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Analysis of hand-arm vibration syndrome in drummers

Luis M. Roseiro [a, b], Maria F. Paulino [b], Maria A. Neto [b], Ana M. Amaro [b, *]

[a] Polytechnic Institute of Coimbra, Coimbra Institute of Engineering, Mechanical Engineering Department, Coimbra, Portugal
[b] CEMMPRE, Department of Mechanical Engineering, University of Coimbra, Pinhal de Marrocos, Coimbra, Portugal

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ABSTRACT

Around the world there are a great number of musical bands, therefore the number of professional drummers is also high. Drums are usually played by striking with the hand, or with one or two sticks, therefore professional drummers need to have a fitness levels similar to those of top athletes. Even though that the drum kit is one of the more physically demanding instruments, as it uses all the limbs, particularly the hand-arm system, some injuries can appear in the musicians. In fact, due to continuous vibrations and repetitive motions, drummers are subjected to risk factors that can lead to musculoskeletal disorders (MSDs). The European Directive 2002/44/EC on the minimum health and safety requirements, regarding worker exposure to risks from physical agents (e.g. vibration), limit the exposure to vibrations. The aim of this study was to analyze the level of exposure to hand-arm vibrations (HAV) in six drummers, three of them have formal Musical Training (MT) and the other three do not have any musical Training (NMT). All drummers were evaluated while playing drum and the vibrations were measured in both hands, but also in both drumsticks. In the case of drumsticks the results indicate that impacts and transient vibrations lead to a higher musculoskeletal injuries, particularly in the case of the musicians without MT. The data obtained in the present study can be an improvement in the design of new tools for the drummers in order to reduce the value of the HAV transmitted and, consequently decrease the risk of musculoskeletal injuries in the musicians.

1. Introduction

An understanding of the work demands of professional drummers can be used to training drummers preventing performance-related health problems. While psychology and physical demands have already been investigated, less is known about the level of exposure to vibrations. Actually, in their work, drummers are exposes to a range number of risk factors, such as continuous vibrations and repetitive motions, which can cause Musculoskeletal Disorders (MSDs). The MSDs are injuries and disorders that can affect the human body's movement or musculoskeletal system, soft tissues (muscles, tendons, ligaments, joints and cartilage) and also the nervous system. These injuries can significantly reduce the mobility and increase pain in the hand and arm. According to Leaver et al. (2011) the health risks differ substantially with the type of instrument played. In the case of drummers, because the drum is a percussion instrument were the sound is produced through the impact of the drumstick on the drum-set, there are continuously exposed to vibrations. Consequently, multiple parts of body, such as hand-arm system, can suffer injuries due to the induced vibrations. Several symptoms can be developed by the drummers, as for example: vascular injury, resulting in finger blanching or “white fingers”, tendonitis or a variety of nerve entrapment neuropathies, such as the carpal tunnel syndrome. Piligian et al. (2000) have concluded that people that is exposed to highly repetitive tasks requiring forceful exertions, sustained or awkward postures, or vibration are very susceptible to MSDs, but these risks can be reduced with some ergonomics corrections. Stanhope (2016) performed a study to compare the musculoskeletal disorders in musicians and sportspeople, concluding that the types of MSDs developed by musicians are less visible than those experienced by the sportspeople, which can be a great problem concerning their existence and severity. In fact, if the injuries are diagnosed early it is possible to take some actions to reduce its effect or initiate an appropriate treatment to avoid its propagation, whereas if detected at advanced stage it can become a serious illness. The MSDs is the most common injuries detected in

* Corresponding author.
E-mail addresses: lroseiro@isec.pt (L.M. Roseiro), maria.paulino@dem.uc.pt (M.F. Paulino), augusta.neto@dem.uc.pt (M.A. Neto), ana.amaro@dem.uc.pt (A.M. Amaro).

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musicians (Dommerholt, 2010) and, normally, to recover they need to be treated by physiotherapists. Zaza (1998) made a systematic review on the incidence and prevalence of playing-related musculoskeletal disorders (PRMDs) in classical musicians and concluded that these disturbs are comparable to the prevalence of work-related musculoskeletal disorders reported for other occupational groups. Bragge et al. (2006) also carried out a review study to evaluate MDs in pianists, concluding that this musicians are susceptible to MSDs. However, because most of the reported studies showed methodological limitations, he concludes that from those studies is difficult to make any conclusion concerning associations between risk factors and MDs in pianists. Later on 2013, Lee et al. (2013) performed a study to evaluated musculoskeletal problems in string players and have found that playing an instrument demands repetitive movements in prolonged non-ergonomic postures, making musicians susceptible to musculoskeletal disorders.

In fact, as drumming requires the use of all limbs, the drummers are subjected to numerous risk factors, which may lead MSDs. Cuden at al (Cuden et al., 2015). have concluded that to reduce the risk of injuries, the drummers should choose a drum set or piece compatible with the anthropometric characteristics of musicians. Nowadays there is already a recognition that musicians suffer health problems derived from their occupation and lifestyle. However, according to Roset-Llobet et al. (2000), the musicians are not able to recognize the health risks for them self, they only know that the instrument played, especially percussion instruments, can induce these risks. As mentioned previously, the sound in a drum is originated by the drumheads whereby the drummer is exposed to vibration for long periods that can cause various types of hand dysfunctions. The most common are loss of sensibility, blanching and Hand-Arm Vibration Syndrome (HAVS). Hand-Arm Vibrations (HAV) are related to vibrations induced on hands and arms, usually, they are the most studied, with the vibrations lying in the range of 6.3 and 1250 Hz (Roseiro et al., 2016). Normally the HAVS are associated with workers of industries with vibration exposure, like construction, cutting, welding, agriculture vehicles and industrial trucks (Solecki, 2007; Waters et al., 2008; Rehn et al., 2002; Vihlborg et al., 2017). Nevertheless this problem can also appear in people that have the hands exposed to vibrations, like the drummers. The HAVS is a syndrome that affects the blood vessels, joints, muscles and nerves of the hand, wrist and arm. According Fridén (2001), the exposure to HAV can cause a variety of vascular and neuromuscular symptoms, like tingling in digits, discomfort or inflammation in the wrist and hand, digital lightening, cold intolerance, feebleness of the finger flexors or basic muscles and discoloration and trophic skin lesions of the fingers. Malchaire et al. (2001) has carry out a study in order to establish a relationship between the level of vibration to which workers are exposed and their musculoskeletal complaints. According these authors the risk of development of severe neurosensory lesions can be 6% or 10% of the population, depending on the varying levels of exposing, from 2.5 m/s^{-2} to 5.0 m/s^{-2}, respectively. Gerhardsson and Hagberg (2014) have observed that the injuries depend on several factors, namely on the intensity and duration of exposure to the vibration, the type of processes involved and the tools used.

In the literature, the majority of studies for the assessment of the mechanical vibration effects on the hand-arm system were performed according the calculation method outlined in the ISO 5349-1 (López-Alonso et al., 2013; 5349–1 I, 2001; 5349–2 I, 2002; Knez and Boltezar, 2013). Dong et al. (2004) have performed a study to measure the vibration energy absorbed by the human fingers-hand system when exposed to vibrations, concluding that the standard ISO 5349–1 may underestimate the effect of high frequency vibrations on the risk of finger disorders. Later, the same authors (Dong et al., 2005), have noticed that it is important to understand the transmission of vibration from a tool handle to the hands that are in contact with those vibration tools using a practical biodynamic response approach. This approach may be considered as a branch of dynamics that studies living systems and tries to give an understanding of why the human response to dynamic excitations vary with the frequency and direction of vibration. The two mechanical responses of the body that are often used to describe the effect of vibrations in the body are transmissibility and impedance. The mechanical impedance (or the resistance to vibration) allows to evaluate the force that is required to make the body move at each frequency while the transmissibility gives the fraction of the vibration that is transmitted from the vibration source to the body. Dong et al. (2005) have concluded that when the hand-resonant frequency range matches the dominant vibration frequency range of a percussive tool, it's expected that the hand-palm biodynamic response and the vibration power transmission may have an association with the vibration-induced injuries or disorders in the wrist-arm system. Therefore, the material constituent of the drumsticks that are used by drummers influences the vibration induced in the drummer's hand-arm system. In general, the drumsticks are made in wood. In fact, this kind of material is capable of producing balance between full sounds and great articulation on drums and cymbals (constituent's parts of drum). However, for producing a brighter sound and a major durability, the drumsticks in nylon are also used. Zaza et al. (2000) have showed that the type of material employed in the drumsticks can play an important role in the level of vibrations transmitted to drummers, while Cuden et al. (2015) have concluded that the fulcrum point of the drumsticks are at 1/3 of the length from the blunt end. Hence, the ergonomic set-up of drum kits and the material of drumsticks are two important points that can minimize the health risk factors of drumming. Addressing these issues, this study used always the same component arrangement of the drum kit and the same drumsticks, the drummers were only allowed to adjust the seat height.

Although proper drum kit and posture can reduce the exposure of the drummers to stress and strain, the application of an appropriate drumming technique can be also very important and this study aims to evaluate if there's differences on the vibration exposure of the drummers with and without musical training. Moreover, in the literature there are several reports addressing MSDs in the industrial workers that are exposed to vibrations, but, to the authors' knowledge, very few studies addressed the HAVS in professional drummers. A second purpose of this study was to quantify the exposure to HAV of a drummer in order to calculate the risk of appearing HAVS. The data obtained in the present study can be used to prevent injury and/or enhance the performance of drummers and to help the drumstick manufacturers in the design of tools that reduce the value of the HAV transmitted.

2. Materials and methods

This research study applied the calculation method outlined in the International Standard (ISO) 5349 (5349–1 I, 2001; 5349–2 I, 2002; Knez and Boltezar, 2013). Six male volunteers have participated in this study, three of them with formal Musical Training (MT), musicians who have had specific drum training, and the other three with no formal musical training, i.e. musicians who play spontaneously. Some relevant characteristics of each subject are presented in Table 1. All the volunteers used the same drum and the same drumsticks. The vibrations were measured in both hands of the drummers and in the drumsticks.