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MISMATCH BETWEEN ANTHROPOMETICS AND CHAIR DIMENSION OF PRIMARY SCHOOL CHILDREN (LEVEL 1) IN NORTHERN REGION, MALAYSIA

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INTRODUCTION

Several studies have been done on the issue of mismatch between the anthropometrics dimension among school children and classroom furniture in different countries. All the studies shared the same results, showing that there is mismatch between the two variables (Mohd Azuan K. et al. 2010; Castellucci, Arezes & Viviani 2009; Nurul Asyiqin et al. 2009; Lueder & Rice 2008; Gouvali & Boudolos 2006; Lipardo et al. 2006; Murphy, Buckle & Stubbs 2003). The issue on mismatch in this paper does not only focus on chair dimension and anthropometric variables of the children, but it also investigates the possible negative implication of seating posture due to the mismatch (Castellucci, Arezes & Viviani 2009; Gouvali & Boudolos 2006; Parcells, Stommel & Hubbard 1999; Panagiotopoulou et al. 2004). Mismatch between body dimension and chair design may lead towards awkwardness of sitting position among the children. The awkward sitting posture will then refer to pressure at joints and muscle fatigue during sitting. This phenomenon could lead towards permanent damage to the body. Therefore, allowing the children to continuously use incorrect design of chair will jeopardise the children's health (Gouvali & Boudolos 2006; Lipardo et al. 2006) and could cause back pain (Lueder & Rice 2008).

In Malaysia, primary schools consist of two levels: Level 1 and Level 2. Level 1 comprises school children aged between 7–9 years old (Year 1–3) and Level 2 comprises school children aged between 10–12 years old (Year 4–6). Basically, school children have to spend between 5–6 hours in the classroom for a week. Savanur, Altekar and De (2007) mentioned that school children normally spent 60%–80% of their time sitting on the chair during their class session. Therefore, it is pertinent for school children to use correct chair design to avoid mismatch between chair dimension and anthropometric variable. Designing products, especially school furniture that fit school children's body dimension will help to maintain their physical health, comfort, well-being and performance as well as productivity (Tunay & Melemez 2008; Parcells, Stommel & Hubbard 1999; Pheasant 1988).

Panagiotopoulou et al. (2004) suggests that correct sitting posture should be encouraged during the early age of school children. However, the idea should also be synchronised with other factors such as practical design of the chair, correct anthropometric dimension and types of activities involved (Murphy, Buckle & Stubbs 2003).

The aim of this study is to establish the percentage of mismatch between the anthropometrics variable and the classroom chair dimension used during school children's learning sessions and determine whether school chair design and dimension promote good sitting posture among the children during learning sessions in schools.

RESEARCH METHODS

Direct Observation

A total of 108 school children aged between 7–9 years old (Level 1) from government schools were involved in this research. The investigation was conducted at 12 different primary schools, covering urban and rural areas in three different states of the Northern region of Peninsular Malaysia (Perlis, Kedah and Pulau Pinang). About 36 students from each school were randomly selected with school permission.

Anthropometris Variable

Anthropometer, height and weight scale, and goniometer were used as main tools in obtaining anthropometric data of the respondents. Static measurements of anthropometric were taken on the respondents' position of standing upright on the floor and sitting correctly on a chair. The four measurements of anthropometrics variable (Panero & Zeinik 1979) in the research are shown in Figure 1.

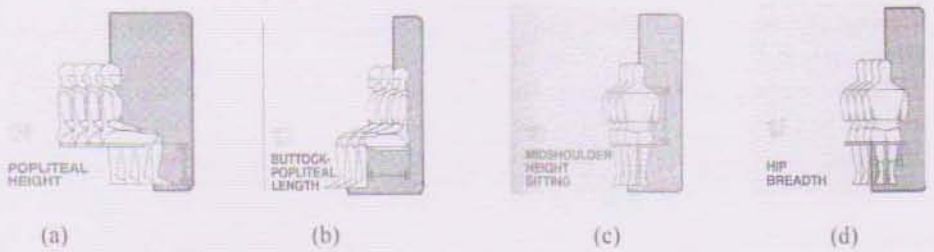

Figure 1 Anthropometric variable used for seating: (a) popliteal height (PH), (b) buttock-popliteal length (BPL), (c) mid-shoulder height sitting (MHS), and (d) hip-breadth (HB)

Source: Panero and Zeinik (1979)

Chair Dimensions

Types of chairs used in schools (Level 1) were identified. Seat size definitions were also recorded by referring to the chair dimension (Panero & Zeinik 1979) that can be explained as follows (Figure 2):

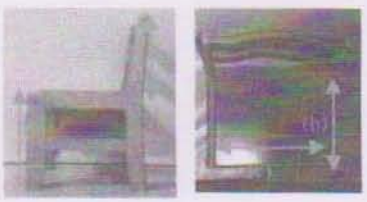

Figure 2 Classroom chair dimension: (a) seat height (SH): The distance from the floor to the surface of the chair seat, (b) seat width (SW): measured horizontally on the surface of the seat, (c) seat depth (SD): measured vertically on the surface of the seat, (d) backrest height (BRH): measured vertically from the seat backrest to seat surface

In this study, the method used by Gouvali and Boudolos (2006) was adopted to find out the percentage of mismatch between anthropometrics variable and chair dimensions among the school children. All statistical data were analysed using SPSS. Both anthropometrics variable and chair dimension were used as variables. Referring to the method used by Gouvali and Boudolos (2006).

all the data were analysed in order to establish the mismatch between the anthropometrics of the school children and the school chairs.

Video Analysis

A video handy-camera was used to record 30 minutes of postural seating behaviour of the respondents in the classroom during their learning sessions. Awkward postures that attribute to discomfort were identified. The three approaches mentioned were used to check on the correlation between variables and discomfort posture seating.

RESULTS AND DISCUSSION

Anthropometric Data and Analysis

Tables 1, 2 and 3 show the anthropometric descriptions of primary school students aged 7–9 years old.

Table 1 Summary of anthropometric dimensions of Year 1 students (aged 7 years old)

Antropometric dimension (cm)	N	Mean	SD	Minimum	Median	Maximum
Weight	36	28.6194	12.72293	12.00	27.1500	70.00
Stature	36	122.1667	9.37821	102.50	122.7500	140.00
Popliteal height	36	33.9806	3.29266	27.50	34.0000	42.00
Buttock-popliteal length	36	32.4333	3.06929	26.50	32.2500	39.50
Hip-breadth	36	25.4611	4.72551	16.50	25.2500	38.50
Shoulder height	36	37.3306	5.37336	25.50	37.5000	54.00

Table 2 Summary of anthropometric dimensions of Year 2 students (aged 8 years old)

Antropometric dimension (cm)	N	Mean	SD	Minimum	Median	Maximum
Weight	36	31.7806	13.99437	11.00	32.3000	70.20
Stature	36	127.0000	9.78629	111.00	125.5000	146.00
Popliteal height	36	36.4000	3.89292	28.00	36.0000	45.20
Buttock-popliteal length	36	33.8778	4.43545	25.00	33.2500	45.20
Hip-breadth	36	26.9722	5.69569	18.00	26.2500	41.40
Shoulder height	36	37.9389	6.31991	26.00	38.2500	48.00

Table 3 Summary of anthropometric dimension of Year 3 students (aged 9 years old)

Antropometric dimension (cm)	N	Mean	SD	Minimum	Median	Maximum
Weight	36	43.0764	19.39490	13.00	44.0000	94.35
Stature	36	122.1667	9.37821	102.50	122.7500	140.00
Popliteal height	36	38.2750	3.88104	29.00	38.0000	45.00
Buttock-popliteal length	36	36.2417	3.53694	29.50	36.0000	43.00
Hip-breadth	36	30.9083	7.11704	19.40	32.0000	45.50
Shoulder height	36	41.8417	6.38254	28.00	41.4500	54.00

Based on the survey, the anthropometrics variable of weight shows there is a large standard deviation which indicates that the data points are far from the mean. This shows that there is dispersion in which the data spread out over a large range of value. Other anthropometrics variables are low standard deviations which indicate that the data points tend to be very close to the mean. Weight is an important variable to justify discomfort in the posture due to the flat surface of the chair design available in schools. Due to the flat seat surface, a large amount of

weight can cause high compression to the buttock-popliteal length and hip breadth, pain at the ischial tuberosities and blood circulation to be constricted.

Chair Dimension

According to the observation done in 12 different primary schools, there are 13 different dimensions of chairs revealed from the observations, as shown in Table 1. There are two types of chairs used in the primary schools, which are wooden chairs and plastic chairs. Wooden chairs are used in all 12 schools. However, only one school is using plastic chairs for Year 2 and Year 3 children, and another school is using plastic chairs for Year 2 only. Generally, wooden chairs appear to have similar design to each other. However the dimensions varied (refer to Table 4).

Table 4 Chair dimensions in primary schools (all dimensions are in cm)

Chair	Seat height	Seat width	Seat depth	Backrest height	Year	School
Wooden chair						
A	33.7	38.5	38	31.5	Y1, Y3	12SKMH
B	34	36.5	32	29	Y1	10SKBG
C	36	38	35.4	31.5	Y1, Y2, Y3	9SKDK
D	37	39	42	31.7	Y1, Y2, Y3	2SKKS
E	38	38	38.5	32	Y1, Y2, Y3	4SKSR
F	38	38	41	31	Y1, Y2, Y3	6SKSM
G	38	37.7	38.3	32.5	Y1, Y2, Y3	11SKJH
H	38	37.5	42.25	31.5	Y1, Y2, Y3	3SKPM
I	38.5	38.5	38	31.5	Y1, Y2, Y3	1SKBE
J	39	38.1	38.2	32	Y1, Y2, Y3	8SKAJ
K	39.1	38.1	38.6	30	Y1, Y2, Y3	5SKBBSL
L	39.1	38	38.5	30	Y1, Y2, Y3	7SKS
Plastic chair						
M	43.3	38.5	42	36.7	Y2, Y3 Y2	10SKBG 12SKMH

Percentage of Mismatch Between Anthropometrics Variables and Chair Dimension (Refer Table 4)

The results (Figure 3) obtained show that the number of match and mismatch between seat height and popliteal height is equally scored. The 50% of match consists of 54 students while the other 50% of students also consists of the equivalent number of 54 students. There are two types of mismatches, whether the respondents have small or large values of popliteal height that did not match to the seat height of the chair. Respondents who have small value of popliteal height that did not match to the seat height consist of 42 students, while those who have large value of popliteal height that did not match to the seat height consist of 12 respondents. A seat surface that is too high for those respondents who have small value of popliteal height can cause compression at the thigh and constrict the blood circulation that can cause numbness. Whereas, if the seat surface is placed too low, it may cause the leg to be extended in a forward position that can deprive stability to those respondents who have large value of popliteal height. And it can also deprive the sitter of proper lumbar support due to the body forward movement.

The findings (Figure 4) show that only 20% (22 students) of the respondents match to the seat depth, and the rest of the 80% (86 students) show the mismatch. There are two types of mismatches, whether the respondents have small or large value of buttock popliteal length that did not match to the seat depth of the chair. The results generated show that respondents who have small value of buttock popliteal length that do not match to the seat depth of the chair consists of two students, whereas the rest of 84 students do not match the seat depth because of their large

value of buttock popliteal length. According to Panero and Zeinik (1979), if the depth of the seat is too great for users who have small value of buttock popliteal length, this can cause discomfort and problems with the blood circulation due to the compression behind the knee at the front of the seat pan. Meanwhile, if the seat depth is too shallow for those with great value of buttock popliteal length, it will deprive the sitter proper support under the thigh and also give sensation of tipping off the chair.

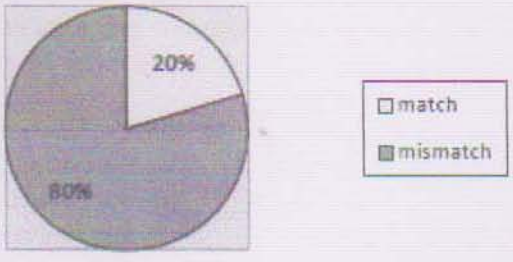

Figure 3 Percentage of mismatch between seat height and popliteal height

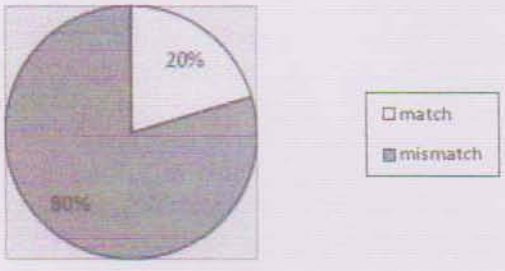

Figure 4 Percentage of mismatch between seat depth and buttock-popliteal length

The findings (Figure 5) also show that only 24% (24 students) of the respondents match to the seat width, while the rest of 76% (84 students) show the mismatch. There are two types of mismatches, whether the respondents have small or large hip-breadth that did not match to the seat width of the chair. About 75 students of small hip-breadth and nine students of large hip-breadth do not match to the seat width. According to the observation result of this paper, a small seat width can cause compression to the surplus of large hip-breadth which causes irritation to the user. A large seat width for small hip-breadth will cause pain in the area behind the knee while doing the lateral movement as the knee collides with the edge of the seat pan. From the observation of the paper, the chair design available in the school does not allow the lateral movement for the user. In order to achieve stability, a good seat width not only should be enough to accommodate the user with the largest hip-breadth and to support the ischial tuberosities, but it should also allow space for lateral movement to the user (Gouvali & Boudolos 2006).

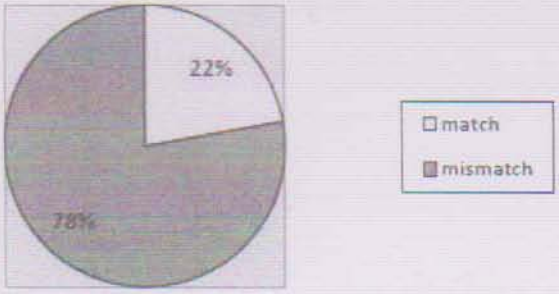

Figure 5 Percentage of mismatch between seat width and hip-breadth

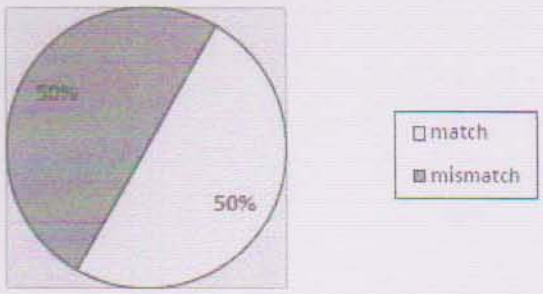

Figure 6 Percentage of mismatch between backrest height and mid-shoulder height

From the results generated above (Figure 6), we have shown that the number of match and mismatch of backrest height and mid-shoulder height are equally scored which is 50% (54 students). There are three types of mismatches, whether the respondent has low, too low or too high mid-shoulder height in which the backrest height did not support the lumbar region of the user. About two students are under the category of too low and too high mid-shoulder height respectively, while the rest of 50 students are categorised in the too high mid-shoulder height section. According to Panero and Zeinik (1979), the main function of backrest is to provide

support for the lumbar region and provision for the extension of the buttock area. An appropriate backrest height is below the scapula to facilitate mobility of the trunk and arm (Gouvali & Boudolos 2006).

Based on percentages obtained in Figures 3, 4, 5 and 6, mismatch appears in all variables. There is critical percentage of mismatch amongst primary school students and the chairs available in schools during learning sessions. Results indicate that the existing chairs available in schools do not meet the inclination of anthropometric data variables of children. This situation highly contributes to the factor of discomfort and awkwardness of sitting positions amongst primary school students during learning sessions in schools.

By merging the variables, the results show a wide percentage of mismatch between the anthropometrics variable of primary school children (Level 1) and chair dimension used in the class. Only 4% (4 students) fitted to the chair used in the school, while 96% (104 students) did not fit to the chair during the learning session in class (refer to Figure 7). Therefore, this figure shows that a big percentage of school children have awkward sitting positions and are exposed to back pain illness as discussed earlier.

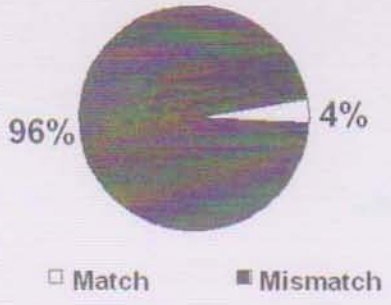

Figure 7 Percentage of mismatch by merging the anthropometrics variables and chair dimension

Video Analysis

Video handy-cam recorded the postural seating changing by duration

Respondent I: Muhd Yusri Nazri 7 years old						
Duration	0–5 minutes	6–10 minutes	7–15 minutes	16–20 minutes	21–25 minutes	26–30 minutes

Figure 8 Sekolah Kebangsaan Suka Menanti, Alor Setar, Kedah (wooden chair)

Respondent II: Ivan Cheah 8 years old						
Duration	0–5 minutes	6–10 minutes	7–15 minutes	16–20 minutes	21–25 minutes	26–30 minutes

Figure 9 Sekolah Kebangsaan Minden Height, Pulau Pinang (plastic chair)

Seat height and popliteal height

The hanging feet while sitting can weaken body stability. The sitting position of extending and position forwarded body not only depriving them from any stability but also deprive the sitter proper lumbar support as it causes the backslide away from the backrest.

Seat depth and popliteal buttock length

The incorrect dimension of chair force students to place their buttock forward to the edge to reach the floor surface can cause constricted the blood circulations. In addition, it deprives the backrest from the back, the user try to recline as to achieve the backrest support.

Seat width and hip breadth

The incorrect dimension of seat width refused the user from the lateral movement.

Backrest height and mid-shoulder height

In order to achieve comfort for backrest, the user force to seat in depth of the chair in which he have to forward the body movement while writing.

Figure 10 Sitting posture and behaviour (wooden chair)

Seat height and popliteal height

The student tries to reach floor surface to obtain stability for sitting. This position stresses the muscular at the feet. These incorrect postures can lead permanent damage to body.

Seat depth and popliteal buttock length

The incorrect dimension of chair force students to place their buttock forward to the edge to reach the floor surface can causes the thigh compresses and constricted the blood circulation. As to reduce discomfort at the feet, he have stretch and open wide his leg in awkward position.

Seat width and hip-breadth

The mismatch of the hip-breadth and seat width causes compresses at the under thigh, this allow interruption of blood flow and causes numbness at the muscle. It refuses the user from the lateral movement.

Backrest height and mid-shoulder height

In order to achieve comfort for backrest, the user recline while sitting on the chair.

Figure 11 Sitting posture and behaviour (plastic chair)

CONCLUSION

In conclusion, statistic results from the analysis indicate a clear mismatch between chair dimension used in class and anthropometrics of the students who participated in this study. The chair dimensions were not standardised (measurement of four variables of chairs) which showed a mismatch with the respondents. The mismatch between the chair dimension and the anthropometric of the respondents could create several possible awkward sitting postures amongst primary school students.

Due to the mismatch, the most possible issue is awkward sitting postures among students, where they will lean forward their body and put their buttocks on the edge of the seat pan in order to achieve stability. The sitting posture does not only cause compression under the thigh, numbness and fatigue, but also deprives the user from the back rest for some time during learning sessions.

Therefore, a proper standard dimension of chairs that fits the students is very important to prevent permanent damage to their body. However, regarding to the statistic results, as the age of the users increases, the anthropometrics data will also increase proportionally, thus reducing the number of students who match the existing chairs from time to time. Hence, providing a proper standard dimension of adjustable chair for each student in primary school (Level 1) could be a solution to this problem.

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