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Health and safety training and prevention of hand-arm vibration syndrome through education

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Abstract.
BACKGROUND: Exposure to hand operated vibrating tools in the construction industry places workers at risk for developing hand-arm vibration syndrome (HAVS), which is a common occupational disease.
OBJECTIVE: To outline health and safety training obtained by construction workers and to assess which factors influence anti-vibration (AV) glove utilization following an educational intervention provided during a clinical assessment for HAVS at an occupational health clinic.
METHODS: One hundred participating workers from the construction industry referred for a HAVS assessment at a hospital-based ambulatory occupational health clinic in Toronto, Ontario, Canada. A baseline and two-month follow-up questionnaire were completed.
RESULTS: Almost all of the participants indicated that they had completed health and safety training within their workplace. However, few received training specific regarding HAVS or AV gloves. Participants' AV glove use improved from 4.3% at baseline to 53.3% at follow-up two months later. Key predictors of participants wearing AV gloves was sharing the educational intervention information with their supervisors and working in a workplace with 20 or more employees.
CONCLUSIONS: Training specific to HAVS and AV gloves is lacking in the construction industry. The educational intervention proved most effective in increasing AV glove use when the information was shared within the workplace.

Keywords: Hand-arm vibration syndrome, anti-vibration gloves, training, construction

1. Introduction

Exposure to hand-operated vibrating tools in the construction sector places workers at risk for developing hand-arm vibration syndrome (HAVS). Approximately 1.37 million employees were estimated to work in the construction industry in Canada in 2014, and many of these workers use vibrating tools on a regular basis [1]. It has been estimated that approximately 50% of workers in the United States exposed to hand-arm vibration have already developed HAVS or will develop it in the future [2]. Damage to the vascular, neurological, and musculoskeletal systems of the hand and arm due to hand-arm

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vibration is typically progressive with continued vibration exposure and is often irreversible, leading to upper extremity disability, and detrimental impacts on activities of daily living and vocational ability [3,4]. Results from a national study in Great Britain suggest a higher risk for finger blanching and sensory symptoms for workers employed within the construction sector [5]. Commonly used tools in construction including concrete breakers, chain saws, and jigsaws were all found to be associated with reported symptoms [5]. The use of anti-vibration (AV) gloves is often recommended to workers as personal protective equipment in order to reduce their vibration exposure, keep their hands warm and dry, and as protection against other exposures in the workplace [6]. The effectiveness of AV gloves to reduce vibration is influenced by several factors including: type of glove, tool operated, operator differences, and variable operating conditions [6]. Additionally, training in the use of safety clothing and equipment has been shown to influence safety performance within the construction industry [7].

Prevention efforts are imperative for the protection of workers exposed to hand-arm vibration and the management of HAVS. Improvements in occupational health education and training opportunities are crucial in order to improve the identification of workplace hazards, understanding of health effects, and utilization of control strategies [8]. Significant differences in the level of vibration exposure resulting from the same tools operated by different workers further demonstrates the need and the potential impact of worker education and training [9].

Furthermore, workers frequently identify immediate occupational health and safety risks in their workplace as opposed to risks associated with delayed outcomes or effects [10]. Therefore, there is potential for workers to underestimate vibration as a hazard due to the latency period prior to the onset of symptoms.

In Ontario, Canada, it is the duty of an employer to "provide information, instruction and supervision to a worker to protect the health or safety of the worker" [11]. In 2014, basic worker health and safety awareness training was made mandatory for all workers in Ontario. The training outlines the duties of the workers, supervisors, and employers according to the Occupational Health and Safety Act, common workplace hazards, participation in joint health and safety committees, and additional resources within Ontario's workplace health and safety system. Furthermore, fall protection training for workers working at heights and Workplace Hazardous Materials Information System (WHMIS) training for the safe use, storage and removal of chemicals and hazardous materials in the workplace is mandatory within industry. However, without education focused specifically on prevention and risk reduction strategies for HAVS in the construction industry, a continued lack of knowledge and under-recognition of this common occupational disease will persist [12,13].

The construction industry poses a challenge for preventing HAVS as the delivery of occupational health and safety programs is difficult to implement. Challenges within the construction sector have been previously documented to include such factors as: scheduling challenges, unpredictable job tasks of workers, working in isolation, and travel between multiple work sites [14]. The potential for different professional and trades personnel to be present in the same construction work setting, sometimes from different contractors within the same construction site, further complicates the delivery of a consistent safety message across the overall organization [10]. Various factors such as management presentations regarding safety, provision of safety booklets, and provision of safety equipment, have been shown to significantly influence safety performance within the construction industry [7].

This study was conducted to outline health and safety training obtained by construction workers and to assess which factors influence AV glove utilization of construction workers following an educational intervention and assessment at an occupational health clinic for HAVS.

2. Methods

2.1. Participants

A total of 105 workers from the construction industry referred for an assessment of HAVS at a hospital-based ambulatory occupational health clinic in Toronto, Ontario, Canada, were recruited and 100 (95%) agreed to participate. A baseline questionnaire was given to all participants at the time of their initial HAVS assessment with an occupational medicine physician. Two months following the assessment and educational intervention, a follow up questionnaire was mailed to all participants [15].

2.2. HAVS Educational intervention resource

A team of researchers and clinicians at the Centre for Research Expertise in Occupational Disease (CREOD) created the HAVS educational resource, a one page, double-sided, laminated document, based on current best practices in the prevention and treatment of HAVS [15]. The resource was designed to provide HAV/HAVS educational information in a convenient form for workers in the construction industry and to provide the potential for their sharing with other workers, including management personnel at their workplaces. The resource provides education on the types of damage (vascular, nervous, and musculoskeletal systems) and the symptoms that may occur in workers with HAVS, as well as the prevalence and treatment options for HAVS. Also, prevention strategies in the workplace are discussed, in particular developing an anti-vibration tool purchasing policy and that ensuring tools are well maintained, and additional online resources are provided. Participants were each given three copies of the educational resource and they were asked to distribute them at their respective workplaces.

2.3. Data analysis

All data were compiled and analyzed using IBM SPSS Statistics for Macintosh, Version 23.0 (IBM Corp., Armonk, NY). The health and safety training and sharing of the educational resource results were analyzed using descriptive statistics. McNemar's test was used to assess the differences in AV glove utilization as a result of the intervention within the population. A stepwise logistic regression was used to ascertain the effects of sharing the educational information within the workplace and the size of the workplace on the likelihood that participants would wear AV gloves when exposed to hand-arm vibration following the intervention. A significant level of $p = 0.05$ was set to determine significance for all analyses.

3. Results

All of the participants in the study were male ($N = 100$). The mean age of the participants was 46.77 years (SD = 10.59) and has worked in the construction industry for an average of 25.19 years (SD = 11.49). All of the participants were regularly exposed to hand-arm vibration, with the majority (69.1%) being exposed to vibrating tools for more than 3 hours per day.

Table 1
Post-intervention assessment of HAVS education resource sharing by participating workers at their respective workplaces

Did you give the resource to:	Yes	No
Your Employer	17 (34.7%)	32 (65.3%)
Your Health and Safety Representative	29 (60.4%)	19 (39.6%)
Your Supervisor	22 (45.8%)	26 (54.2%)
Your Co-workers	33 (68.8%)	15 (31.3%)

Table 2
Stepwise logistic regression analysis of possible predictors of AV glove use post educational intervention

Parameter	Estimate	SE	Odds Ratio (95% CI)	P Value
Intercept	−1.1647	0.5826	–	0.0456
Educational Materials Given to Supervisor	1.8591	0.7401	6.42 (1.51–27.38)	0.0120
Number of Employees in Workplace ($\geqslant 20$)	1.6971	0.7773	5.46 (1.19–25.05)	0.0290

Model $\chi^2(2) = 11.804$, $p = 0.003$.

3.1. Health and safety training

Almost all of the participants indicated they had completed occupational health and safety training within their workplace (90% Occupational Health and Safety Act, 96% WHMIS, 85% general health and safety training). In contrast, only 5% of participants received specific HAVS training. In regard to protective gloves, 49% indicated that they had received training, but only 8% of participants had received training about anti-vibration (AV) gloves.

3.2. Educational information sharing

Participants were asked in the follow-up questionnaire to indicate the personnel within their workplace with whom they had shared the HAVS educational resource that had been given to them at the occupational health clinic. The majority of participants (68.8%) shared the material with their co-workers, as indicated in Table 1.

3.3. AV glove use

The follow-up response rate was 57%; however, seven participants were excluded from the statistical analysis because they indicated that they had not returned to work since the HAVS assessment and educational intervention. Before the intervention, two (4.1%) participants indicated they wore AV gloves when exposed to hand-arm vibration. Following the educational intervention and assessment, the number of participants that indicated they wore AV gloves increased to 25 (53.2%). An exact McNemar's test determined that the difference in the proportion of wearing AV gloves before and after the intervention was statistically significant, $p < 0.0001$. As indicated in Table 2, the logistic regression model was statistically significant, $\chi^2(2) = 11.804$, $p = 0.003$. The model explained 31.6% (Nagelkerke R^2) of the variance in AV glove use and correctly classified 75% of the cases. Of the predictor variables only two were statistically significant: sharing the educational resource with their supervisor (Odds ratio: 6.42; 95% CI: 1.51–27.38) and returning to a workplace with 20 or more employees (Odds ratio: 5.46; 95% CI: 1.19–25.05).

4. Discussion

Training opportunities targeted specifically on education and the prevention of HAVS are a missing component of current occupational health and safety training programs in the construction sector in Ontario, Canada. However, education and early detection of symptoms are crucial for the management of HAVS because treatment options are limited and the pathology associated with HAVS is often irreversible [16]. Increasing the knowledge of workers may improve their ability to seek appropriate medical treatment and begin discussion with physicians and may influence the recognition and reporting of occupational diseases [17]. Previous research related to HAVS has shown that workers often do not seek medical assessment for their early HAVS-related symptoms, with many workers waiting several years before seeing a physician [18,19]. Increased efforts are needed to ensure more immediate action is taken and workers are educated and protected. Worker education is important in generating knowledge of vibration and is a precursor to the intention of a worker making a behaviour change to reduce exposure [20].

The educational information targeted to construction workers with HAVS should be designed and delivered in a format to overcome the barriers presented within the construction industry. In distributing the HAVS educational material at the occupational health clinic, several barriers to conducting occupational health and safety interventions in the construction industry were alleviated, including scheduling challenges and time pressures, unpredictable job tasks, location of workers, and budgetary constraints [14,21]. The one-page, double sided, laminated format was designed to be easily used and disseminated in the construction work environment so that the information had the potential to be shared with other personnel in the workplace [15]. The design and implementation of the current intervention reinforces the importance of developing relevant content and considering important contextual information to optimize effectiveness as proposed by Karanika-Murray and Biron [22].

Although most participants indicated that they had shared the resource with their co-workers, the educational intervention proved to be most effective in commencing the use of AV gloves when shared with the employees' supervisors and in workplaces with 20 or more employees. Past research in the construction sector has highlighted company size to be a contributing factor to occupational health and safety performance [23]. Specifically, small construction firms (less than 25 employees) have been found to lag behind larger firms in terms of occupational health and safety performance, as they are limited in terms of their ability to implement comprehensive management plans [24]. As a result, injury prevalence rates have also been documented to be higher in smaller firms (less than 20 employees) [25].

Further changes in the workplace as a result of the educational intervention included the purchasing of tools with lower vibration emission values, process changes, reduction in employee exposure duration, and the provision of additional education opportunities regarding HAVS [15]. These are important control strategies implemented by employers at construction worksites as a result of the educational intervention that demonstrate the potential for additional positive changes associated with this educational intervention [15].

5. Conclusions

Current health and safety training opportunities related to HAVS within the construction industry are not adequately preventing and protecting workers. It is likely that this is also the case in other industries such as mining, forestry, and agriculture, which all require exposure to hand-operated vibrating tools. If workers are provided with relevant educational resources that have the ability to be shared within the workplace, then positive safety behaviour changes can result. Increased educational opportunities for HAVS awareness and education tailored to specific workplaces to reach workers, supervisors and employers are important occupational health and safety priorities.

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Conflict of interest

The authors have no conflict of interest to report.

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