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Occupational Exposure to Hand-arm Vibration and Associated Factors among Metehara Sugar Industry Workers: East-shoa, Ethiopia

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Abstract

Background: Hand-arm vibration is vibration transmitted to a person's hand & arm when using hand-held power tools or while holding materials being processed by plant. Hand-arm vibration exposure from the use of vibrating tools is a common health problems uncommonly investigated in industrial workers on the globe. However, evidence clarifying the present situation is limited on the extent of hand-arm vibration exposures associated with sugar industry sectors in most of sub-Saharan African countries, like Ethiopia. The aim of present study was to assess extent of hand-arm vibration exposures & associated factors among Metehara sugar industry workers.

Methods: A facility based cross sectional study was carried out for a period of February 15-July 30, 2017 in Metehara sugar industry. A total of 552 eligible workers were included by stratified random sampling techniques. Data were collected by trained personnel (n=12) through pre-tested interview administered questionnaire after informed consent. European Union & Safe work Australia guideline exposure point based system was used to assess workers daily hand arm vibration exposure. Exposure duration was determined by multiply the number of repetitions required by the average task duration (trigger time) for each vibration producing tool. Data was analysed by STATA version12. Adjusted odds ratio was taken as a measure of effect with 95% confidence interval.

Results: This study revealed that, the extent of hand-arm vibration exposure was 182 (33%). Lack of safety training, lack of risk assessment enforcement, lack of ant-vibration device, absence of safety audit & lack of job rotation practice were estimated a positive association with probability of occupational exposure evidence having adjusted odds ratio 5.12 (3.52, 5.2), 3.94 (2.6, 5.86), 1.96 (1.27, 3.02), 7.17 (4.05, 8.7) & 2.89 (2.74, 5.31) respectively.

Conclusion & Recommendation: The estimated levels of hand arm vibration exposures for vibrating tools found to be higher than permissible exposure limit. Lacks of safety audit, lack safety training, lack of ant-vibration device, lack of risk assessment enforcement & lack of job rotation practice were considerably attributes for this higher occupational exposure. Hence, Metehara sugar industry should be develop anti-vibration tool purchasing policy aim to buy tools with the lowest vibration levels possible & should practice job rotation systems.

Keywords: Exposure; Hand-arm vibration; Metehara; Sugar industry

Introduction

Background to the study

Hand-arm vibration (HAV) is vibration transmitted to a person's hand and arm when using hand-held power tools, hand-guided machinery like powered lawn-mowers or while holding materials being processed by plant. HAV is commonly experienced by people who use jack-hammers, chainsaws, grinders, drills, riveters and impact wrenches [1].

Hand-arm vibration can cause a range of conditions collectively known as hand-arm vibration syndrome (HAVS), as well as specific diseases such as white finger or Reynaud's syndrome, carpel tunnel syndrome and tendinitis. It is a common health of the industrial workers uncommonly diagnosed. Vibration syndrome has adverse circulatory & neural effects in the fingers. The signs & symptoms include numbness, pain & blanching (turning pale & ashen) [1,2].

The findings show that, there are many different types of hand-held power tools and equipment which can place workers at increased risk of developing HAVS. Some of the more common ones are: chainsaws, impulse tools, concrete breakers, cut-off saws, hammer drills, hand-held grinders, jigsaws, pedestal grinders, polishers, power hammers & power chisels [1,3].

In case of Ethiopia, evidence clarifying the situation on hand-arm vibration exposure by this vibrating tools in sugar industry sectors was minimal & also existed research based evidence was self-reported type of assessment focusing on work related injury in which it lacks strength [4] & none in metehara sugar industry workers.

This is why; this paper investigates the factors & extent of hand – arm vibration exposures, it would contribute to changing the knowledge & practice of occupational health & safety at work. Thus, this study was conducted for the purpose of assessing the extent of hand-arm vibration exposures & associated factors among metehara sugar industry worker.

Statement of the Problems

Work has been argued as hazardous for health & safety. Therefore, the health & safety of workers at the workplace cannot be forgotten, due to emerging mechanized both agricultural farm & factory operation in developing countries like Ethiopia [4,5].

Approximately over 2.9 billion workers worldwide are exposed to occupational hazards at work including sugarcane factory sector. Every 15 seconds, more than 153 workers are injured & every day, more than 6,300 people die as a result of exposure to hazards. Poor basic occupational health & safety service reduced working capacity of workers causes' estimated economic loss up to 10-20% of growth national productivity (GNP) of a country [6,7].

According to international labor organization (ILO) in 2013/14 report about 170,000 sugarcane workers around the world was killed annually as a result of exposure to hazards. In U.S alone about 2.5 million workers are exposed to hand-arm vibration (HAV) [6].

Due to the burden of stated problems, demands for basic occupational health & safety services have grown significantly due to the health impact of these hazards & costs for workers as well as organization. However, workers health & safety problems are increasing with time; the industrial hygiene programmes also increased again the chances of giving solution to the problem, still the workers' health & safety were worsening & job dissatisfaction is growing in the globe [6,7].

The UK developed guidelines under the Control of Vibration at Work Regulations in 2005 using the 2002 EU Physical Agents (Vibration) Directive. This regulation established & introduced vibration exposure action & limit values for Hand-Arm Vibration: the Exposure Action Value is 2.5 m/s^2 A [8] & the Exposure Limit Value is 5.0 m/s^2 A(8) respectively over the course of a 8-hour workday. This regulation serves as a good guide to evaluate HAV exposure, and also offers suggestions with respect to reducing associated risks [1,2].

In case of Ethiopia, regulation & standards for controlling vibration exposure is absent [4]. Most of the contemporary research conducted in Ethiopia on the field of occupational health & safety issues emphasis on work related injury. Studies reveal that, factors like age of a workers, unsafe act & unsafe work condition, duration of exposure, non-use of personal protective equipment (PPE), lacks job rotation, limited health & safety training, job dissatisfaction, long weekly working hours & irregular safety inspection & employment pattern are significantly associated with occupational exposure [4], but evidence is limited on the factors like safety audit, duration of exposure, vibration protection equipment.

Information on hand-arm vibration exposures is important at the industry level or at national level & making the problem of vibration hazards more visible to industrial safety related decision makers. However, in Ethiopia there was limited systematized, collecting, organizing, analysing, interpretation & reporting of vibration exposure at work place.

In addition, existing data on level of hand-arm vibration exposure hazards at industry as well as national level is also not enough & even if it is present it is difficult obtain at time it wanted.

Considering health & safety implication constituted by vibration hazards in terms of morbidity, mortality & paucity of data on the level of occupational exposure to hand-arm vibration hazards in Ethiopia with very limited attempts have been made to investigate extent & associated factors [8].

This maybe undermines the actual burdens of occupational exposure rate [9] & the burden of vibration exposure is none in metehara sugar industry. On the contrary, this study reduces the gap related to extent of hand-arm vibration exposures & associated factors.

Justification/Significance of Study

Metehara sugar industry is one of the biggest sugar industries which have the highest number of both manual & mechanized sugarcane workers as compared to other sugar industry in Ethiopia [10]. Hence, it has a high reliability of data collection which a general population of other sugar industry can be inferred from.

Uncharacterized occupational hazards maybe exist when there is insufficient validated exposure data available to make a decision on potential hazard & risk of exposed workers. Hence, the importance of this study can be seen in diverse ways. Assist in evidence-based decision making for effective exposure measurement programme. Also, provides up to date information important to formulating safety policies & strengthening existing a regulatory frame work aimed at protecting the health & safety of workers in metehara sugar industry. It also helps to promote a proactive approach to finding & fixing workplace hazards before they can cause injury or illness.

Besides, serving as important references by adding value of existing literature on occupational health & safety & assist teaching learning process of in development related discipline like field epidemiology. It could also provide bases of other sugar industry in Ethiopia to adopt the recommendations in formation of effective health & safety measure in their industry as well. This study also helps for workers, vibrating tools manufacturing companies, industry, educational centers, policy maker and ministry of labour & social affairs to see the gap & to address the problem & reduce workers occupational exposure to vibration producing tools.

Research Question

Is sugarcane workers' exposure to hand-arm vibration within the OHS standard?

What factors affect the magnitude of occupational exposure to hand-arm vibration?

Objectives

General objectives

To assess Extent of Hand-arm vibration Exposure & associated Factors among Metehara Sugar industry workers, Ethiopia: February 15- May 30, 2017.

Specific objectives

To determine magnitude of hand-arm vibration exposures among metehara sugar industry workers

To identify factors associated with hand arm vibration exposure among metehara sugar industry workers

Methods & Materials

Study setting and period

The study was conducted at Metehara sugar industry located 200 km east of the capital city Addis- Ababa, on the Addis-Dire Dawa-Djibouti road in the upper Awash Valley. It is situated at 8° 53'N & 39° 52'E. The industry started producing plantation white sugar on 9th November, 1969 with an initial crushing capacity of 1700 tons of cane per day (TCD). Currently, the industry has a total concession area of 14,733 hectares out of which about 10,300 hectares was covered with cane plantation. The workforce includes professionals, clerical & manual labourers. At peak time the workforce reaches more than 7,176 where 3,700 are permanents & the remaining are seasonal worker [10].

Study design

A cross sectional study approached by quantitative technique was carried out for a period of February 15-May 30, 2017 In Metehara sugar industry.

Source population: Sugar industry workers

Study population: All sugar industry workers found in metehara district.

Study unit: Selected metehara sugar industry workers who fulfil inclusive criteria.

Inclusion criteria: Sugar industry workers currently working in metehara district, available at the time of data. Collection & willing to participate with those directly engaged in factory operation process.

Exclusion criteria: Workers who were not directly involved in the production process such as management staff were not included in the study because by virtue of their occupation they had less exposure to vibration hazards relative to others.

Workers who are absent during the time of data collection may be due to chronically injured and far apart from the work place & workers who are not willing to participate in the study.

Study variables:

Dependent variable: Hand-arm vibration exposure (exposed or not).

Independent variable:

Socio demographic factors: Sex of workers, age of workers, educational level, monthly salary of workers, employment pattern, working experience.

Job related factors: Safety training, job rotation, Safety inspection, labour inspection & safety audit practice.

Working environment factors: Job category, unsafe work condition, Hours worked per week, ventilation systems

Personal characteristics of worker: Utilization of PPE, obeying safety notice, current job satisfaction, periodic medical examination, awareness on unsafe act & unsafe work condition.

3.9. Sample size & sampling procedures

Sample size was determined using single population proportion formula with an assumption of occupational exposure to physical hazard among sugar industry workers revealed that 59% of workers in different occupational work environments were exposed to varieties form of physical hazards (31) was used, With 5% degree of precision, $Z\ddot{R}/2$ was a standard Z score & 1.96 corresponding to 95% CI the sample size was calculated.

$$ni = \frac{(Z\alpha/2)2\ p\ (1-p)}{d2}$$

$$ni = \frac{(1.96)2\ (0.59(1-0.59)}{(0.05)2} = 372$$

$$n\ f = \frac{ni}{1+(ni/N)} = \frac{372}{1+(372/7{,}100)} = 353 + 5\%\ \text{non-response rate} = 552$$

Stratified random sampling technique was applied to get the desired sampling units.

Hand arm vibration exposure varies with the nature of the work & working condition.

With the assumption, the working sections were used to stratify in to agricultural operation & factory operation.

The departments were also stratified in to sub-sections. Accordingly the required sample size has estimated using proportional allocation to size (PS).

A sampling frame with a list of all workers with their working section was developed & a simple random Sampling technique was used to select the study unit.

Whenever study participants were interviewed for some reason (e.g. absence) attempt was made three times to interview the respondent rather than simply considering them as non-response.

Operational definitions & definition of terms

Associated factors: These are conditions which contribute in the occupational exposure to hazards at work. Including: Personal characteristics, socio-economic factor, job related factor, working environment factor.

Exposure point per hours: The rate at which exposure will rise at the specified vibration magnitude established for vibrating tools [1].

Personal protective equipment: Workers were observed for their utilization of specialized clothing or equipment for protection against occupational hazards at the time of interview. The observation was made for about 5 minutes just before starting administration of the questionnaire.

Hand-arm vibration exposure: Based on the level of expert-based exposure assessments (recognized measurement techniques,) result if estimated value of exposure for each vibration producing tools was above manufacturer declared value; we considered as the worker was occupationally exposed to specified hazards.

Safety audit: Self- reported & personal observation of whether the factories health & safety management systems & safety inspection programme were regularly examined either by the factory or other relevant agencies prior to this study.

Utilization of personal protective equipment: Means wearing & availability of Personal protective equipment [11].

Data collection tools & techniques

A standardized structured questionnaire adopted from national institute of occupational safety & health was used for data collection [12]. Quantitative data was collected using standardized interviewer administered questionnaire. Additional data on occupational exposure to vibration hazards was collected using workplace observation checklist.

Hand-arm vibration exposure level measurement

International labour organization & Safe work Australia guide exposure points based system, was used to assess workers daily hand arm vibration exposure [1]. The exposure duration is not the overall time spent on a specific job rather the trigger time during which the hands are actually exposed to vibration. Workers exposure duration was estimated by strict observation & measurement of a sample period of typical work.

To determine the exposure duration, multiply the number of repetitions required by the average task duration or trigger time for each tool. In this study declared values of vibration magnitude in (m/s^2) given for each vibration producing tools by the manufacturer was used.

Data management

Code-book was used to transfer collected information to a transfer sheet or code sheet. The data file was created from information on code sheet by entering data from a computer keyboard. Check/clean-up of data file for accuracy was done by data cleaning, examine distributions, Contingency cleaning. Case sorting was run to identify missing variables.

Data was back up by saving it in different folders in computer, removable flash disk. A continuous variable was coded & some coded variables were recorded. Non over lapping numerical code was given for each question & qualitative data was coded manually.

Data processing & analysis

Data was processed for entry & entered into Epi-info version 3.5.1 software. Exploratory analysis was run to clean & check the accuracy of data entry. Advanced statistical analysis was performed by STATA Version 12 software. Frequency distribution, percentage, tables was used to present results of bi-variate & multy-variate analysis.

Hosmer & leme show goodness of fit test was conducted. Col-linearity of each independent variable was checked in order to the model not affected by STAT version 12 software. Adjusted odds ratios with 95% confidence intervals were calculated for each of independent variables that were significant on bi-variate analysis at $P<0.05$ & multiple variable analyses were done using logistic regression to see the relative effects of independent variables on the dependent variable by controlling the effect of confounding factor.

Data quality

Experienced data collectors were selected & trained (12 in number). These were three occupational health & safety laboratory expert, one occupational health & safety officer, four diploma nurses, three masters of public health fellows at Adama University due to proximity to the study area, two public health experts previously who had exposure in data collection & research work. The questionnaire was prepared in English & translated to Amharic language & later translated back to English by expert. The questionnaire was pretested in 5% (25 workers) outside the study area in Wonji sugar industry. The principal investigators was closely following the day-to-day data collection process & ensure completeness & consistency of questionnaire administered & measurement conducted each day before transferring in to computer software. Participants who were involved in pretest excluded in the actual data analysis.

Ethical considerations

The ethical approval for this study was obtained from Mekelle University College of health science ethical review board. Permission letter was written for Ethiopian sugar corporation & then to metehara sugarcane factory by sugar corporation & the informed verbal consent was obtained from the respondents, after the necessary explanation about the purpose, benefits & risks of the study & also their right on decision of participating in the study. The assurance of confidentiality was performed by omitting name of the study participants from the questionnaire, by telling the safety of the place where the questionnaire was stored after data collection & also the analysis was not for individual it is for groups.

Dissemination of result

The primary objective of this study was for partial fulfillment in the requirements to degree of master of public health in field epidemiology. The result will be submitted to the department of Epidemiology, School of Public Health, College of health sciences Mekelle University, Metehara Sugar industry & other stakeholders. It was presented at national & international conference & publication at international journals was attempt.

Results

Socio-demographic characteristics

A total of 552 workers completed the questionnaire making response rate 99.1%, of whom 96.7% were males. About 66 (12%), 151 (27.4%) & 335(60.7%) of participant were daily laborer, permanent & contractual workers respectively (Table 1).

Socio demographic variables	Frequency	Percent (%)
Sex		
Male	534	96.7
Female	18	3.3
Age group (in year)		
15-24	29	5.3
25-34	192	34.8
35-44	257	46.6
>=45	74	13.4
Marital status		
Single	48	8.7
Married	502	90.9

Divorced	2	0.4
Educational Level		
Read & write	17	3.1
Primary (1-8)	216	39.1
Secondary (9-12)	193	35
College diploma	103	18.7
Degree & above	23	4.2
Working experience		
<1 year	16	2.9
1-5 year	85	15.4
6-10 year	209	37.9
>=11 year	242	43.8
Employment pattern		
Daily laborer	66	12
contractual	335	60.7
permanent	151	27.4

Table 1: Socio demographic characteristics among Metehara Sugar industry workers, East shoa-Ethiopia, May 30, 2017(n=552).

Variables	Frequency	Percent (%)
Wearing of available ant-vibration device		
Yes	172	31.2
No	380	68.8
Obeying safety notice		
Yes	166	30.1
No	386	69.9
Preplacement & Periodic medical examination		
Yes	103	18.7
No	449	81.3
Aware of unsafe act & unsafe condition		
Yes	207	37.5
No	345	62.5
Satisfaction with current job		
Yes	148	26.8
No	404	73.2
Year of service with utilization of vibrating tools		
1-5 year	196	35.5
>=5 year	356	65.5

Table 2: Personal characteristics among Metehara Sugar industry workers-East shoa-Ethiopia, May, 2017(n=552).

Personal characteristics of the study participant

This study reveal that, a majority 380 (68.8%) of the respondent had reported as they did not use ant-vibration device. The reasons stated for not using ant-vibration device were; majority (93.5%) factory not provided; 67.8% lack of awareness; 67.6% did not feel comfortable & 66.8% decrease work speed. Majority of 404 (73.2%) study participant dissatisfied by their current jobs (Table 2).

Job Related Factors

This study revealed that, majority (82.8%) of workers report that anti-vibration devices provided for them were not the right equipment. About 38.4% of respondent had obtained prior health & safety training. The data shows that, (87.7%) respondent report that there was no labour inspection conducted in their working section (Table 3).

Variables		
The right ant-vibration device provision		
Yes	95	17.2
No	457	82.8
Health & safety training		
Yes	212	38.4
No	340	61.6
Ant-vibration device use & risk assessment enforcement		
Yes	89	16.1
No	463	83.9
Job rotation systems have been practiced		
Yes	98	17.8
No	454	82.2
Routine health & safety inspection conducted		
Yes	214	38.8
No	338	61.2
Labour inspection have been conducted		
Yes	68	12.3
No	484	87.7
Safety audit have been conducted		
Yes	80	14.5

No	472	85.5

Table 3: Job related factors reported by Metehara Sugar industry Workers-East Shoa-Ethiopia, May 30, 2017(n=552).

Variables	Frequency	Percentage (%)
Working in an area of unsafe work condition		
Yes	382	69.2
No	170	30.8
Weekly working hours		
<48 h per week	186	33.7
>48 h per week	366	66.3
Job/working section categories		
Milling section	36	7
Boiler section	105	19
Maintenance	49	9
Power turbine	102	18.5
Evaporation plant	99	17.9
Sulpher station	12	2.3
Vacuum plant	38	6.8
Workshop	44	7.9
Centrifugal section	38	6.8
Sugar packing	29	5.3

Table 4: Working environment characteristics of Metehara Sugar industry workers-East shoa-Ethiopia, May, 2017(n=552).

Working Environment Characteristics

Eleventh working section were visited & relatively most of workers 105(19%) were working in boiler section followed by 102 (18.5%) power turbine. Majority 382 (69.2%) of the respondents reported that, they were working area of unsafe work condition (Table 4).

Extent of Hand-arm Vibration Exposure

In this study, the level of hand-arm vibration exposures in metehara sugar industry workers in which it measured by vibration exposure point systems guide line established by safe work Australia Work & International labour organization. This study revealed that, hand-arm vibration exposure was found to be (182=33%). The measurement of vibration exposure magnitude was read from the hand arm vibration monitoring chart attached at the annex part of this study [1].

In this study, an exposure to a vibration magnitude of 16 m/s2 (reading from vibration exposure chart) for 2 h while using impulse tools results in 1000 points (reading from vibration exposure chart) which is above recommended exposure point limit (see red color box).

Similarly, exposure to a vibration magnitude of 18 m/s2 for 50 minute while using a jack-hammer results in 650 points which is also above exposure limit (see red color box). Almost all of the rest hand tools emitted vibration with respective magnitude as indicated in (Table 5).

S.n	Tools/process	Average No. of repetitions	Vibration magnitude	Exposure points per hour	Exposure duration	
			in m/s2	(reading from Chart)	(recorded by data collectors	
			(declared by manufacturer)		hour	min
1	Liaise/impulse tool	15	16	1000	2	30
2	Shapers/brush cutters	8	4	32		24
3	Sharpeners/ steam valve	10	7	98	1	
4	Forge machine	15.5	8	385	3	50
5	Grinder machine	19.5	6	430	6	
6	Power chisels	8	5	100	2	
7	Grip loader /jigger pick	15	16	1000	2	57
8	Jack hammer	12.5	18	650		50
9	Hammer drills	11.5	9	160	1	
10	Concrete breakers	5.5	12	290	1	30
11	Chainsaws	9.5	6	145	2	40

Table 5: The level of daily hand-arm vibration measurements of different working section in Metehara Sugar industry workers, East Shoa-Ethiopia, May 30, 2017(N=552).

Factors Associated With Hand-arm Vibration Exposure

Multivariable binary logistic regression analysis showed that; a workers who were working in area where risk assessment enforcement absent were 3.94 times more likely to be exposed to hand arm-vibration than those who were working in area where risk assessment conducted (AOR= 3.94; 95% CI (2.6, 5.86). And also engagement in area where lack of safety training were 5 times more likely to be exposed to hand arm-vibration than those who have got safety training with the corresponding (AOR=5.12; 95% CI , 2.52, 5.88).

Similarly, a workers who were working in area where no systems for safety audit were 7 times more likely to be exposed to hand arm-vibration than those who work in area where systems for safety audit practiced (AOR=7.17; 95% CI (4.05, 7.87). In addition, A workers who did not use ant-vibration device were 1.96 times more likely to be exposed to hand vibration than those who did (Table 6) use personal protective device (AOR=1.96, 95% CI (1.27, 3.02).

Characteristics	Hand-arm vibration exposure				
	Yes	No	COR(95% CI)	AOR(95% I)	p-value
Absence of risk assessment enforcement					
<48 h per week	142	91	1		
>48 h per week	40	279	10.88(7.12, 6.61)*	3.94(2.6, 5.86)**	0.001
Available ant-vibration device					
Yes	50	122	1		
No	132	248	1.29(1.24-1.92)*	1.96(1.27, 3.02)**	0.001
Labor inspection conducted					
Yes	59	173	3.22(2.14,4.84)*	0.24(0.11,0.52)**	0.001
No	143	197	1		
Safety Audit conducted					
Yes	12	73	1		
No	170	297	6.14 (2.76-13.64)*	7.17 (4.05, 7.87)**	0.001
Safety training					
Yes	28	61	1		
No	154	309	1.08 (1.06-1.76)*	5.12(2.52, 5.88)**	0.001

Table 6: Bivariate & Multi-variate analysis of predictor variables on Hand-arm vibration exposure among Metehara sugar industry workers, East shoa–Ethiopia, May 30, 2017.

*Significant at P <0.05 bivariate analysis, ** Significant at P <0.05 multivariate analysis, 1= Reference group

Discussions

This study revealed that, the extent of hand-arm vibration exposure among metehara sugar industry workers was 32.9% (95% CI; 29%-37%) which can be comparable with what had been reported from Zambia 34 % [**13**]. However, this value was not agreeing with the report on Australian OHS education Accreditation board 43 % [14]. This variation maybe due to different in time period, different in exposure condition such as short working period with vibrating tools, intermittency of vibrating tool used as in the present study area & different data collection tools (vibration meter) was used in previous study unlike as the present hand –arm vibration exposure is determined by pre-declared vibration point systems.

This finding shows that vibration emission of the had hold tool like jack-hammer, impulse tools, Grip loader /jigger pick, Forge machine and the like were emits higher vibration magnitude which is beyond recommended occupational daily exposure limit. The implication of this exposure level maybe reaching a level which could lead to Hand-Arm Vibration Syndrome. This may be an indicator of a hand-arm vibration problem and controls should be put in place to eliminate or minimize exposure, so far as is reasonably practicable. Moreover, both exposure action value & exposure limit value established for hand-arm vibration for some vibrating tools in the present study area is beyond recommended limit.

Therefore, we suggested assessment by a competent person may be needed if there is inadequate information about the vibration emission of the tool, the tool is being used in an unusual way or if you are uncertain about the effectiveness of controls.

Factors related to hand-arm vibration exposure

This study identified important predictors influencing the occurrence of hand-arm vibration exposure. Lacks safety audit at work were a significant predictor for hand-arm vibration exposure & workers from an area where no safety audit conducted were six times more likely than workers from an area where safety audit conducted to be exposed to vibration hazards (AOR=6.62 (2.48, 7.62; p<0.001). This may be due to lacks competent personnel at the factory, non-adherence with OSHA convention & recommendation concerning industrial code of practice among factory administration. Therefore, not implementing safety audit had played a greater role in exposing workers to vibration hazards at large.

Non-use of ant-vibration device was also a significant predictor for hand-arm vibration exposure & workers who did not uses anti-vibration device were 1.96 times more likely than workers uses personal protective equipments to be exposed to physical hazards (95% CI; 1.35, 3.36),p=0.001) . This may be due to limited health & safety training, less attention from factory managers on appropriate & timely provision, lacks regulation & enforcement on use of PPE. This finding was aligned with the study conducted Tendaho sugarcane factory in Ethiopia [8].

The finding from this study, suggest that chronic exposure to vibration producing tools maybe leads to complicated ill health like irreversible neurological disorders.

Strength of the study: Expert based vibration exposure measurement

Limitations of the Study

1. The health effect of hand-arm vibration exposure was not assessed.

2. The extent of hand-arm vibration exposure levels of workers by vibration meter was not quantified due to lack of vibration meter.

3. The whole body vibration was not assessed due to its complexity of data collection & lack of vibration meter in this study which may be under estimation of the magnitude of vibration exposure to the study area.

Conclusions

The extent of hand-arm vibration exposure associated with sugarcane manufacturing process of metehara sugar industry posed a potential hazard to workers health & safety as well as industry productivity. This study revealed that, the level of hand arm vibration exposure determined were found to be higher than occupational

exposure limit for each vibrating tools used in the industry for varieties of purpose. The major determinant factors associated with hand-arm vibration exposure were lack of safety audit, lack of appropriate ant-vibration device, absence of periodic safety training & absence of risk assessment enforcement were considerably enhances the chance of hand-arm vibration exposure at work.

Recommendations

Based on the study findings, the recommendations offered by the study as follow-

For sugar industry administration

Implementation of vibration protection programs & gives immediate mechanical solution (Engineering modifications) of industrial machinery.

Should apply administrative controls like work rotation systems & reduce duration of exposure; should provide timely & appropriate ant-vibration device for the workers.

Should implementation of workplace safety audits related to workplace safety.

For occupational health & safety service department

Conduct routine surveillance of working section & risks analysis to know safe level of exposure; should be ensuring proper fit & re-enforcement of vibration protection device use in conjunction with task-specific training.

For industry workers union & workers

Should ensure appropriateness of vibration protection device & consist utilization; should enforce compliance with health & safety measures in the industries.

For researchers

The present study was discovering the level of hand-arm vibration exposure but not identifies the health effect as result of this exposure. Therefore; the cohort study designed will be better to establish causal-effect relationship between exposure & occurrences of any vibration related health disorders.

Conflict of Interest

None declared.

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References

1. Gourab B (2016) Guide to measuring and assessing workplace exposure to hand-arm vibration. Healt Safe Exe 1: 1-8.
2. Gourab B (2016) A review on the occupational health of sugar cane workers. Int J Biomed Res 8: 1-3.
3. Selvi T (2016) Occupational health hazards among automobile mechanics working in an urban area of Bangalore. Int J Med Sci Pub Healt 1: 1-5.
4. Kassu J (2016) A literature review on global occupational safety and health practice & accidents severity. Int J Qua Res 10: 1-5.
5. Teklit G (2016) Occupational risks and hazards exposure, knowledge of occupational health and safety practice and safety measures among workers of leather plc. MOJ Public Healt 4: 1-7.
6. ILO (2014) Safety and health at work. ILO 3: 1-48.
7. WHO (2010) Identification and recognition of occupational diseases. BRI 74: 1-82.
8. Osman Y (2010) Assessment of occupational injuries in tendaho agricultural development S.C, Afar Regional State. Ethiop J Health Dev 24: 1-9.
9. Takele T (2005) Assessment of prevelance of work related injuries among small and large scale industrial workers in north Gonder Zone. Amah reg 5: 17-24.
10. Yohannes B (2015) Energy assessment, generation and utilization efficiency in Ethiopian sugar factories. Mete Sug Factor 1: 1-15.
11. Saba A (2013) Appraisal of occupational health and safety practices in power holding company of nigeria. Int J Scientif Eng Res 4: 1-6.
12. OSHA (2010) Promoting productive work place through safety & health research. NIOSH 1-16.
13. Siziya S (2013) Exposure to occupational health hazards among Zambian workers. Occup Med (Lond) 63: 1-15.
14. Marion B (2012) Overview of the occupational exposure limits for hand-arm and whole-body vibration. Austral Acoust Soc 12: 1-5.