Asian Journal of Research in Infectious Diseases

Volume 15, Issue 4, Page 24-34, 2024; Article no.AJRID.113305
ISSN: 2582-3221

Safety and Health Risk Management in Selected Kenya Tea Development Agency Factories in Bomet County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRID/2024/v15i4340

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/113305

Original Research Article

Received: 18/12/2023
Accepted: 22/02/2024
Published: 19/04/2024

ABSTRACT

Factory workers are faced with myriad of occupational safety and health risks as they carry on their day to day duties in their workstations. These safety and health risks are as a result of exposure to occupational hazards such as noise, organic dust, non-safeguarded or poorly safeguarded machines, poor ergonomics, poor floor conditions and falls, hot surfaces, among others. The objective of this research was to establish the safety and health risk management in Kenya Tea Development Agency Factories in Bomet County. The study used cross sectional analytical research design that allowed data collection at one point in time and involved photography, interviews, observation and measurements (air quality and noise) for data collection. The independent variables were classified under individual and system characteristics. Individual

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characteristics were the demographic variables while system characteristics were the hardware that make up a tea factory. The intervening variables were the system that make up safety and health management system and administration in the factory. The study was undertaken in Bomet County which has eight KTDA tea processing factories. The target population was employees in Tea Factories managed by KTDA. The study population was 1019 workers in tea factories in Bomet County with a sample size of 317 employees. Simple random sampling gave every worker a chance to be included in the study. The Yamane (1968) sample size determination formula was used in the study since the target population was less than 10,000 people. Authorization was obtained from Kenyatta University Graduate School and ethical clearance sought from Kenyatta University Ethical Review Committee while the research license was obtained from NACOSTI. Access to the KTDA Factories was granted by management through the managing director at the head office. Informed consent was sought from workers before participating in the study. Focus Group Discussion guide, interviewer administered questionnaires, noise meter and particulate counter was used for data collection. Data was summarized using descriptive statistics such as mean, frequencies and percentages. The inferential statistics; chi square and binary logistic regression model was used to test association between variables. Qualitative data was grouped according to emerging themes. Data was presented using charts and tables. The prevalence of occupational hazards in tea factories was 41.3%. The study statistically established that machinery without safeguards was the most prevalent occupational hazard at 40.5%. In the sampled factories and specific sections, Kapkoros Tea Factory and Withering sections recorded higher mean equivalent noise levels (91.4 dBA and 97.3dBA) above exposure limits (90.0dBA) stipulated under The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 while both PM2.5 and PM10 levels in sampled factories were below OEL and generally high at the sorting section (0.34mg/m3 and 1.035 mg/m3) but within the exposure limits specified under The Factories and Other Places of Work (Hazardous Substances) Rules, 2007. The study established that provision of PPEs, workplace occupational audits, risks assessments, occupational trainings and occupational examination of workers were the mitigation strategies employed by the factories in safety and health risks management. Level of education (p=0.0001) and work experience (p=0.0001) were statistically significant socio-demographic characteristics and predicted safety and health risks management. The study recommends the employer to institute tests on the efficiency and adequacy of all safety risk mitigation strategies. The study findings can be used for policy formulation and institutionalize changes when managing OSH risks in Kenyan tea industry.

Keywords: Organic dust; poor ergonomics; disease; health risk.

1. INTRODUCTION

Physical, chemical, biological agents and unfavorable working environments predispose workers to a chain of occupational hazards and deleterious safety and health risks. Low- and middle-income countries (LMICs) and industrialized high-income countries are faced with serious safety and health risks and work-related injuries and diseases. There has been a drastic drop in chemically related disorders and occupational related injuries but however a rise in the cases of psychological hazards, disabilities and other vulnerable cases among workers in industrialized nations that are high income while in countries with low-and middle-income (LMICs) exposure to occupational hazards is still common (Rantanen, 2017).

According to World Health Organization, there was reported 350,000 deaths due to fatal accidents and 2000000 deaths due to work related diseases313m get non-fatal accidents (September 2021 WHO) [1]. It further reports that long working hours, workplace exposure to particulate matter, asthmagens, carcinogens, ergonomic risk factors and exposure to noise levels are the risk factors to the diseases and work-related accidents.

A study in 2017on occupational hazards among tea factory workers of Bahawalnagar in Pakistan illustrated that workers suffered from cough and sneezing (25.4%), headaches (15.9%), tinnitus (15.9%) and heat cramps (4.8%) due to exposure to the following occupational hazards; organic dust, noise and high temperatures respectively. The study further asserts that workers were exposed to unguarded machines and machine parts, chemical and biological agents. It was established from the study that there is a compensation mechanism for workplace injuries but however, no major injury or fatal accident has ever occurred to warrant compensation (Rafique et al, 2017)

In a generalized study on the factors contributing to occupational injuries among workers in manufacturing sector in Africa, casual workers and those workers who do not receive the requisite safety training had higher odds in incurring workplace injuries. This is because casual workers rarely benefit in occupational training since most of the employers regard this as costly affair because of their on and off nature of work. The study aimed to identify the contributing factors to occupational injuries at the regional level [2].

Kenya has about 71 professional government occupational safety and health officers and faced with an estimated 140, 000 workplaces. About 2.9% workplaces are annually inspected (ILO 2013) [3]. According to the 2019 Kenya Population and Housing Census, Kenya has 47.5 M people with 18 M being the working population both in formal and informal sector [4]. Owing to the number of workplaces, the DOSHS officers are unable inspect all workplaces in order to check the implementation of the safety and health programs leaving a lot of workers exposed to occupational hazards. According to Vision 2030, Kenya seeks to achieve sustainable development in a clean and secure environment which is only achievable by having in place a health workforce [5].

Tea growing in Kenya is classified as the largest employer in the private sector that employ over eighty thousand workers in tea estates and about three million people depending directly or indirectly for their livelihoods. Apart from horticulture and tourism sector, tea crop as a cash crop is one of the main country's foreign exchange earners. Black tea is a major produced grade, however, green, yellow and white tea are produced according to the market order. Tea is picked from the farms and delivered to the factory for processing. At the factories, the main operation is tea processing with sections such as production sections (floor), stores, workshops, weighbridges, plants and equipment such as air receivers and boilers, kitchen, quality control room, sanitary conveniences and administrative office where potential occupational safety and health (OSH) aspects and impacts are found (Kimeto, 2016).

Like in any other employment sector, programs on occupational safety of employees in workplaces are developed. However, little or no implementation of these programs hence workers in the tea factories are exposed to OSH risks in their daily routines. Non-safeguarded moving parts of machines, chemical exposure, exposure to biological agents and poor working conditions like extremes of temperatures and poor hygiene are the main safety and health hazards in the tea processing sector (Dey et al., 2012).

The workers will continue being injured if they are not checked, monitored or supervised which in turn deprives the tea sector as well as the country of a healthy workforce which is an important element for sustainable economic growth. The study therefore sought to determine the extent of safety and health risk management in KTDA tea Factories within Bomet County in Kenya.

1.1 Statement of the Problem

Tea manufacturing involves withering, cutting, fermentation, drying, sorting, packing, dispatch, routine machine maintenance and cleaning activities. In the process, workers are exposed to safety and health hazards which include; exposure to high noise levels from sources such as packing machines, vibro screens in the sorting sections and running vans of the withering sections; exposure to inhalable and respirable tea dust at the drying, sorting and packing sections; physical injuries such as cuts from non-safeguarded machines, exposure to vibrations from the packer machines, exposure to hot surfaces such as steam line system, electrical hazards from faulty industrial electrical equipment and inappropriate electrical cabling; fire hazards, poor floor conditions, standing for long hours and repetitive work activities. Manual Material Handling from wood billeting activities, boiler operations, loading and offloading of trucks is also evident in these factories. Exposure to these occupational hazards results in musculoskeletal injuries, respiratory defects, hearing impairments, fatigue, fatal and non-fatal injuries. In 2019, Work Injury Evaluation Clinic awarded an employee of Mogogosiek Tea Factory Company Limited in Konoin sub-county of Bomet County a compensation of 1.5M. The employee was attending to broken down elevator conveyor when an electrical shock and a subsequent fall from height occurred. A case which was also reported to Directorate of

Occupational Safety and Health Services. Additionally, according to Rotich [6], exposure to noise, ergonomic risks and exposure to dust are most prevalent occupational risks in KTDA tea factories in Bomet County. This necessitated the need to determine safety and health risks management in order to close the gaps existing in safety and health risk management system [7].

2. MATERIALS AND METHODS

2.1 Research Design

The study used a cross sectional analytical research design to analyze safety and health risks management in selected KTDA Factories in Bomet County that also allowed collection of data at one point in time. It was an interactive analytical cross-sectional study that involved photography, interviewing and observation for data collection.

2.2 Target Population

The target population was the workers in KTDA managed Tea Factories in Kenya.

2.3 Study Population

The study population was workers in eight [8] KTDA managed tea factories in Bomet County undertaking tea processing activities which consisted of 1019 workers. The management of Kenya Tea Development Agency Limited confirmed the number of workers as the current population.

2.4 Sampling Techniques

All the eight KTDA tea factories were selected for the study as shown in Table 1-3. Every worker stood an equal opportunity of being included in the research which was achieved using simple random sampling technique. There were three categories of respondents; respondents in the factory floor (Leaf reception, Withering, CTC, Drying, Packing and Dispatch), respondents in auxiliary sections (Boiler, firewood billeting and storage section and workshops) and workers undertaking routine cleaning and maintenance activities. A full list of all workers in each category was obtained, respondents were then randomly picked from the list for interviews. Purposive sampling technique was applied in determining the sections to measure dust and noise levels.

2.5 Sample Size Determination

Since the target population is less than 10,000 people, the Yamane (1968) sample size determination formula was applied,

$$n = \frac{N}{1+N(e^2)}$$

Where;

n=the desired sample size
N=The study population in the 8 KTDA tea factories in Bomet County which was 1019
e= the margin of error

Calculation;

$$n = \frac{1019}{1+1019(0.05^2)}$$

$$n = 288$$

Non response rate of 10% was added to get a sample size of 317

2.6 Sample Size

The sample size consisted 317 employees in KTDA tea factories in Bomet County which was proportionately distributed to the number of workers in each of the eight [8] tea factories.

2.7 Data Collection Techniques

Both secondary and primary data was collected for this study. Secondary data was obtained from the factory. The primary data sources were the responses from the questionnaires, photographs taken and observation checklists. Data was collected through administration of questionnaires by trained research assistant. Before administration, the respondents were taken through the consent form and once they agreed, they consented by signing. Questionnaires were administered to respondents who met inclusion criteria. Four [9] Focus Group Discussions were conducted each consisting of 10 participants. Participants were taken through the discussions using FGD Guide. Each discussion took 40-60 minutes.

2.8 Data Collection Tools

The study used Noise Meter and Particulate Counter, structured questionnaires, observation checklist, Focus Group Discussion guide and Workplace Risk Assessment and Control

Table 1. Prevalence of occupational hazards

Variables		Have you been injured while at work (Yes n=131)	
		Frequency	**Percentage %**
Cause of the injury	Unguarded machine	53	40.5%
	Repetitive task	19	14.5%
	Carrying heavy load	18	13.7%
	Non-insulated electrical conductors	16	12.2%
	Hot Surfaces	9	6.9%
	Unprotected work at height	6	4.6%
	Slippery Floor	5	3.8%
	Excessive noise	3	2.3%
	Falling objects	2	1.5%

(WRAC) technique for data collection during the study.

2.9 Noise Meter

Noise levels sampling was done using a calibrated Cirrus Research Noise Meter serial number: G300618, CR: 162and Open Field Microphone serial number; 413564B.The sound level meter was calibrated by Kenya Bureau of Standards Laboratory Procedure MET/15/CP/02 on 22nd September 2022 and with calibration certificate number: BS/MET/19/15/3/10/02. Noise sampling was done at a height of 1.5 meters from the ground and 1-meter way from the source. The run time was averagely 15 minutes per sampling point with 9 points being sampled. According to Safe Work Australia Code of Practice on Managing Noise and Preventing Hearing Loss developed in 2018, noise level measurement should be taken over a period of time that will give representative of the noise produce when working or performing a task.

Noise level sampling was done at the processing and at the auxiliary sections and measured against Occupational Exposure Limits provided under The Factories and Other Places of Work (Noise Prevention and Control) Rules, Legal Notice number 25 of 2005 [4]. The unit of measurement was decibels (dBA).

2.10 Particulate Counter

Particulate Matter (dust) sampling was done using calibrated Osiris dust monitor serial number: TNO4400. The dust monitor has been calibrated and issued with calibration certificate number: 17216. The device is able to counter and measure airborne particles which include PM_{10}, $PM_{2.5}$ particles with a resolution of 0.1 µg/m^3. The dust monitor also measured the total suspended particles (TSP) and $PM_{1.0}$. Individual particles drawn through the nephelometer are analyzed as they go through a laser beam then finally collected on a reference filter. Osiris dust monitor was set to 8 hours for every sampling point and done randomly in areas observed to have high levels of organic dust. Four tea factories were randomly selected for dust measurements. This was measured against Occupational Exposure Limits stipulated under The Factories and Other Places of Work Hazardous Substances Rules, Legal Notice No. 60 of 2007 [10].

2.11 Structured Questionnaire

The study used interviewer administered questionnaire which was administered by trained field assistant. It was administered to workers in the eight KTDA tea factories in Bomet County. Every questionnaire was serialized for accountability and to increase chances of having them back. All the respondents were capable of answering question in English.

2.12 Observation Checklist

Observation checklist was used with photographs. A digital camera was used to take photos after consent was sought from the Factory Unit Managers. This was done in alignment to the objective of the study to capture and record the key areas and working conditions against safety and health risks. No personal identification or face recognition was captured in the photographs taken.

2.13 Workplace Risk Assessment and Control (WRAC) technique

Safety and health risk management assessment was done through an existing risk ranking technique by way of observation and interviews. Risk ranking model is a severity/probability model which take in place existing safeguards that limits the probability of hazard causing injury. The study adopted Workplace Risk Assessment and Control (WRAC) [8] technique to Identify and Analyze hazards. The occupational risk ranking model involved assigning numerical value of 1-5 (low to high) based on the control measures in place in minimizing the probability of hazard causing incident. Occupational risk rating is obtained by multiplying the Probability factor by the Severity factor (Risk Ranking = Probability x Severity)

2.14 Focus Group Discussion Guide

The Focus Group Discussion Guide was also used. The guide was made, structured and aligned to specific objectives of the study. The focus group discussion was facilitated and moderated by the research assistant. Forty participants were randomly selected to participate in the discussions. Each Focus Group Discussion had 10 participants. All the discussions were streamlined according to the guide with each discussion taking utmost 60 minutes

3. RESULTS AND DISCUSSION

3.1 Prevalence of Occupational Hazards at the Factories

The overall prevalence of occupational hazards at the factories was 41.3% with 131 respondents experiencing injuries in the last one year. Unguarded machines and machine parts was the most prevalent (40.5%, n=53) occupational hazard in the factory. Repetitive task was prevalent occupational hazard at 14.5%, carrying heavy load at 13.7%, non-insulated electrical conductors at 12.2%, hot surfaces at 6.9%, unprotected work at height being prevalent at 4.6%, slippery floor at 3.8%, excessive noise and falling objects were prevalent occupational hazards in the tea factories at 2.3% and 1.5% respectively. From the focus group discussion, when asked about the most prevalent occupational hazards, it emerged that cut injuries and exposure to high levels of noise were common safety and health risks at the factory.

> *"We are often exposed to high levels of noise and open machine parts such like machine chains and sprockets. High noise levels is mostly from Withering and Driers area"- FDG 2*

3.2 Exposure to Dust and Noise at the Factory

Dust and noise were measured in the factories. Four out of eight tea factories under KTDA register in Bomet County were randomly picked for the measurements.

3.3 Dust Exposure Levels

Measuring of dust was done to ascertain safety risk to particulate matter. The concentration of PM_{10} (inhalable dust) and $PM_{2.5}$ (respirable dust) were measured and then subjected to the provisions under Hazardous Substances Rules, Legal Notice No. 60 of 2007 [10] and other international specifications. Buccal analysis to determine the concentration of the inhaled particles within the respiratory tract of the individual workers was not undertaken. The table below illustrates occupational exposure limits for both respirable and inhalable dust.

Dust measurement was done using calibrated Osiris Air monitoring equipment. The particulate counter was set at 8 hours interval and then mounted randomly in sections of the Factory and within the breathing zone (0.3m radius). The measured average of dust concentration at each section was then recorded as displayed on the screen of the particulate counter (Table 2). The particle counter's flow rate was 5 liters per minute.

3.4 Dust Level Results

It was established that the sorting area of the factories has both high respirable and inhalable dust with recorded 1.6 mg/m^{3}and 2.2mg/m^3 respectively. CTC section recorded the lowest respirable dust at 0.1mg/m^3 while CFU recorded the lowest inhalable dust at 0.2mg/m^3. Among the groups, Kobel Tea Factory recorded highest PM_{10} at 2.023 mg/m^3 while Kapkoros Tea Factory recorded the lowest PM_{10} at 0.521 mg/m^3. Respirable dust ($PM_{2.5}$) were high in Kapkoros Tea Factory (1.164 mg/m^3) while Mogogosiek Tea Factory recorded the lowest $PM_{2.5}$ (0.0613 mg/m^3). From the dust measurements, both $PM_{2.5}$ and PM_{10} in the factories were within the daily exposure limits set out in The Factories and other Places of Work (Hazardous Substances) Rules of 2007 [10]. The levels were however above the East African Air Quality Specifications, American Conference of Governmental Industrial Hygienists [11]

Table 2. Dust Level Parameters, (mg/m^3)

Units	Mogogosiek Tea Factory (mg/m^3)		Kapkoros Tea Factory (mg/m^3)		Tirgaga Tea Factory (mg/m^3)		Kobel Tea Factory (mg/m^3)	
Sample d Points	**PM2.5 (mg/m^3)**	**PM10 (mg/m^3)**	**PM2.5 (mg/m^3)**	**PM10 (mg/m^3)**	**PM2.5 (mg/m^3)**	**PM10 (mg/m^3)**	**PM2.5 (mg/m^3)**	**PM10 (mg/m^3)**
Sorting	0.004	0.659	6.370	0.186	0.069	2.768	0.113	5.094
Drying	0.067	1.045	0.169	0.927	0.142	2.219	0.075	0.858
CTC	0.093	1.232	0.032	0.283	0.106	0.146	0.006	0.099
CFU	0.035	0.194	0.067	0.112	0.132	0.261	0.043	0.135
Packing	0.098	0.265	0.278	1.479	0.036	0.273	0.141	5.776
Wood Billeting	0.071	0.193	0.065	0.137	0.139	0.319	0.026	0.178
Mean Dust Levels in each Factory	0.0613	0.598	1.164	0.521	0.104	0.997	0.067	2.023

Table 3. Noise parameters of the factories, dBA

Units	Mogogosiek Tea Factory			Kobel Tea Factory			Kapkoros Tea Factory			Tirgaga Tea Factory		
Sampled Points	**Lmin**	**Lmax**	**Leq**	**Lmin**	**Lmax**	**Leq**	**Lmin**	**Lmax**	**Leq**	**Lmin**	**Lmax**	**Leq**
Withering	94.2	102.9	96.2	93.5	95.2	94.7	97.7	99.0	98.4	98.9	100.8	100.0
CTC	87.3	89.2	88.3	85.8	87.4	86.4	88.8	90.0	89.7	85.3	87.3	85.9
CFU	85.2	87.5	85.9	81.8	85.2	82.6	84.7	85.8	85.1	87.1	88.1	87.5
Drying	87.1	92.0	88.4	82.0	85.8	82.7	90.2	91.3	90.7	87.5	88.4	87.8
Sorting	86.3	91.3	87.3	85.7	89.1	86.8	88.3	90.6	89.5	84.5	86.3	85.0
Packing	82.1	94.5	84.5	81.9	93.4	91.7	86.8	97.1	92.2	86.3	90.4	88.5
Workshop	74.1	100.0	92.6	75.4	80.4	77.2	84.8	97.3	90.3	71.3	88.6	79.0
Boiler	74.2	85.1	77.1	73.3	82.0	80.9	82.9	83.3	83.1	81.5	87.4	82.2
Generator	99.6	101.1	100.4	100.1	100.9	100.5	102.1	103.9	103.5	88.4	104.1	101.6
Mean Noise Levels	85.6	93.7	88.9	84.4	88.8	87.1	89.6	93.1	91.4	85.6	91.3	88.6

(ACGIH) guidelines and above WHO Air Quality Guidelines [11].

3.5 Noise Exposure Levels at the Factory

Industrial noise was measured to determine exposure to noise levels in different sections of the factory. During the study, the randomly selected sections of the factories were fully operational. Noise measurement was done at a height of 1.5 meters from the ground and 1 meter away from the façade of the noise source near the operator's consoles using a calibrated Cirrus Noise Meter (Table 5). The setting was meant to reduce the impact residual sound from non-relevant sources of sound. The measured noise levels were compared to the Occupational Exposure Limits as outlined in the Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 [9]. The measured noise levels determine the potential health risks to employees in terms of Noise Induced Hearing Loss (NIHL). Noise measurement was done by mounting the noise meter and setting it into 15 minutes duration then recorded the results (Table 4). The 15-minute measurement interval allowed stabilization of the sound pressure and improved the accuracy.

3.6 Noise Parameters in Factories and their Mean

Equivalent continuous sound pressure level (Leq) in factories ranged from 80.8-101.5 dBA. The study ascertained that when the Leq, Lmax and Lmin values in the factories were examined, it was evident that the values and exposures in the factories are close. The daily exposure levels ranged from 85.3-97.3 dBA. The withering section recorded the mean equivalent continuous sound pressure level (Leq) as 97.3dBA the highest among the other production sections. At the auxiliary sections, the generator room while running recorded the highest while the boiler section recorded the lowest equivalent continuous sound pressure level at 101.5 dBA and 80.8dBA respectively. Among the factory units, Kapkoros Tea Factory recoded mean equivalent noise levels above the OEL (91.4dBA) stipulated under The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 [9]. This is because during the study, most of the machines had worn-out bushes that needed maintenance. The noise levels for the other sampled Factories were below OEL provided under The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 [9] except at the withering section. Audiometric results from secondary data illustrated normal audiometry. The tests have been done by a designated health practitioner as required under Rule 4 [2] of The Factories and Other Places of Work (Medical Examination) Rules, 2005 [12].

Table 4. Daily noise exposure time

Working Section	Daily Working Time inhours	Resting (Tea/Lunch Breaks) in hours
Withering	6.5	1.5
CTC	6.5	1.5
CFU	6.5	1.5
Drying	6.5	1.5
Sorting	6.5	1.5
Packing	6.5	1.5
Workshop	6.5	1.5
Boiler	6.5	1.5
Generator	0.5	1.5
Mean	5.8	1.5

3.7 Mitigation Strategies for Safety and Health Risks

Occupational medical examinations, provision of personal protective equipment (PPEs), safety and health risk assessments, internal safety inspections and industrial trainings were the strategies used by the factory to reduce safety and health risks exposure at workplace. The study established that 269 (84.9%) respondents had undergone occupational medical examinations and 317 (100%) had been provided with different types of personal protective equipment. Additionally, 317 (100%) of the participants indicated that safety and health inspections are undertaken in their workstations while 317 (100%) indicated that the factory undertakes internal safety inspections.

3.8 Factors Associated with Management of Safety and Health Risks

The management of safety and health risks at the factory was measured by the frequency of occupational injuries and occupational deaths at the workplace. Chi-square statistic and binary logistic regression analysis were used to test the association between work experience and management of injuries at the factory.

3.9 Chi-Square Test

The study established that there was no significant relationship between age and management of safety and health risks at the factory (p=0.187), there was no significant relationship between gender and management of safety and health risks at the factory (p=0.224) and no significant association between marital status of the respondents and management of safety and health risks (p=0.235) as the P values were greater than 0.05.

Chi-Square analysis further found that the association between the respondent's level of education and management of safety and health risks was statistically significant at (p=0.0001), working station and management of safety and health risks being statistically significant at (p=0.0001) and the association between work experience and management of safety and health risks was statistically significant at (p=0.0001) as the P values were less than 0.05.

3.10 Bivariate Analysis

The level of education was significantly associated (p=0.001) with the management of safety and health risks with an odds ratio of 0.532 and a significant association (p=0.001) between respondent's work experience and management of safety and health risks with an odds ratio of 0.507. The analysis also established that there was no significant association (p=0.238) between respondent's workstation and management of safety and health risks at multivariate.

3.11 Multivariate Analysis

At multivariate analysis, the study also established that the level of education was significantly associated with the management of safety and health risks at the factory (p=0.001) with an adjusted odd ratio of 0.502. Management of safety and health risks at the factory was significantly associated with work experience at (p=0.001) with an adjusted odd ratio of 0.498.

Table 5. Factors associated with management of safety and health risks

Variable	Category	Injured at work			Chi-square	P Value
		Yes	No	Total		
Age	25-29 Years	48	44	92		
	30-34 Years	75	38	113		
	35-39 Years	36	26	62		
	40-44 Years	15	17	32		
	Above 44 Years	12	6	18	6.169	0.187
Gender	Male	124	96	220		
	Female	62	35	97	1.482	0.224
Marital Status	Single	75	56	131		
	Married	103	74	177	2.897	0.235
	Widowed	8	1	9		
Level of Education Completed	Non-formal education	6	7	13		
	Primary school	7	21	28		
	Secondary School	71	51	122		
	Middle Level College	86	51	137	21.462	0.0001
	Bachelor's Degree	16	1	17		
Working Station	Workshop	24	20	44		
	Green leaf Offloading	5	18	23		
	Factory Floor	71	43	114		
	Wood fuel sheds	21	16	37		
	Boiler	48	8	56		
	General Housekeeping	48	8	56		
	Auto-garage	8	6	14	36.397	0.0001
Work Experience	Less than 1 year	1	6	7		
	1 year	4	19	23		
	2-3 years	68	51	119		
	4-5 years	48	41	79	33.739	0.0001
	Over 5 years	64	15	79		

Table 6. Bivariate Analysis across demographic characteristics

Variable	Injured at work			
	Odds Ratio	Confidence Interval at 95%		P value
		Lower	Upper	
Level of education	0.532	0.390	0.725	**0.001**
Working Station	0.899	0.764	1.058	0.238
Work experience	0.507	0.383	0.672	**0.001**

Table 7. Association at multivariate analysis

Variable	Injured at work			
	AOR	95% CI		P value
		Lower	Upper	
Level of education	0.502	0.407	0.712	**0.001**
Work experience	0.498	0.376	0.659	**0.001**

Key: AOR-Adjusted Odds Ratio, CI- Confidence Interval

Note: P values were calculated using the logistic regression model. P is significant if < 0.05

4. CONCLUSION

The research concludes that the safety and health risks management at KTDA tea factories in Bomet County was fair and that;

4.1 Conclusion one on Specific Objective One

Unguarded machinery and machine parts was the most prevalent occupational hazard in the factory. Most of the Occupational injuries were as a result of exposed moving parts of machines.

4.2 Conclusion Two on Specific Objective Two

Based on the findings, it was established that routine occupational medical tests, provision of personal protective gears, scheduled occupational risks assessments, safety inspections and industrial trainings were the mitigation measures adopted by the factories to reduce safety andhealth risks exposure.

4.3 Conclusion Three on Specific Objective Three

The level of education and work experience are predictors of safety and health risk management at the factory.

5. RECOMMENDATIONS

Based on the findings of this research, the following recommendations are made:

5.1 Recommendation One on Specific Objective One

Having noted unguarded machine and machine parts as the most prevalent occupational hazard in the factory, it is recommended the factory management develop inventory of all machines at the factory. The management should then come up with a scheduled on routine integrity and functionality checks on the safeguards to minimize injuries. Monitoring and evaluation of performance of occupational trainings, safety health risk inspections and risks assessments should also be done.

5.2 Recommendation Two on Specific Objective Two

Having highlighted provision of occupational medical tests, personal protective gears, safety and health risk assessments and inspections and occupational trainings were the mitigation measures employed by the factories to reduce safety and health risks exposure, the management advised to evaluate the effectiveness of these interventions

5.3 Recommendation Three on Specific Objective Three

With the research identifying level of education and work experience as predictors to the safety and health risks management at the factories, the research recommends that assignments of duties and workstation at the factories should be done after a thorough job safety analysis has been done and assignment given to workers based on their levels of education and work experience

5.4 Recommendations for Further Research

- The effectiveness of the mitigation strategies on safety and health risks in KTDA teafactories
- Occupational Safety and Health Risks perception among workers in tea manufacturingfactories in Kenya
- Prevalence of musculoskeletal disorders and associated risk factors among workers inKTDA tea factories

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Authorization was obtained from Kenyatta University Graduate School and ethical clearance sought from Kenyatta University Ethical Review Committee while the research license was obtained from NACOSTI

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/113305