Biological Consequences of Exposure to Mechanical Vibration

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Abstract

A special issue of the journal Dose-Response entitled “Biological Consequences of Exposure to Mechanical Vibration” is proposed. When there is the interaction of physical agents, such as mechanical vibration to a body, physiological stress can be generated leading to expected and unexpected consequences. The aim is to describe effects due to the stress generated by the energy delivered in biological systems by mechanical vibration produced by different sources through studies involving human beings and experimental models. The evaluation of effects in molecular, cellular, and systemic level will contribute to increase the medical and biological knowledge about the interaction of mechanical vibration, as well as the understanding of the stress and mechanisms of the biological responses of the mechanical vibrations. The main topics will be related to neurophysiological responses to mechanical vibration generated in different sources, clinical approaches of the mechanical vibration generated in oscillating/vibratory platform, undesirable effect of the mechanical vibration generated in oscillating/vibratory platform, mechanical vibration in occupational activities, biological effects of ultrasound and infrasound, and quantification and physical approaches of the mechanical vibration.

Keywords

whole-body vibration, mechanical vibration, biological effects, neuromuscular response, bone response

Editorial

Mechanical vibrations are present in our lives in different situations. There are natural vibrations in the tissues and organs that are responsible for various and important functions, such as heart rate, peristaltic movement of the digestive tract, contractions of the blood vessels, and muscular contractions. In addition, during various daily activities, our bodies are exposed to mechanical vibrations of the external environment that can transmit energy to the organs and tissues. These absorbed energies can aid the organism to perform metabolic functions efficiently.

In a healthy subject, the transmission of mechanical vibrations from the environment to the body can occur in simple activities, as walking or running due to the impact of the feet with the ground. Moreover, sports participation, such as kicking a soccer ball or hitting/catching a ball with the hands (basketball or volleyball), induces vibrations and oscillations in the tissues and organs. Similarly, vibrations would be transmitted through the legs during skiing or through the arms during bike riding. Naturally, it is possible to think of other sports, as tennis, where a racquet is used to hit a ball. In this case, the racquet that is in the hand of the player transmits the vibration of the shock to the body. In some occupational activities, the vibration of the equipment is also transmitted to the body of the individuals, as in the case of drivers of a bus, trucks, tractors and other types of farm machinery, and pilots of helicopters and airplanes.

The initial transmitted mechanical vibration to the soft tissue continues through a variety of different biological structures, such as bone, cartilage, synovial fluids, joints, and muscles. Depending on the characteristics of the tissue, the

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energy of the mechanical vibration is dampened. All these phenomena are related to biomechanical parameters of the mechanical vibration such as frequency, peak to peak displacement, and peak acceleration. Naturally, each tissue has specific biomechanical characteristics, and this fact is highly relevant to the interaction of the external mechanical vibration with the tissue due to the resonance. The observed biological effects would be partly due to this interaction that would lead to neuromuscular responses with the involvement of hormonal and nonhormonal signaling pathways.

There is a strong relationship between mechanical vibration that enters the body of the subject and the vibration of tissues. It can be speculated that this relationship also could be associated with the evolution of human beings on our planet, increasing the load transmitted to the body due to the bipedal movement. Moreover, as there is a vibratory energy into the molecules, it is suggested that the biological effects of mechanical vibration could occur due to energy absorption of mechanical vibration at molecular level.

There is evidence that the physical agent, mechanical vibration, has important effects on human beings. Healthy individuals are exposed to the mechanical vibrations in their normal daily activities, including sports. However, in individuals with disability and/or disease, exposure to this physical agent does not occur naturally during their usual activities. Then, the vibratory platform has high relevance as a source of mechanical vibration. The possibility of using sources of mechanical vibration as a clinical intervention started about 60 years ago. Previously, Russian researchers observed that astronauts who were on a special mission had a decrease in muscle and bone mass due to zero gravity. A vibration platform was developed to treat these astronauts. These platforms generated oscillatory and sinusoidal mechanical vibrations with controlled frequencies and peak-to-peak displacement, resulting in whole-body vibration exercise (WBVE). Various beneficial effects have been reported due to the dose of energy associated with the WBVE, and neuromuscular responses have been described. Increases in muscular strength/power, flexibility, and gait speed; improvements in bone mineral density, balance, and the quality of life; and decreased pain and risk of falls have been reported. Moreover, different populations, such as postmenopausal women and individuals with obesity, sarcopenia, diabetes, chronic kidney disease, fibromyalgia, Parkinson disease, stroke, multiple sclerosis, cerebral palsy, Duchenne muscular dystrophy, osteogenesis imperfecta, spinal muscular atrophy, osteoarthritis, and chronic obstructive pulmonary disease, have been treated with this kind of exercise.

Based on these considerations, we proposed this special issue of the journal Dose-Response entitled “Biological Consequences of Exposure to Mechanical Vibration.” When there is the interaction of physical agents, such as mechanical vibration to a body, physiological stress can be generated leading to expected and unexpected consequences. The aim is to describe effects due to the stress generated by the energy delivered in biological systems by mechanical vibration produced by different sources through studies involving human beings and experimental models. The evaluation of effects in molecular, cellular, and systemic level will contribute to increase the medical and biological knowledge about the interaction of mechanical vibration, as well as the understanding of the stress and mechanisms of the biological responses of the mechanical vibrations. The main topics will be related to neurophysiological responses to mechanical vibration generated in different sources, clinical approaches of the mechanical vibration generated in oscillating/vibratory platform, undesirable effect of the mechanical vibration generated in oscillating/vibratory platform, mechanical vibration in occupational activities, biological effects of ultrasound and infrasound, and quantification and physical approaches of the mechanical vibration.

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