the Data Collection Tool

Questionnaire in Swahili version were pre tested at Ubungo power plant to check if the tool was relevant and understood.

3.9 Validity and reliability

In order to increase validity and reliability of the study, emphasis was put on proper formulation of questions and pre testing of investigation tools. This made it possible for tools to suit the target population and also increase consistence of the results.

3.10 Measurement Instrument

Model vibration Meter (SD 8205) with piezoelectric accelerometer was used for measurement of vibration level with the following specification, Acceleration range 0.05 – 400m/s^2 and Sensitivity ±10%, 50 mV/g.

3.11 Measurement consideration

i. Gas fired combustion engines

Vibration magnitude was measured on surface of combustion engines. Accelerometer was placed on the alternator side, which have high vibrations.

ii. Workplace vibrations

Measurements were done at different points on top walk-through and on ground surface. Top-walk through was 2 meter high from ground floor, and Ground floor was the basement of combustion engines. The measurement was taken at 1 meter on top walk-through, 2 meter and 4 meter away fromgas combustion engines.

3.12 Measurement procedure

Whole Body Vibration measurements were done according to the measuring procedures outlined in International Standardization Organization, ISO 2631-1(1997), European Directive 2002(17).Accelerometer was connected to the vibration meter (SD 8205) and placed in the points prepared for recording vibration levels. The time required for fitting and removal of the accelerometer and the data acquisition system were 10 minutes as recommend by manufacturer in order to get a correct data.

Different vibration levels were measured at 1 meter on a top walkthrough and at 2 meters and 4 meters on the ground level. The result obtained from the vibration meter was downloaded and entered into Microsoft Excel to obtain the weighted root mean square m/s^2.

3.13 Data Analysis

The collected data were cleaned, coded, entered, and analyzed using Statistical Package for Social Sciences (SPSS) version 20. Continuous variables such as age, weight and height were described by mean and standards deviation (Mean $\pm$SD) and descriptive statistics were used to analyze the average and percentages (%).Chi-square test was used to prove the association between vibration levels and whole body vibration health effects among workers. The results were summarized in Tables; Statistical significance was defined as a 2-sided P value <0.05.

3.14 Ethical Consideration

Ethical clearance was sought from Muhimbili University of Health and Allied Sciences research and publication committee with reference number DA.287/298/01A.A letter was sent to Ubungo 1 power Plant requesting permission to conduct research study, the written permission was approved. The study methods and aims were explained to each individual and were free to participate or not. Those who meet the criteria for study and agreed to participate was given Swahili written consent and signed before data collection begun. Issues of rights, privacy and confidentiality were considered.

CHAPTER FOUR

4.0 RESULTS

This chapter presents and interprets study findings; a total of 70 workers from Ubungo 1 Electrical Power Plant participated in the study. The workers included Operators 13(18.5%), maintenance workers 31(44.2%) and other office workers 26 (31.1%). Maintenance workers and operators performed their duties within production area while others workers includes office workers, securities, cleaners, stores and supply officers performed their duties away from production area but within the plant.

4.1 Demographic information of the study Population

Demographic information of workers in Ubungo 1 power plant included age, gender, body mass index, education level, marital status, number of working hours per day and Working shift were presented in Table 4.1.

Results showed that majority of the respondents were males 81.43% while female were only 18.57%. Also majority 98.6% have age above 25years and 57(80%) have secondary education and above.

Assessment of respondents Body Mass Index (BMI) was done on the ratio of weight (kg) and height (m^2). Normal weight represented by body weight ranging between 18-24 kg/m^2 as well as overweight ranging from 25-31kg/ m^2. The findings of this study revealed that, 72.9% respondents had overweight.

Majority of the workers 51 (72.9%) at the plants worked for more than four years, and the plant management ensured staff 55 (78.6%) were working within a normal working hours.

Table 4.1 Demographic characteristics of workers in Ubungo 1 power plant. Data shows number and percentage of workers n (%)

Characteristics	Operators (n=13)	Maintenance workers (n=31)	Other workers (n=26)
Gender			
Male	12 (92.3)	31(100)	14(53.8)
Female	1 (7.7)	0	12(46.2)
Age group (years)			
18-24	0	1(3.2)	0
25-34	2 (15.45)	9(29)	9(34.6)
35-44	3(23.1)	9(29)	13(50)
45-60	8(61.5)	12(38)	4(15.4)
Age mean (SD)	44.23 (9.04)	40.10(11.74)	38.35 (8.09)
Weight(kg) Mean (SD)	77.42 (10.25)	77.80 (18.37)	73.08 (10.10)
Height(cm) Mean (SD)	167.08 (9.18)	170.30 (0.27)	166.24 (4.92)
BMI n (%)			
18-25 (kg/m^2)	2(15.4)	10(32.3)	7(26.90)
> 25 (kg/m^2)	11(84.6)	21(67.7)	19 (73.1)
Education level n (%)			
No education	0	0	1 (3.8)
Primary school	4 (30.8)	2 (6.7)	6 (23.1)
Secondary	3 (23.0)	6 (19.4)	4 (15.4)
Diploma	5 (38.5)	17 (54.8)	2 (7.7)
Higher education	1 (7.7)	6 (19.4)	13 (50.0)
Marital status n (%)			
Single	5 (38.5)	8 (25.8)	6 (23.1)
Married	8(61.5)	18 (58.1)	16 (61.0)

Cohabiting	0	5 (16.1)	3 (11.5)
Separated	0	0	1 (3.8)
Working years n (%)			
1-4years	3 (23.1)	7 (22.6)	12 (46.2)
> 4years	10 (76.9)	24 (77.4)	14 (53.8)
Number of working hours per day n (%)			
<8 hours	9 (69.2)	24 (77.4)	22(84.6)
≥8 hours	4(30.8)	7(22.6)	4(5.4)
Working in shift			
No	7 (58.3)	13 (43.3)	18 (72)
Yes	6 (41.7)	17 (56.7)	7 (28)

% Percentages, Abbreviations: SD, Standard Deviation, BMI, Body mass index

Using Chi square analysis, the result indicated that there was a gender difference among power plant workers with statistical significance at $p<0.05$ (Table 4.2)

Table 4.2 Social demographic characteristic of 70 workers in Ubungo 1 power plant

		Operators	**Maintenance workers**	**Other workers**	**Chi square**	**P value**
sex	Male	12 (17.1%)	31(44.3%)	14 (20.0%)	21.168	0.000
	female	1 (1.4%)	0	12 (17.1%)		

Chi-square test $p<0.05$

4.2 Whole body vibration health effects among workers in Ubungo 1 Power Plant

Result indicated abdominal rumbling were a leading problem 68.2% followed by abdominal pain 63.6% then low back pain was 52.3%, fatigue were 52.3%, and headache 43.2% among workers in Ubungo 1 Power Plant with statistical significant $p<0.05$ (Table 4.3)

Table 4.3 Whole Body Vibration Effects experienced by 70 workers in Ubungo 1 power Plant; Data represents number of workers and percentages, n (%)

WBV Effects	Maintenance workers and Operators n=44	Other workers n=26	Row Total N =70	P value
Low back pain	23(52.3%)	2(7.7%)	25 (35.7)	0.000*
Abdominal pain	28(63.6)	8(30.8)	36 (51.4)	0.008*
Abdominal rumbling	30(68.2)	7(26.9)	37 (52.6)	0.001*
Nausea	8(18.2)	5(20)	13(18.6)	0.913
Heartburn	11(25)	8(30.8)	19(27.1)	0.566
Sleep disturbance	8(18.2)	3(11.5)	11(15.7)	0.461
Chest pain	20(45.5)	7(26.9)	27(38.6)	0.124
fatigue	23(52.3)	7(26.9)	30(42.9)	0.038*
Loss of balance	19(43.2)	6(23.1)	25(35.7)	0.09
Visual Dysfunction	13(29.5)	7(26.9)	20(28.6)	0.8
Headache	19(43.2)	3(11.5)	21(31.4)	0.006*
Circulatory problems (High blood Pressure	11(25)	2(7.1)	13(18.6)	0.072

4.3 Gas fired combustion engines characteristics

Ubungo 1 power plant has twelve (12) modern computer controlled gas fired combustion engines that were manufactured in 2015. Each engine has a capacity of 8.73 MW and was designed to operate on natural gas at low pressure 5 bar (73PSI). The engines were installed in two parallel halls, each hall containing 6 combustion engines. During data collection only nine combustion engines were working. Maintenance workers and operators ensured the smooth running of the engines.

4.4 Magnitude of vibration produced by combustion engines in Ubungo 1 power plant

The measurement were done in nine gas fired engine machines, the results showed that the maximum vibrations were 26.37$\pm$0.5 m/s^2 and the minimum vibration were 20.9$\pm$ 0.24 m/s^2, as shown in Figure 4.1.

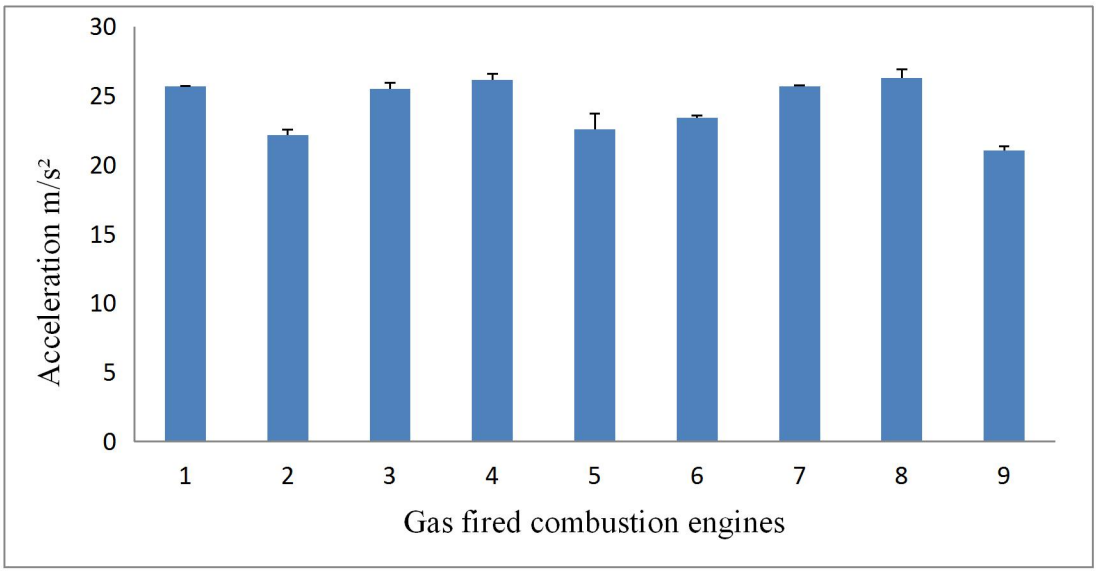


Figure 4.1 Vibration Magnitude for nine gas fired combustion engines in Ubungo 1 Power plant

4.5 Vibration levels measured at different points on the floor surface from gas fired combustion engines installed at Ubungo I power plant

4.5.1 Top walk-through vibration levels

Vibration levels were measured on top-walk through at 1 meter from vibration source (gas fired combustion engines), the results shows at one meter (1m) vibration levels exceeded the exposure limit value of 1.15m/s^2 as shown in Figure 4.2

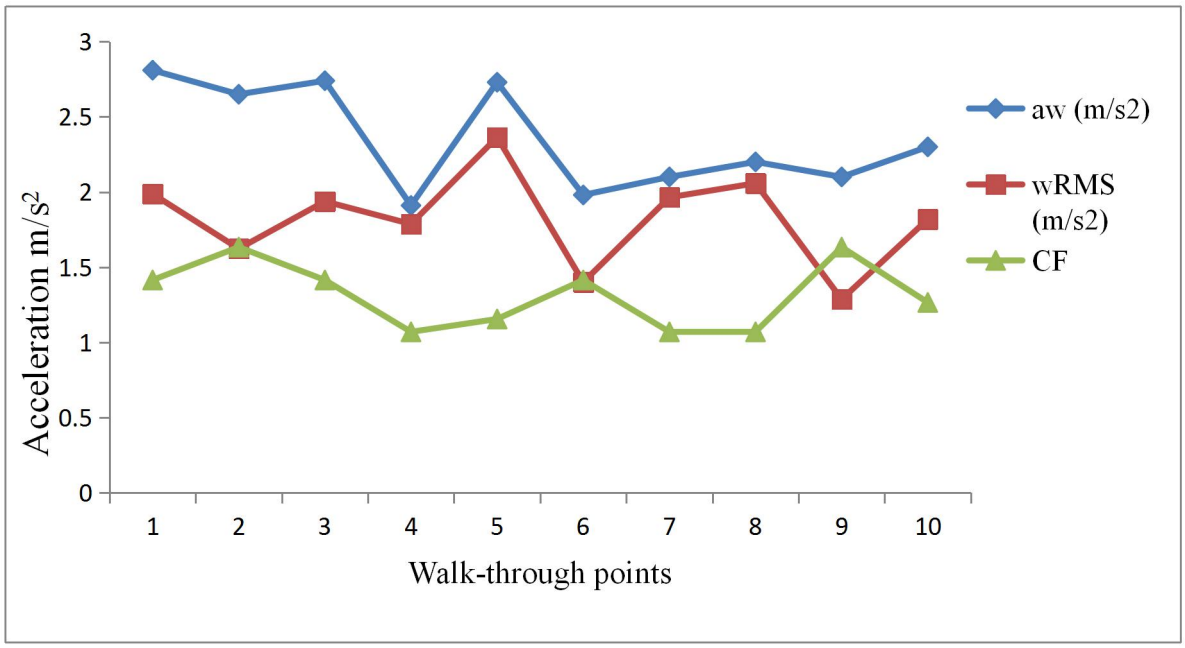


Figure 4.2 Vibration Exposure level on walk-through, 1 m from vibration sources

4.5.2 Ground floor vibration levels

Vibration levels were measured at 2 m from combustion engines, and result shows that the vibration levels were within the allowable limit, between the EAV and ELV (0.5m/s^2-1.15m/s^2) as shown in Figure 4.3.

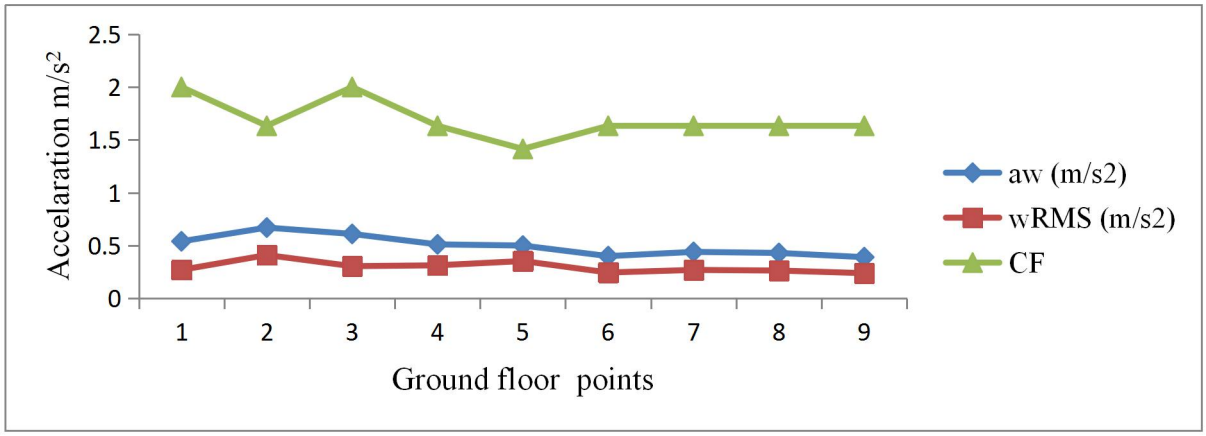


Figure 4.3 Vibration exposure level on ground floor, 2 m away from vibrations sources

Vibrations levels were measured at 4 meters away from combustion engines on the ground surface, and the result shows vibrations were at a lowest level below EAV 0.5m/s^{2}as presented in Figure 4.4

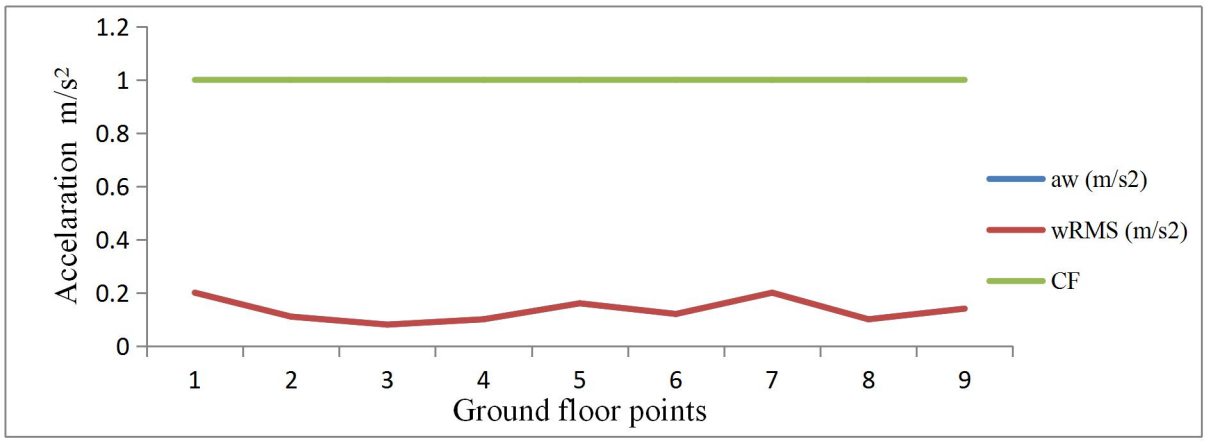


Figure 4.4 Vibration exposures on ground floor, 4m away from vibrations source

Summary of vibration levels measured at a distance 1 meter on top walk-through, 2 meters and 4 meters on the ground floor away from combustion engines.

Table 4.4 Vibration levels measured at different points away from combustion engines

Vibration levels (m/s^2)	Distance measured at different points					
	Top walk-through		Ground floor			
	1 meter		2 meters		4 meters	
	aw	wRMS	aw	wRMS	aw	wRMS
Minimum	1.91	1.29	0.39	0.24	0.08	0.08
Maximum	2.81	2.36	0.67	0.47	0.14	0.14

According to the European Directive 2002/44/EC on mechanical vibration (17), exposure values were normalized to an eight-hour reference period,(A8) in m/s^2 as shown in Table 4.5

Table 4.5 Show the recommended Exposure Action (EAV) and Limit Values (ELV) forWhole Body Vibration in m/s^2

Exposure values	WBV (m/s^2)
Daily exposure action value (EAV)	0.50
Daily exposure limit value(ELV)	1.15

4.6 Association between the level of exposure and WBV health effects among workers in Ubungo 1 power plant

4.6.1 Vibration exposure

Using Chi square test, the results showed that there is significant association between vibration exposure and WBV health effects experience by workers. Workers exposed to vibration level(>1.15 m/s^2) shows WBV health effects such as low back pain 52%, abdominal pain 80%, sleep disturbances 27%, loss of balance 52% and chest pain 56% with statistical significant, p value <0.05. (Table 4.6)

Table 4.6 Association between Vibration levels and WBV effects experience by workers in Ubungo 1 power plant; Data represents number of workers and percentages, n (%)

WBV health Effects	Vibration levels		
	≤1.15m/s^2 n=45	>1.15m/s^2 n=25	*p*-value
Low back pain	12(26.5)	13(52)	0.034*
Abdominal rumbling	21(46.1)	16(64)	0.16
Heartburn	12(24.4)	8(36.8)	0.135
Nausea	7(15.6)	6(24)	0.385
Abdominal pain	16(35.6)	20(80)	0.00*
Fatigue	19(42.2)	11(44.3)	0.87
Sleep disturbance	4(8.9)	7(27.3)	0.035*
High blood pressure	8(18.5)	5(38.5)	0.187
Eye strain	12(26.7)	8(32)	0.63
Headache	11(24.4)	11(44)	0.09
Loss of balance	12(26.7)	13(52)	0.032*
Chest pain	13 (28.9)	14(56)	0.025*

4.6.2 Breakdown attended in combustion engines

Results showed that workers who frequently attended breakdown when occurred in power plant have reported experience WBV health effects such as low back pain, abdominal pain, abdominal rumbling, fatigue loss of balance and chest pain with p value <0.05 as shown in Table 4.7.

Table 4.7 Association between workers attending breakdown in power plant and WBV health effects experience by workers in Ubungo 1 power plant, Data represents number of workers and percentages, n (%)

WBV health effects	Workers		
	Not attended breakdown n=26	Attending at least one breakdown n=44	*P*-value
Low back pain	2(8)	20(44)	0.002*
Heartburn	7(28)	12(26.7)	0.9
Abdominal pain	7(28)	29(64)	0.003*
Abdominal rumbling	6(24)	31(68.9)	0.00*
Fatigue	6(24)	24(53.3)	0.017*
Sleep disturbance	2(8)	9(20.3)	0.18
High blood pressure	2(8)	11(24.4)	0.119
Headache	3(12)	19(42.2)	0.009*
Loss of balance	5 (20)	20(44.4)	0.04*
Chest pain	6 (24)	21(46.7)	0.062

Chi-square test,* p<0.05

4.6.3 Time taken for fixing machines (maintenance time)

From Chi square analysis, Results showed that there was association between time taken for fixing machines (Workers consuming at least 1 hour in repairing machines per day in a production area) and reported WBV health effect in Ubungo 1 power plant such as Low back pain, abdominal pain, abdominal rumbling, Fatigue, headache, and loss of balance with *p* value<0.05. (Table 4.8)

Table 4.8 Association between time taken for fixing machines and WBV effects experience by workers Ubungo 1 power plant, Data represents number of workers and percentages, n (%)

WBV health effects	Time taken for fixing machines		
	None	1 hour and above	
	n=25	n=45	*P*-value
Low back pain	2 (8.1)	23 (51.1)	0.00*
Abdominal rumbling	6 (24)	30(68.8)	0.00*
Heartburn	7 (28)	12(26.7)	0.9
Abdominal pain	7 (28)	29(64.4)	0.003*
Fatigue	6(24)	24(53)	0.017*
Nausea	4(16)	9(20)	0.68
Sleep disturbance	2 (8)	9(20)	0.186
High blood pressure	2 (8)	11 (24.6)	0.09
Eye strain	7(28)	13(28.9)	0.93
Headache	3 (13.6)	19 (42.4)	0.009*
Loss of balance	5 (20)	20(44)	0.041*
Chest pain	6 (24.2)	21 (46.8)	0.06

Chi-square test,* p<0.05

CHAPTER FIVE

5.0 DISCUSSION

The study asses vibration levels and reported WBV health effects among workers in Ubungo 1 power plant, Tanzania. The findings have been discussed in subheading mentioned.

5.1 Demographic information

Findings from this study indicates that men were more than women 57 (81%) compared to men in the power plant. This is similar to the study done in Chile, and women working in manufacturing industry no matter of the size were dominated by males (28).

Also findings shows the mean ages were 44.23 $\pm$9.038, 40.10 $\pm$ 11.746, 38.35 $\pm$8.099 among operators, maintenance workers and other office workers respectively in Ubungo 1 power plant. Compared to study done in Kosovo power plant, the mean age were 47.98 ± 8.97 and 49.44 ± 8.03 years (10). Smith et al, 2014 explain the association of age and increase in claim-risk among the oldest group (45 and older) and was statistical significant, so prevention effort should be taken so as to reduce impact to workers (31).

5.2 WBV health effect experience by workers in Ubungo 1 power plant

5.3 Magnitude of vibration produced by combustion engines in Ubungo I power plant

The magnitude of vibration produced by gas-fired combustion engine were of different range with a maximum of 26.37 $m/s^2 \pm$ 0.5 and the lowest of 20.98 $m/s^2 \pm$0.23, according to Wartsila standard/acceptable vibration levels (producer of these gases fired combustion engines), the maximum allowed vibration level for Wartsila engine which complied with ISO 10816-6 was 27 m/s^2 (from Wartsila Machine manual).

The difference between the maximum vibrations required and measured from combustion engine in Ubungo 1 power plant was 0.63m/s^2. This means there is small difference to reach the maximum permissible limit. Operating machine at high vibration might lead to imbalance of machines due to it weariness of some parts or misalignment which can lead to breakage of machine parts(2). Current situation in Ubungo 1 power, one of the concrete bases for placing engine machine has been broken and it is associated with high vibration produced by engines.

5.4 Workplace Vibration levels

It was observed that vibration level were high at a distance of 1 meter on the top walk-through from the vibration source, the Weighted root mean square value of the vibration were 2.36 m/s^2 for eight hour, which were above the vibration exposure limit value of 1.15m/s^2 (figure 4.2), this is similar to the study done in Nigeria showed that people who working near generators at 1m were exposed to high vibration level of 6.14 m/s^2 (19). This vibration levels were above the recommended levels which put workers vulnerable to high health risks.

At 2m away from the gas-fired engines (figure 4.3), the observed wRMS values was 0.62m/s^2 maximum and 0.4m/s^2 minimum . This was below the vibration exposure limit 1.15m/s^2 as shown in Table 5. wRMS acceleration were found to be within the recommended values, this implies that most of the workers working in this area, should take a precautions, in terms of using properly protection devices such as safety shoes so as to reduce the effects.

At 4m away from vibration sources (figure 4.4), the maximum vibration level were 0.2m/s^2. According to EU directory (Table 4.5), $_W$RMS value was below recommended Exposure Action Value of 0.5m/s^2, this was similar to the study done in Nigeria which show that vibration was reduced with distance (19)(15).

It was observed that vibration on top walk-through arises from machines component connected with Engines, so vibration can easily transferred to the beams of walk-through and causes impacts. Vibration reaches ground floor have been minimized by fixing Dampers (stiffness), as a result vibration could not travel much to the ground floor. Also between machines they have a highly rigid support structure which could tolerate a greater amount of ambient vibration.

5.5 Association between vibration levels, time taken for fixing machines, breakdown attended by workers and whole body vibration health effects experience by workers

The findings shows workers exposed to vibrations levels above the recommended ELV of 1.15m/s^2, have reported WBV health effects, such as low back pain 13(52%), abdominal pain 20(80%), sleep disturbances 7(27%), loss of balance 13(52%) and chest pain 14(56%) with statistical significant of p value <0.05. These percentages were higher compared to the study done in Nigeria among the generator users workers suffer with abdominal pain were 22(11%), low back pain back pain 88(44%) (19)(15). This might be contributed by their nature of the work performed in the power plant and exposure time.

Time taken for fixing machine parts/repairing engines contributed much on exposure to vibrations. Study findings shows that workers exposed to longer time on vibratory surface when doing maintenance report WBV health effect such as 20(44.4%) low back pain, abdominal rumbling 30(68.8%), abdominal pain 29 (64.4%), headache 19(42.4%) and loss of balance 20(44%). Compared to the study done in Iran among heavy vehicle drivers, the WBV health effects of long-term exposure to vibration were headache 36(23.2), low back pain 83(53.6%), abdominal pain 25(16.1%) (4).

Also Another study done in Barents among mining drivers, the results showed that workers exposed to mean daily exposure time between 1.9 and 6.7 hour experienced WBV health effects (28). In Ubungo1 power plant maintenance of machines takes more than hour to be done, this activities increase the chances of individual exposed to Whole Body Vibration and lead to health problems.

5.6 Strengths and limitations

This is the first study conducted to assess workplace vibration levels and WBV health effects among workers at power plant in Tanzania. Despite of the strength, the study has some limitations; Logistic regression was not employed in determining risk factors associated with Whole Body Vibration health effect; this is due to limited sample size.

Another limitation was study design; A cross Sectional study design was employed, which has time limit; data collection took only one week which does not reflect the whole year vibration records.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Majority of workers in Ubungo 1 Power Plant have reported experience WBV health effects, and most of them are found to perform their duties in production section (Maintenance workers and operators). The vibrations produced by Gas Fired Combustion Engines were within the recommended vibration levels below 27m/s^2, but also high vibration levels (above exposure limit value) were measured on top walk-through. Thus the study shows that Regular exposure to high vibration levels (above 1.15m/s^2) increase the health risk among workers.

6.2 Recommendations

1. Occupational and safety department should take appropriate preventive measures which will reduce vibration exposure level to workers, include having a workshop building away from production area where some of the activities can be performed.
2. The Occupational Health and Safety department should also conduct periodic monitoring of vibration in the workplace and communicate with workers through different safety signs in the workplace.
3. Monitoring of Engines vibrations should be continuous so that to maintain its consistence, this will help to improve the performance of the machines and reduce the breakdown of machines.
4. More studies should be conducted among workers, in exploring more the effects of whole body vibration induced by being exposed to vibration in power plant.

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APPENDICES

Appendix 1: Informed Consent Form: English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF PUBLIC HEALTH AND SOCIAL SCIENCES

Informed Consent ID NO: ……

Introduction

Consent to participate in a study

Greetings! I _____, on behalf of Ms. Evamary Ludovick, a student at Muhimbili University of Health and Allied Sciences, request for your participation in a research study that she is required to submit in partial fulfillment of the requirements of Masters of Science in Environmental and Occupational Health. The study is supervised by a staff member of the Environmental and Occupational Health Department-Muhimbili University of Health and Allied Sciences and is titled: **Vibration level and reported health effects among workers in Ubungo I power plant.**

Purpose of the study

The purpose of the study is to collect information on vibration exposure levels and determine the related health effects experienced by workers in Ubungo I power plant.

What are you being asked?

If you agree to participate in this study the following will occur:

You will be given a research questionnaire and required to fill it by answering the question asked.

Confidentiality

The names of the participants will remain anonymous during the presentations of findings.

Benefits

If you agree to participate, I shall be grateful as this study is meant to provide data which is currently not available and can be gathered from the information that you will provide as you respond to questions provided in the questionnaire.

Findings from this study will provide valuable information that will help to recommend for appropriate dust control and preventive measures in Electrical power Plants as well to enrich the available OHS regulations and therefore useful to policy and decision makers in revising occupational health and safety legislation and guidelines in protecting worker's health and the public.

There will be no compensation as the study has no risks. The study also has no monetary personal benefits and there will be no costs incurred in your participation.

Potential risks

We do not expect any harm to happen to you during your participation in this study.

Participation and Rights to withdraw

Participation is entirely voluntary and can be terminated at any time even if you have already given your consent. Refusal to participate or withdraw from the study will not involve penalty or loss of any benefits to which you are otherwise entitled.

Whom to Contact

In case of any question or query concerning this study, please contact the principal investigator, Evamary Ludovick (Msc. EOH) from MUHAS, P. O. BOX 65001, Dar es Salaam, mobile number 0754-891-434. If you have any question about your rights as a participant you may contact Dr Stephen Kishinhi, Supervisor of this study, MUHAS. P.O. Box 65001, Dar es Salaam-Tanzania

I ……... have read the contents of this form and understand and my questions have been adequately answered. I agree to participate in this study.

Signature of participant…… Date…….

Signature of researcher …… Date……..

Appendix 2: Informed Consent Form (Kiswahili)

CHUO KIKUU CHA AFYA NA SAYANSI SHIRIKISHI MUHIMBILI

IDARA YA MAZINGIRA NA AFYA KAZINI

FOMU YA RIDHAA

Namba ya utambulisho……

Ridhaa ya kushiriki kwenye utafiti

Utambulisho

Habari,jina langu ni _____ kwa niaba ya Evamary Ludovick, mwanafunzi wa Chuo Kikuu cha Afya na Sayansi Shirikishi Muhimbili, nakukaribisha ushiriki kwenye utafiti huu ambao ni kwaajili ya kukamilisha shahada ya uzamili ya Mazingira na Afya Kazini. Utafiti huu unasimamiwa na mmoja wa wakufunzi wa chuo cha Muhimbili katika kitengo cha Mazingira na Afya kazini.

Madhumuni ya Utafiti

Lengo la utafiti ni kukusanya taarifa juu ya kiwango cha mtetemo sehemu ya kufanyia kazi na madhara ya kiafya wanayopata wafanyakazi katika kiwanda cha kuzalishia Umeme. Tutachunguza magonjwa yanayo sumbua wafanyakazi na visababishi vinavyopelekea madhara kutokea.

Ushiriki

Endapo utakubali kushiriki katika utafiti huu utatakiwa:

Kujibu maswali yote yanayohusu ufahamu wako juu maswala yanayohusiana na kazi unayofanya na mazingira ya kazi yako na kutambua sababu mbalimbali zinazoweza kupelekea wafanyakazi kuanza kupata matatizo kiafya kama ya kuumwa kichwa/na macho, maumivu ya tumbo, ugonjwa wa moyo na maumivu ya nyonga.

Usiri

Taarifa zitakazokusanywa na dodoso hili zitakuwa za siri na zitaingizwa kwenye ngamizi kwa kutumia namba za utambulisho

Faida

Kama utakubali kushiriki kwenye utafiti huu ni faraja kwa vile utafiti huu una lengo la kuchangia kupata takwimu ambazo zitasaidia katika kuboresha miongozo ya usalama na afya kwa wafanyakazi wa viwandani. Pia matokeo ya utafiti yatasaidia kuleta mbinu bora za kudhibiti mitetemo sehemu ya kazi ili kuzuia madhara yatokanayo na mitetemo hiyo

Hakutakuwa na fidia yoyote katika kushiriki kwako kwa kuwa utafiti huu hauna madhara yoyote. Pia utafiti huu hauda faida binafsi za kifedha na hakuna gharama za kifedha ambazo mshiriki atatakiwa kulipia kwa ajili ya ushiriki wake.

Madhara

Hatutarajii upatwe na madhara yoyote kutokana na ushiriki wako katika utafiti huu.

Haki ya kujitoa au vinginevyo.

Ushiriki katika utafiti huu ni wa hiari. Kutoshiriki au kujitoa kwenye utafiti huu hakutakuwa na adhabu yoyote na hutopoteza stahili zako endapo utaona ni vyema kufanya hivyo.

Mawasiliano

Kama utahitaji ufafanuzi zaidi juu ya utafiti huu, usisite kuwasiliana na Mtafiti Mkuu Evamary Ludovick, mwanafunzi wa shahada ya Uzamili ya Mazingira na Afya Kazini katika chuo kikuu cha Afya na Sayansi Shirkishi, Muhimbili S. L. P 65001, Dar es Salaam au namba ya kiganjani 0754 891434. Kama una swali juu ya stahili zako unaweza kuwasiliana na Dr Stephen Kishinhi ambaye ni msimamizi wa utafiti huu, S. L. P 65001, chuo kikuu cha Afya na Sayansi Shirkishi, Muhimbili S. L. P 65001, Dar es Salaam.Tanzania

Mimi ……... nimesoma / nimesikia na kuelewa vizuri madhumuni na utaratibu wa kushiriki katika utafiti huu. Ninakubali kushiriki karika utafiti

Sahihi ya Mshiriki …….. Tarehe …….

Sahihi ya mtafiti …… Tarehe……

Appendix 3: Questionnaire- English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF PUBLIC HEALTH AND SOCIAL SCIENCES

DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH

P.O.BOX 65015, DAR ES SALAAM, TANZANIA

Date of interview…… Questionnaires number ……

Station…….. Position…….

Please, put check (√) in front of the correct question number which to indicate number and write a correct number example age put in a years.

SECTION 1: DEMOGRAPHIC CHARACTERISTICS

S/N	**Question**	**Coding classification**
1	Age (years)	……
2	Weight	……
3	Height	……
4	Sex	1 = Male
		2 = female
5	Marital status	1 = Single
		2 = Married
		3 = Cohabiting
		4 = Separated
		5 = Widow
6	Level of education	1 = No education
		2 = Primary school

		3 = Secondary school
		4 = Diploma
		5= Higher education (degree)
7	How long in this job?	…….years.
8	How many working hours per day?	……. hours.
9	How many working hours' per a week?	……..hours.
10	Are you working in Shift?	1=No 2=Yes
11	Have you work in vibration workplace before?	
12	**If yes** Mention the place	……..
13	For how long have you been on that job?	

SECTION II: WHOLE BODY VIBRATION HEALTH EFFECTSAMONG WORKERS

Low back pain

Please tick the correct answer (√) of the statement provided

14 Have you had a low back pain/ache during the past 12 months?

a. No

b. Yes

15 If no, have you had a low back pain or ache previously, before the last 12 months?

a. No pain

b. Yes, a severe pain

16 How often have you had low back pain with in a past 12 month?

17 During the past 12 months has your low back pain or ache interfered with your normal work?

a. No

b. Yes

18 Have you been absent from work because of low back pain during the past 12 months?

a. No

b. Yes

19 When your back pain or ache was at its worst during the past 12 months did you have difficulty carrying out any of the following activities?

	Activities	No	Yes
i	Walking	◌	◌
ii	Sitting	◌	◌
iii	Standing	◌	◌
iv	Lying	◌	◌
v	Dressing yourself	◌	◌
vi	Climbing stairs	◌	◌

Digestive disorders

20	Did you experience during the last 4 weeks	No	Yes
i	Abdominal Pain	◌	◌
ii	Heartburn	◌	◌
iii	Abdominal rumbling	◌	◌
iv	Bloating	◌	◌
v	Nausea	◌	◌

21 When was the last time you had your blood pressure checked?

Mention……

22 Have you EVER been told by a doctor, nurse, or other health professional that you have high blood pressure?

a. No

b. Yes

23 If yes, and if you are female, was this only when you were pregnant?

a. No

b. Yes

Chest pain

24 Do you have a chest pain or discomfort?

a. No

b. Yes

Fatigue

25 Do you have a problem of being overtired (feeling lack of energy)?

a. No

b. Yes

Sleeping time

26 How many hour of sleep do you get each night?.....

		No	Yes
27	Do you have a problem falling in sleep?	◌	◌
28	Do you have a frequently reoccurring headache?	◌	◌
29	Do you think sudden trouble seeing in one or both eyes?	◌	◌
30	Have you ever given specific headache/eyes diagnosis?	◌	◌
31	Have you had any history of head trauma (such as concussion, head injury)?	◌	◌
32	How long ago did your headache(s) become a problem?	◌	◌
33	When in the day do your headaches usually occur?	◌	◌

Loss of balance

34 Have you ever loss of balance when working?

a. No

b. Yes

If answer is Yes,

35 At what condition, does the problem appear?

Explain……..

SECTION III: WORK ACTIVITIES

36 How many breakdowns do you attend per day?

Mention……

37 How long will it take to fix machine/equipment problems when it has been occurred?

Mention…….

38 Depend on the type activities performed where do you position yourself towards electric production machines?

a. Nearby machine engines (with in 1 meter)

b. Few distance away from machines (2 meters – 3 meters)

c. Outside the building (more than 4meters)

THANK YOU

KIAMBATISHO

Dodoso 4– Swahili Version

CHUO KIKUU CHA AFYA NA SAYANSI SHIRIKISHI CHA MUHIMBILI

SHULE YA AFYA YA JAMII

IDARA YA AFYA MAZINGIRA NA MAHALA PA KAZI

S.L.P. 65015, DAR ES SALAAM, TANZANIA

Tarehe ya usaili …… Nambari ya dodoso ……

Kitengo……. Cheo……

Weka alama ya vema**(√)** mbele ya jibu sahihi, na andika numbari/jibu kwenye nafasi

KIPENGELE I: TAARIFA BINAFSI

1	Umri wako	…….miaka
2	Jinsia	Mume Mke
3	Uzito	Kilogramu……
4	Urefu	Sentimita ……..
5	Hali ya ndoa	1 = Sijaoa/ olewa
		2 = Nimeoa/olewa
		3 = Naishi na mwenza bila ndoa
		4= Tumetengana/achana
		5 = Mjane
6	Kiwango cha elimu ulionayo	1 = Sijasoma
		2 = Elimu ya msingi
		3 = Elimu ya sekondari
		4= Diploma
		5= Elimu ya juu
7	Una muda gani tangu uanze kufanya kazi hii? Taja miaka	Miaka ……..

8	Unafanya kazi saa mangapi kwa siku? Taja Saa	Saa…….....
9	Unafanya kazi hii siku ngapi kwa wiki? Taja idadi ya siku	Siku ……
10	Unafanya kazi kwa shifti?	Hapana b. Ndio
11	Kabla ya kuajiriwa hapa ulishawahi kufanya kazi eneo lenye mitetemo	a. Hapana b. Ndio
12	**Kama jibu ni ndio,** Taja kazi hiyo	----------
13	Ulifanya kwa miaka mingapi?	Miaka----------

KIPENGELE II: ATHARI ZA KIAFYA KWA MFANYAKAZI

Maswali yafuatayo yanaangalia athari mbalimbali za kiafya kwa mfanyakazi alizokabiliana nazo mwaka mmoja uliopita kutoka sasa.

Tafadhali weka alama ya **vema (√)** kwenye jibu unalofikiri ni sahihi kwa kila swali.

Maumivu ya chini ya mgongo

14. Ulishawahi kusumbuliwa na maumivu chini ya mgongo ndani ya kipindi cha miezi 12 iliyopita kutoka sasa?
    a. Hapana, sijawahi
    b. Ndio, nimeshawahi

15. Kama Hapana, Ulishawahi kupata maumivu ya chini ya mgongo, miaka mingine ya nyuma?

a. Hapana

b. Ndio

16 . Ni mara ngapi umekuwa ukisumbuliwa na maumivu ya chini ya kiuno ndani ya mwaka mmoja uliopia kutoka saa?

Taja idadi ----------

17. Miezi kumi na mbili (12) iliyopita kutoka sasa, Maumivu uliyokuwa unayapata chini ya mgongo yaliweza kuingilia/kuharibu ufanyaji wako wa kazi wa kawaida?

a. Hapana
b. Ndiyo

18. Ulishawahi kuacha kwenda kazini kwa sababu ya maumivu chini ya mgongo ndani ya mwaka mmoja uliopita?

a. Hapana
b. Ndiyo

19. Wakati ukiwa unaumwa au kusumbuliwa sana na maumivu chini ya mgongo unapata ugumu wowote kutimiza baadhi ya majukumu ya kazi zako za kila siku?

	Jukumu	Hapana	Ndiyo
i	Kutembea	◌	◌
ii	Kukaa	◌	◌
iii	Kusimama	◌	◌
iv	kulala	◌	◌
v	Kuvaa	◌	◌
vi	Kupanda ngazi	◌	◌

Magonjwa ya tumbo

20 Kusumbuliwa/kupata dalili zifuatazo miezi mitatu (3) iliyopita.		Hapana	Ndiyo
i	Maumivu ya tumbo	◌	◌
ii	Kiungulia	◌	◌
iii	Tumbo kunguruma	◌	◌
iv	Tumbo kujaa gesi	◌	◌
v	Kichefuchefu	◌	◌

Magonjwa ya moyo

21. Mara ya mwisho kupima shinikizo la damu (BP) ni lini?

    Taja ----------

22. Ulishawahi kuambiwa na mtaalamu wa Afya kwamba unatatizo lolote la Shinikizo la damu?
    a. Hapana
    b. Ndiyo

Kama Ndiyo, na ni Mwanamke, jibu swali linalofuata.

23. Je hii ni wakati ukiwa mjamzito?

a. Hapana

b. Ndiyo

Maumivu ya kifua

24 Je unatatizo la kifua kuuma na kutojisikia vizuri (discomfort)?

a. Hapana

b. Ndio

25. Je unasumbuliwa na uchovu wa kupitiliza, mpaka unahisi kuishiwa nguvu?

a. Hapana

b. ndio

Maumivu ya kichwa na macho

26 Unalala masaa mangapi kwa siku?

Taja muda unaolala ----------

		Hapana	**Ndiyo**
27	Je unachelewa kupata usingizi unapohitaji kulala?		
28	Je unasumbuliwa na maumivu ya kichwa kuuma?		
29	Je unasumbuliwa na maumivu ya macho kuuma?		
30	Je umeshawahi kufanya uchunguzi kubaini tatizo la kichwa/macho kuuma? Kama ni ndio, Taja kisababishi tafadhali----------		

31	Umeshawahi kupata jeraha lolote kwenye kichwa? (kama vile mtikisiko wa nguvu, kujigonga)?		
32	Ni kwa muda gani tatizo la maumivu ya kichwa limeendelea kukusumbua? Taja muda----------		

33 Ni wakati gani maumivu ya kichwa yanatokea mara nyingi? Taja Muda

Kizunguzungu

34 Je umeshawahi kupata kizunguzungu unapokuwa eneo la kazi?

a. Hapana
b. Ndiyo

Kama jibu ni Ndio

35 Ukiwa kwenye mazingira gani hali hiyo ya kizunguzungu inatokea?

Elezea ----------

SEHEMU YA III: UTENDAJI KAZI

36 Je kwa siku unaweza ukafanya matengenezo/marekibisho mara ngapi kwenye mashine?

Taja idadi ----------

37 Unachukua muda gani kurekebisha/ kutatua tatizo pale mashine/sehemu ya mashine inapokuwa imeharibika?

Taja (dakika au saa)

38. Kutegemeana na hiyo kazi unayoifanya, una kaa umbali gani kutoka kwenye mashine za kuzalishia umeme? Taja----------

a. Karibu kabisa na machine husika (ndani ya mita 1)

b. Mbali kidogo na machine (mita 2 – mita 3)

c Nje ya jengo (zaidi ya mita 4 kutoka kwenye machine)

ASANTE SANA

Appendix 5: Workplace assessment checklist (English)

SN	ITEM	YES	NO	COMMENT
1	**Availability of personal protective equipments (PPEs)**			
	Foot wear (safety shoes)			
	Clothing/apron/overall			
	Helmet			
	Ear muff			
	Are the following equipments used by workers?			
2.	**Utilization of personal protective equipments (PPEs)**			
	Proper safety shoes			
	Clothing/apron/overall			
	Helmet			
	Ear Muff			
	Are the following facilities available at work area			
3.	**Work environment**			
a.	Type of machine, New/Current/ Outdated			
b.	How much production per day?			
c.	Are machines serviced?			

d.	When are machines serviced?			
e.	How frequently do service of machines done?			
f.	How long it take in doing service (repairing/maintenance)?			
g.	How many shift per day?			
h.	Working duration per day in hours			
i.	How many workers in the factory?			
4	**Other questions**			
a.	Work area (Inside or outside)			
b.	Number of Engines produce vibration in the industry			
c.	Is there any other activities performed in a place?			
e.	How about a posture?			

Kiambatisho 6: Tathmini ya mahali pa kazi (vitu vya kuangalia)

7.0 (Kiswahili Version)

SN	KIPENGELE	NDIO	HAPANA	MAONI
	MATUMIZI NA UPATIKANAJI WA VIFAA VYA KINGA BINAFSI			
1.	Je vifaa vifuatavyo vinapatikana katika eneo la kazi kiwandani?			
	Viatu vya buti			
	Overali			
	Kofia ngumu ya kichwa			
	Kiziba Masikio			
2.	Je wafanyakazi wanatumia vifaa vifuatavyo wanapokuwa kazini?			
	Miwani ya macho/uso			
	Viatu vya buti			
	Overali			
	Kofia ngumu ya kichwa			
	Kiziba masikio			
	Je vifaa vifuatavyo vinapatikana katika eneo la kazi kiwandani?			
3.	**MAZINGIRA YA KAZI**			
a.	Aina za mashine:Mpya/ Chakavu			
b.	Uzalishaji kiasi gani kwa siku?			
c.	Je mashine zinakaguliwa/zinafanyiwa ukarabati?			

e.	Ni mara ngapi mashine hukaguliwa/kukarabatiwa?			
f.	Inachikua muda gani kumaliza ukarabati kwa machine?			
g.	Je kuna shifti ngapi za kazi kwa siku?			
h.	Je shifti moja ina masaa mangapi?			
i.	Je kuna wafanyakazi wangapi ?			
4	**MASWALI MENGINEYO**			
a.	Kazi zinafanyika nje au ndani?			
b.	Kuna mashine ngapi katika kiwanda zinazo			
c.	Angalia jinsi wanavyofanya kazi (posture)			