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Perception of Discomfort in hands: ergonomics evaluation of manual wheelchair propulsion handrim

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1 Context

The psycho-physiological influence of discomfort on the performance of users, during the handling of a certain product, may be due to high pressures in specific points of one or more regions of the palmar face. High pressures in differents parts of the body can also generate artery compression, veins and nerves and, consequent inflammation, corns and other lesions irradiated for several anatomical regions (BONINGER et al., 2004; AMBROSIO et al., 2005; ALM et al., 2008).

Considering the users' actions during manual propulsion, studies indicate a high prevalence of pain in the upper limbs, mainly the shoulders and wrists (MEDOLA et al., 2010; BONINGER et al., 2004; AMBROSIO et al., 2005; ALM et al., 2008). According to the study of Medola and Sprigle (2014), the reduction in biomechanical overload in manual propulsion and increased efficiency during locomotion are important aspects to be considered in wheelchair design (MEDOLA; SPRIGLE, 2014).

The objective of this study was to evaluate the perception of discomfort and its intensity on hands, in controlled activities with two types of wheelchair handrim.

2 Method

This study presents experimental and transversal approach, characterized by activity simulation in laboratory condition. The sample consisted of 30 subjects, college students belonging to the male gender and age group 18-29 years old. It was adopted as inclusion criteria, the absence of musculoskeletal symptoms in the upper limbs, the 12-month period prior to the experiment. Prior to data collection, subjects were informed about the study's objectives and procedures, and by agreeing to participate, read and signed a Written Informed Consent Form (WICF).

For the activity of mobility in a wheelchair, a distance of 6 linear meters in format "8" (infinity) was established with the purpose of controlling the demands of laterality (right or left handed). Subjects were instructed to sit in the wheelchair in order to maintain upright posture with the back in contact with the backrest of the chair as described in the study of Medola et al., (2012). The route was performed twice, with the conventional hoop (metallic cylindrical tube of 20 mm diameter) (A), and the ergonomic handrim prototype (B),which design and evaluation was previously described in the study Medola et al. (2012), and an updated version of the ergonomic handrim was evaluated in the study of Medola et al. (2014).

After the activity, the subject made the report of the discomfort intensity in the Protocol of Evaluation of Discomfort Perception, guided by a previously established scale (Likert scale with five points - 1 to 5)

Material used in the research: identification protocol, used to collect the subject's identification data and questions concerning the activities performed; Written Informed Consent Form (WICF); Protocol of Evaluation of Discomfort Perception (INOKUTI; SILVA; PASCHOARELLI, 2012); Grip Versatek (Tekscan Inc. - Boston – MA - USA); Manual wheelchair propulsion handrim (A and B) (MEDOLA et al., 2011).

3 Results and Discussion

The intensity of perceived discomfort in the Left Hand (LH) was higher than in the Right Hand (RH) for both propulsion handrim. The RD presented twelve regions with level 4 to the handrim A, while in the handrim B twelve regions were pointed with level 4 and two regions with level 5. However, when analyzing the LH, to the handrim A, it was observed fifteen hand areas with level 4 and five areas with level 5. In turn, the handrim B triggered discomfort in six regions with level 4 and five areas with 5. It must be noted that the influence of the laterality of the subjects during the experimental activity was minimized by the path format ("infinite"). However, the difference in discomfort level between both hands suggests that, in an attempt to compensate for the lack of dexterity LH, right-handed subjects (80%) applied more strength to hold the handrim, resulting in the sharp discomfort in LH.

According to some researchers (RICHTER; NOON; AXELSON, 2007; DIERUF; EWER; BONINGER, 2008; PASCHOARELLI et al., 2008; MEDOLA; ELUI; FORTULAN, 2012), it's important to pay attention to the user's inability to hold the handrim propulsion with the entire palm and fingers, which reduces the mechanical efficiency, once recruit muscles to stabilize the hand on the handrim rather than to generate power for moving the wheelchair forward.

The knowledge about the anatomy, functions and capabilities of the hands is indispensable as well as the different factors that can influence the process of using manual interfaces (MIRKA et al., 2009; DIANAT; NEDAEI; NEZAMI, 2014; MEDOLA et al., 2014; SILVA; SILVA; PASCHOARELLI, 2015). Although the perception occurs from overlapping stimuli, this research was developed in order to minimize the symbolic value of the touched surface and emphasize the tactile perception, in this case, the discomfort.

4 Conclusions

From the results, it can be said that the ergonomic handrim triggered less intense discomfort in relation to the conventional round tube handrim. However, both can be analyzed by complementary studies, aiming their ergonomic adjustments. It's also worth mentioning that, the protocol of evaluation of discomfort used in this research was sensitive to the aim of the investigation. This study contributes to the scientific and technological development in the field of Ergonomic Design and Assistive Technology.

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