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Applying different equations to evaluate the level of mismatch between students and school furniture

H.I. Castellucci [a,*], P.M. Arezes [b], J.F.M. Molenbroek [c]

[a] Facultad de Medicina, Universidad de Valparaíso, Valparaíso, Chile
[b] Research Centre on Industrial and Technology Management, School of Engineering, University of Minho, 4800-058 Guimarães, Portugal
[c] Delft University of Technology, Faculty of Industrial Design Engineering Section Applied Ergonomics and Design, Landbergstraat,15, 2628 CE Delft, The Netherlands

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ABSTRACT

The mismatch between students and school furniture is likely to result in a number of negative effects, such as uncomfortable body posture, pain, and ultimately, it may also affect the learning process. This study's main aim is to review the literature describing the criteria equations for defining the mismatch between students and school furniture, to apply these equations to a specific sample and, based on the results, to propose a methodology to evaluate school furniture suitability. The literature review comprises one publications database, which was used to identify the studies carried out in the field of the abovementioned mismatch. The sample used for testing the different equations was composed of 2261 volunteer subjects from 14 schools. Fifteen studies were found to meet the criteria of this review and 21 equations to test 6 furniture dimensions were identified. Regarding seat height, there are considerable differences between the two most frequently used equations. Although seat to desk clearance was evaluated by knee height, this condition seems to be based on the false assumption that students are sitting on a chair with a proper seat height. Finally, the proposed methodology for suitability evaluation of school furniture should allow for a more reliable analysis of school furniture.

1. Introduction

School furniture is not the only cause of pain and discomfort reported by school children. However, being seated for a long period of time in school furniture is being associated with reports of musculoskeletal discomfort and pain (Fallon and Jameson, 1996). Also, school furniture dimensions, within the context in which it is used, may have an impact on some physical aspects of the students. For example, the high level of mismatch between students and school furniture is being associated with adolescent low back pain (Milanese and Grimmer, 2004). A relationship between furniture mismatch and postural overload is also reported by Batistão (2010), because when the seat height is low, students increase upper back left inclination and right upper arm elevation, and when the seat is short, students decrease the upper back flexion velocity and increase right upper arm elevation.

Furthermore, Sents and Marks (1989) show, in a laboratory setting, that all children earned higher scores on the intelligence test when seated in furniture that suited their body sizes compared to bigger sized school furniture. This finding was corroborated by Wingrat and Exner (2005), when students were seated in 2 different sizes: traditional classroom furniture and appropriately sized desks and chairs. Smith-Zuzovsky and Exner (2004) reveals that students from 6 to 7 years old, who were seated in furniture that fit them well, performed significantly better on the manipulation test than those who were seated in furniture that was too big for them.

The above situation reveals the great importance of defining school furniture dimensions in an appropriate way. Despite that, there is a large number of studies worldwide that show a clear mismatch between anthropometrics characteristics and the dimensions of school furniture (e.g., Afzan et al., 2012; Castellucci et al., 2010; Chung and Wong, 2007; Dianat et al., 2013; Gouvali and Boudolos, 2006; Molenbroek et al., 2003; Panagiotopoulou et al., 2004; Parcells et al., 1999; Saarni et al., 2007). However, Gouvali and Boudolos (2006) state that the equations used to examine the match or mismatch between school furniture and anthropometric dimensions can be problematic in the sense that

* Corresponding author. Tel.: +56 9 54123829.
E-mail addresses: hector.castellucci@uv.cl, icastellucci@ergocare.cl (H. I. Castellucci).

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they are sometimes based on contradictory criteria, originating from theory that has not necessarily been confirmed with research.

The main aim of this paper is to review literature that describes the criteria equation for defining the mismatch between students and school furniture, to apply the different mismatch equations to a specific sample, and to propose a methodology to evaluate school furniture suitability.

2. Method

2.1. Literature review

One literature database, Scopus, was used to identify the studies carried out in the field of mismatch or fit between anthropometric measures and classroom furniture. The search terms used were "school furniture" and "classroom furniture" (Fig. 1).

The inclusion criteria for the selection of the relevant papers are all reviewed articles that are original studies, written in English, and published between January 1980 and January 2013.

The literature review was orientated toward the definition of the mismatch equations. Studies that only present a proposal of a new dimension set size for school furniture, based on, for example, the application of percentiles, were not considered.

Potential mismatch equations were grouped according to the part of the school furniture considered, namely:

- Chair dimensions;
- Interaction between chair and table dimensions.

All mismatch equations, one- and two-way, were considered. For those cases where both the minimum and maximum limit were considered, a two-way equation was considered appropriate and for those with only a maximum or a minimum limit, a one-way equation was the required option.

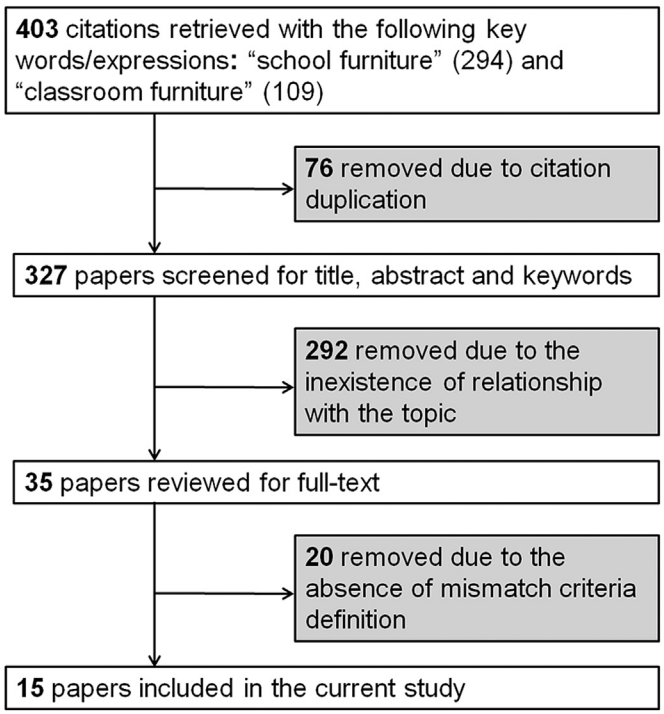

Fig. 1. Diagram of the used search strategy and exclusion criteria.

2.2. Field procedure

2.2.1. Sample

The considered sample involved a group of students, with ages ranging from 5 to 19 years old (11.9 ± 3.5 mean), from basic and secondary schools in the Valparaiso Region of Chile. Fourteen schools were randomly selected from a list given by the Regional Ministerial Secretary of Education and the selection used a cluster design regarding the three types of elementary school administrations in Chile, as well as of the economic background level of the corresponding students.

The sample study consisted of 2261 volunteer subjects (1259 male and 1002 female). The data collection started after written authorization was obtained about the study from the headmaster of the school, which was followed by the collection of the written authorizations obtained from all parents and students.

2.2.2. Anthropometric measurements

The anthropometric measurements were collected from the right side of the subjects, while they were sitting in an erect position on a height-adjustable chair with a horizontal surface, with their legs flexed at a 90° angle, and with their feet flat on the floor or an adjustable footrest. During the measurement process, the subjects were without shoes and wearing light clothing (shorts and t-shirts).

All measurements were taken with a Harpenden standard anthropometer (Holtain Ltd., UK), with an exception made to subjects' stature, which was measure with an estadiometer.

The following anthropometric measures (ISO 7250, 1996) were considered and collected during this study (Fig. 2):

2.2.2.1. Stature. Determined as the vertical distance between the floor and the top of the head, and measured with the subject erect and looking straight ahead (Frankfort plane).

2.2.2.2. Shoulder height sitting (SHH). Vertical distance from subject's seated surface to the acromion.

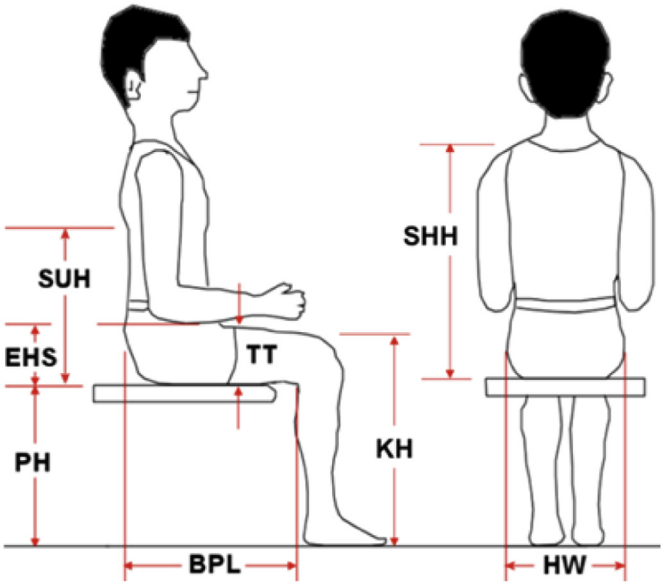

Fig. 2. Schematic representation of the considered anthropometric measurements.