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Evaluation of the Indonesian National Standard for elementary school furniture based on children's anthropometry

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ABSTRACT

In Indonesia, National Standardization Agency of Indonesia issued the Indonesian National Standard SNI 12-1015-1989 and SNI 12-1016-1989 to define the type of furniture dimensions that should be used by children in the elementary school level. This study aims to examine whether the current national standards for elementary school furniture dimensions issued by National Standardization Agency of Indonesia match the up-to-date Indonesian children's anthropometry. Two types of school furniture, small type (Type I, for grade 1–3) and large type (Type II, for grade 4–6), were evaluated in terms of seat height, seat depth, seat width and backrest height of a chair as well as the height and underneath height of a desk. **1146** students aged between 6 and 12 years old participated in the study. Seven anthropometric measurements were taken including stature, sitting shoulder height, sitting elbow height, popliteal height, buttock-popliteal length, knee height and hip breadth. Based on the standard school furniture dimensions and students' body dimensions, numbers of matches and mismatches between them were computed. Results indicated a substantial degree of mismatch between children's anthropometry and the standard dimensions of school furniture. The standard seat height was not appropriate for students among different grades with the mismatch percentage ranging from 63.4% to 96.7% for Type I and 72.7% to 99.0% for Type II. For desk height, the standard dimensions were not appropriate for students among different grades with the mismatch percentage ranging from 32.3% to 88.9% for Type I and 67.7% to 99.0% for Type II. Apparently, the current standards are out of date and need to be updated. Four different sizes of school furniture were hence proposed to accommodate the variation in students' anthropometry from Grade 1 to Grade 6. The proposed standard dimensions (PrS) of school furniture cover a slightly broader range of age and present a higher cumulative fit than the current standard dimensions (CrS). In addition, a better strategy for sizing can be also developed to fit chairs and desks to a larger number of students.

1. Introduction

Elementary school children remain seated for most of their school hours. They carry out most of their activities such as reading and writing in the sitting position. According to Castellucci et al. (2010), children spend approximately a quarter of the day at school, and 80% of that time sitting down doing their school work. Considering the amount of time spent by children in the sitting posture, it is necessary that the school authorities provide the school furniture which promotes good sitting posture. In addition, student's sitting posture is also influenced by the activities performed in the classroom, the anthropometric measures of school children and the measures and design features of school furniture (Yeats, 1997).

Children's postures, especially when seated in school, have been a concern since the 18th century (Zacharkow, 1987). During the last few decades, there has been an increased concern about studies of

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school furniture and their match or mismatch to student's body dimensions. Mismatches between sizes of school furniture and students' anthropometric dimensions have been reported in many countries such as in Greece (Panagiotopoulou et al., 2004; Gouvali and Boudolos, 2006), Iran (Mououdi and Choobineh, 1997; Dianat et al., 2013), Portugal (Assuncao et al., 2013), United States (Parcells et al., 1999), India (Savanur et al., 2007) and Chile (Castellucci et al., 2010). The identified mismatch between sizes of school furniture and students' anthropometry carried negative effect for the students. Panagiotopoulou et al. (2004) reported that 18.3% of the 2nd grade, 20% of 4th grade and 45% of 6th grade students have suffered from recurrent or continuous back pain due to the poor fit of school furniture. Assuncao et al. (2013) found that approximately 58% of students experienced back pain owing to similar reasons. Besides, girls presented a higher prevalence (59%) than boys (47%), and the prevalence increases with age. In a study of British school children by Murphy et al. (2004), it was reported that the improper design of school furniture was significantly associated with neck pain, upper back pain and low back pain. In India, students reported discomfort in shoulder, wrist, knee and ankle regions due to the seat and desk heights which were higher than the comparable students' anthropometric dimensions and that of the recommendations of Bureau of Indian Standards (Savanur et al., 2007). Meanwhile, Castellucci et al. (2016) provided similar evidence for the need to update the Chilean standard for school furniture dimensions.

Some countries decide to use standards to define the type of furniture dimensions that should be used according to students' anthropometric characteristics (Castellucci et al., 2016). Meanwhile in Indonesia, National Standardization Agency of Indonesia issued *the Indonesian National Standard* SNI 12-1015-1989 (NSAI, 1989a) and SNI 12-1016-1989 (NSAI, 1989b) which determine the characteristics and dimensions of different types of chair and desk for Indonesian elementary school children. However, these standards were published more than 26 years ago. Meanwhile, within the 26-year interval since the standards issued by NSAI, no studies have been conducted to examine whether these standards are still able to meet the current needs. Changes in students' demography and body dimensions could make the standards out of date and not relevant. In addition, it seems that these standards were developed without any ergonomics criteria, especially the use of children's anthropometry. This situation can be a consequence of both the lack of knowledge from the government authorities and the lack of a representative anthropometric database of the population in concern (Molenbroek et al., 2003).

Therefore, this study aims to examine whether *the Indonesian National Standard* SNI 12-1015-1989 and SNI 12-1016-1989 for chair and desk dimensions match with the up-to-date anthropometric data of Indonesian children. To achieve this, we first collected the students' anthropometry and then compared the data with the national standard school furniture dimensions issued by NSAI across students from Grade 1 to Grade 6. The percentage of mismatch serves as the key measure to evaluate the difference in between for both small type (Type I, for grade 1–3) and large type (Type II, for grade 4–6) school furniture. Following the results, suggestions for updating the standards and better sizing strategies will be further proposed.

2. Methodology

2.1. Sample and sampling method

The student population of elementary school in Jakarta during 2015 was 825,971 where 76.5% of them went to public schools and 23.5% went to private schools (Jakarta Education Authorities, 2015). Considering a 50% prevalence of school furniture mismatch ($\widehat{p} = 0.5$) to obtain the largest sample (Castellucci et al., 2016), with 3% accuracy and 95% confidence interval, the theoretical sample size is 1068. In the Indonesian education system, there are six grades with male and female students ranging from 6 to 12 years old in every elementary school. Hence, it was decided to take sample to cover all elementary school students' grade and gender.

Prior to conducting this survey, the survey team was sent to a number of seven predetermined elementary school (denoted by A, B, C, D, E, F and G). The headmaster of each elementary school was approached and his/her approval was taken. For each school, the students were selected using a stratified sampling method, subdividing on the basis of grade and gender. Stratified sampling was used to select the participants since this method could guarantee that the samples represent specific sub-groups. The application of stratified sampling to select number of participants across grades contains two stages, as illustrated in Fig. 1. Firstly, the determination of participants in each grade and school to ensure the actual representation of grade. In this step, each grade was adapted as a stratum to draw sample group member. Secondly, the selection of participants from each grade by considering a balanced proportion between boys and girls. By applying stratified sampling, the samples could cover strata of grade and gender. In the first stage, the number of samples in each grade from each school was determined proportionally (illustrated in Fig. 1). For example, let n_{1A} denotes the number of Grade 1 students in School A, n_A denotes the total number of students in School A, n_1 denotes the total number of Grade 1 students in all schools and n_T denotes the total number of students in all schools. The number of samples in Grade 1 (n_{S1}) was determined by multiplying the percentage of students in Grade 1 with the theoretical sample size ($n_{S1}=(n_1/n_T)*1068$). Subsequently, the number of samples in Grade 1 from School A ($n_{S1(A)}$) was determined by multiplying the percentage of students in Grade 1 from School A (n_{1A}/n_A) with the number of samples in Grade 1 (n_{S1}). This similar step was applied to determine the number of participants for each grade from all schools. In the second stage, the number of samples was determined by considering a balanced proportion between boys and girls. For example, let $n_{1A(boy)}$ denotes the number of Grade 1 boys in school A and $n_{1A(girl)}$ denotes the number of Grade 1 girls in school A. The number of samples for boys in Grade 1 from School A ($n_{S1A(boy)}$) was determined by multiplying the percentage of boys in Grade 1 from School A ($[n_{S1A(boy)}]/[n_{S1A(boy)}+n_{S1A(girl)}]$) with the number of samples in Grade 1 from School A ($n_{S1(A)}$). This similar step was then applied to determine the number of participants for each gender for all grades in each school. In addition, a 5–10% of the predetermined number of participants was added for each grade to ensure the number of participants is greater than the theoretical samples as well as to anticipate invalid measurements or mistakes entering the data.

In this study, the final sample involved 1146 children with their ages ranging from 6 to 12 years old. Regarding the theoretical sample size, a sample size of 1146 in this study would be sufficiently precise to estimate the degree of mismatch with a 95% confidence interval. All participants were taken from seven elementary schools in Metropolitan Area of Jakarta, Indonesia (five are public schools and two are private schools). The sample covered both gender and every school grade from Grade 1 (G1), Grade 2 (G2), Grade 3 (G3), Grade 4 (G4), Grade 5 (G5) and Grade 6 (G6). Table 1 presents the grade and gender distribution of students who participated in this study.

2.2. The Indonesian standard school furniture dimensions

For elementary school furniture, *National Standardization Agency of Indonesia* issued *the Indonesian National Standard* (SNI) for