Safety and Health at Work 5 (2014) 131–135

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.org

Original Article

Incidence and Predictors of Hand–Arm Musculoskeletal Complaints among Vibration-exposed African Cassava and Corn Millers

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ARTICLE INFO

Article history:
Received 15 February 2014
Received in revised form
1 April 2014
Accepted 23 April 2014
Available online 14 May 2014

Keywords:
hand-arm vibration exposure
incidence
miller
musculoskeletal complaint

ABSTRACT

Background: Cassava and corn milling is a growing small-scale enterprise in Africa. We aimed to determine the incidence of hand–arm musculoskeletal complaints among vibration-exposed Congolese cassava and corn millers in the previous 12 months.
Methods: A cross-sectional study was conducted, prior to a follow-up study, from March to May 2013 among cassava/corn millers in Lubumbashi, Democratic Republic of Congo, in which 365 millers age-matched to 365 civil workers anonymously answered a questionnaire.
Results: Overall incidence of hand–arm musculoskeletal complaints was 25.8% in millers (vs. 5.2% in civil workers; $p < 0.001$). The risk of experiencing musculoskeletal symptoms was seven times higher in millers [vs. civil workers; odds ratio (OR) = 7.10; 95% confidence interval (CI): 4.03–12.50; $p < 0.0001$]; 2.4 times higher in smoking millers (vs. smoking civil office workers; OR = 2.36; 95% CI: 1.42–3.88; $p < 0.001$); 3.6 times higher in millers with longer daily exposure (> 8 hours; vs. those working ≤ 8 hours; OR = 3.56; 95% CI: 1.93–3.61; p = 0.026); and 7.4 times higher in young millers (vs. older millers, OR = 7.39; 95% CI: 1.29–75.52; $p < 0.001$). Smoking, number of cigarettes, and daily exposure duration were positively correlated with musculoskeletal complaints.
Conclusion: This study revealed a relatively high incidence of musculoskeletal complaints among African cassava and corn millers. The use of anti-vibration protective equipment and the regulation of this hazardous occupation may reduce the burden of musculoskeletal disorders in millers.

1. Introduction

Occupational upper extremity musculoskeletal disorders (MSDs) have become increasingly common and they are a major burden in general medical practice. MSD has a negative impact on the quality of life and, in the United States, ~19 million workers are affected annually. Hand–arm vibration is defined as the transfer of vibration from a tool to a worker's hand and arm. Prolonged exposure to hand-transmitted vibration is associated with an increased occurrence of symptoms and signs in the vascular, neurological and osteoarticular systems of the upper limbs [1,2]. There are several reports on epidemiological studies conducted among manual workers (e.g., drillers, stone carvers, forestry workers, and grinders) in the medical literature in relation to vibration-related MSDs [2–4], and hand–arm vibration is recognized as a significant hazard to workers' health and safety [5,6]. In the literature, there is a lack of occupation-specific information on the scope and causes of MSDs in the Central African region.

In most African countries, flour from cassava and corn is part of the daily diet for a large majority of the population. Cassava and corn milling facilities are among the growing small-scale enterprises in the region. Although the business seems to be lucrative,

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http://dx.doi.org/10.1016/j.shaw.2014.04.003

safety conditions of millers have not been a major concern for employers with regard to the use of protective equipment against vibration, noise, and dust. Moreover, no research has been conducted to investigate the adverse health effects of exposure to the above-mentioned hazards in cassava and corn-milling facilities. The present international collaborative study was designed to investigate the working conditions and health outcomes in African cassava and corn millers. Hereby, we report on the incidence and correlates of upper limbs' musculoskeletal complaints related to chronic hand–arm vibration exposure in Congolese cassava and corn millers occurring during the previous 12 months.

2. Materials and methods

2.1. Study site, design, and participants

Cassava and corn millers were recruited for a cohort study in Lubumbashi, the second most populous town of the Democratic Republic of Congo. Lubumbashi is a city of more than 1 million inhabitants and is believed to be the copper capital of the world [7]. It is located in the southern province of Katanga, which shares borders with Zambia and Tanzania. A baseline survey was conducted in 2013 in all seven counties of Lubumbashi using a validated questionnaire that comprised three parts, with questions related to hand–arm vibration exposure and MSD, dust exposure and respiratory health (occupational asthma questionnaire, American Thoracic Society), dermatitis, and hearing impairment. Regarding musculoskeletal health, specific questions from the Standardized Nordic questionnaire on MSDs [8] were included in our study questionnaire. All cassava and corn-milling facilities were visited by trained surveyors supervised by a panel of experts from the School of Public Health, University of Lubumbashi, thanks to a repertoire of addresses and telephone numbers obtained from local public offices.

In total, 384 cassava/corn millers were recruited (including 1 woman), and among them, 365 male millers were eligible (exposed group). Three hundred and sixty-five civil workers (nonexposed group) without exposure to vibration were recruited from a population of 446 civil workers from local public offices (Fig. 1). They were local provincial government office workers. The office workers matched to the millers were those involved only in office work (typewriting, computer work, secretarial and reception services). A large majority of millers were age-matched to nonexposed

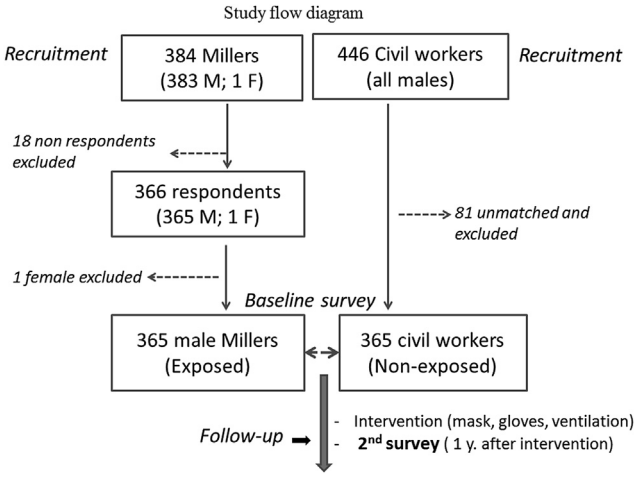

Fig. 1. Study flow diagram of the follow-up study. A total of 365 male cassava and corn millers were age-matched to 365 male civil workers. A baseline survey was conducted and then participants were followed for 1 year after the intervention (protective equipment, and good ventilation). F, female; M, male.

civil office workers; for the remaining 7%, an age difference of ≤ 5 years was considered acceptable.

The inclusion criteria for millers were as follows: being a cassava or corn miller without involvement in another activity susceptible to cause MSDs, having a permanent residence in Lubumbashi, and voluntarily agreeing to take part in the study. For the office workers' group, those involved even partially in a high-risk occupation or activity such as mining work, construction work, or farming were not recruited.

2.2. Definition of MSDs and related symptoms

According to the Centers for Disease Control and the International Classification of Diseases (ICD-10-M99-7; version 2010), MSDs are injuries or disorders of the muscles, nerves, tendons, joints, cartilage of the upper and lower limbs, neck, and lower back that are caused, precipitated, or exacerbated by sudden exertion or prolonged exposure to physical factors such as repetition, force, vibration, or awkward posture. In this study, symptoms that were considered to be related to MSDs are chronic pain, swelling, and stiffness [9,10]. Those complaints were taken into account prior to considering a worker as having experienced a hand–arm musculoskeletal condition if they that lasted more than 1 week, affecting the ability to perform usual work tasks, and occurring during the previous 12 months.

2.3. Brief description of the cassava/corn-grinding machine

The grinding mill consists of a metallic tool with a vibrating engine that produces cassava or corn flour. It is generally composed of three parts: a metallic basin where dried cassava or corn is deposited, the engine that helps broil the crops, and a collector (generally made of a cylindrical cotton fabric). There are one to three millers working in a generally narrow-space milling facility. Participation was voluntary; participants had to answer the questionnaire anonymously after receiving explanations on the objectives of the study. A written approval to conduct the study was obtained from the Ethics Committee of the School of Public Health, University of Lubumbashi in March 2013.

2.4. Statistical analysis

Data were analyzed using Stata version 10 (Stata Corp., College Station, Texas, USA) statistical software. For the analyses, most variables were dichotomized (no = 0; yes = 1). The χ^2 test was used to assess differences between groups and categories within each group of participants, whereas Spearman's correlation test was performed to assess the correlation between MSD symptoms, sociodemographic variables (age, marital status, and level of education), seniority or work experience, daily exposure duration, smoking, use of protective devices, and the nature of the product processed. Cross-tabulation was performed and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated and used to determine the magnitude of associations and the level of risk of work-related MSDs, adjusting for age. A p value < 0.05 was considered statistically significant.

3. Results

3.1. Characteristics of participants and incidence rate of MSDs

Of the 384 vibration-exposed millers who received questionnaires, there were 365 that were returned, making a participation rate of 95.1%. For the millers, the mean age was 26.6 $\pm$ 8.7 years; 5.5% (20/365) of millers were aged 10–17 years. By contrast, civil