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# Mismatch between classroom furniture and the primary school pupils' body dimensions: A systematic review

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## **Abstract**

**Background:** Studies have been done on the mismatch between classroom furniture and students' anthropometric measurements. However, there is a lack of systematic reviews done regarding the mismatch between classroom furniture and primary school students' (6-12years old) students' body dimensions.

**Objective:** The objective of this systematic review is to examine the match/mismatch between classroom furniture (desks and seats) and body dimensions of primary school students and to also identify any furniture features which have been found to be mismatched across the current literature.

**Methods:** Online literature databases EBSCO, Google scholar and ScienceDirect were searched. Publications were then excluded or included based on a full review of titles, abstracts, methodology, research findings and discussions. Publications were included when they reported findings and compared the match between the students' body dimensions and classroom furniture.

**Results:** All studies reviewed indicated a common mismatch between desk height and Elbow rest height, seat height and Popliteal height and seat depth and Popliteal-buttocks length.

**Conclusion:** Seat height, seat depth and desk height were found to be common furniture features in contributing heavily to the mismatch between students' anthropometry and furniture features. There should be an added focus in matching these furniture features to students' anthropometry.

**Keywords** – Furniture, Anthropometry, School, Classroom

## **INTRODUCTION**

Around the age of 6, students are exposed for the first time to their first “workplace” in the form of primary school. As such, Students spend most of their waking hours sitting in school for prolonged periods (Troussier, et al., 1999). In some countries such as Singapore, students can spend up to 7-8 hours or almost a third of the day in school, with a large portion of the time spent reading and writing while seated.

This gives rise to concerns about ensuring good sitting posture for students in schools, especially primary school children who are the youngest end of the schooling spectrum and are in a crucial period of physical growth and development.

Long hours of prolonged sitting have been suggested to result in adverse physical consequences such as poor postural behaviour in the long term (Cardon, De Clercq, De Bourdeauhuij, & Breithecker, 2004) and various musculoskeletal disorders such as back pain, neck and shoulder pain. Thus, the importance of the classroom furniture cannot be understated due to its direct influence on posture and bad sitting posture can be difficult to correct during adulthood or adolescence (Yeats, 1997).

There are several factors which could influence the sitting posture, such as students' anthropometric dimensions, dimensions of classroom furniture (Murphy, Buckle, & Stubbs, 2007) and some other variables. A common observation is that classroom furniture is generally fixed throughout school life for several reasons such as financial cost. But this raises potential concerns about the suitability of the classroom furniture for students as their anthropometric measurements varies over a wide range across the grade levels.

The mismatch between anthropometric measurement and furniture design has been a focus for many researchers (Macedo, et al., 2015; Castellucci, Arezes, & Molenbroek, 2015; Musa & Ismaila, 2014; Agha, 2010). Although there are numerous studies on the mismatch between anthropometry and classroom furniture dimensions, there is a lack of systematic reviews analysing the mismatches. One systematic review regarding the influence of the furniture on students' performance and physical responses (Castellucci H. , Arezes, Molenbroek, de Bruin, & Viviani, 2017) has been found thus far but no systematic review which compiles and examines the current literature about the furniture features which have been commonly mismatched has been found yet.

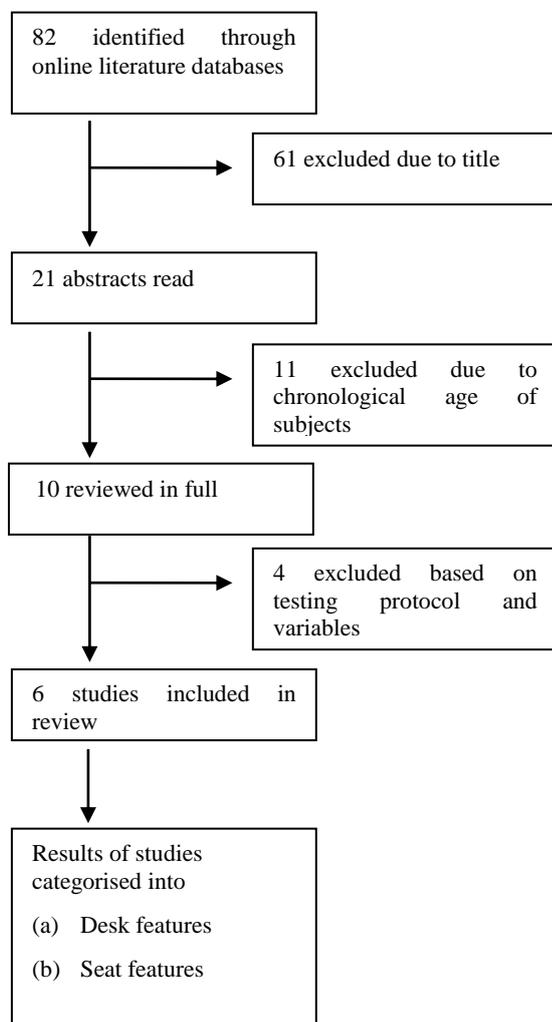
Thus, this review aimed to collate current literature, examine the mismatch between students' anthropometry and furniture dimensions, specifically on 6-12 years old primary school students, and identify any common trends observed across the globe in the hopes

of shedding some light for relevant stakeholders within the education system in Singapore about the mismatch of classroom furniture and students' anthropometry.

## METHODS

For this systematic review, a search strategy was first implemented followed by an assessment of quality for the finalized list of studies included.

### Search Strategy



**Figure 1.** Search strategy: 6 studies categorized into findings of desk dimensions and seat dimensions

One independent author utilized electronic literature databases, EBSCO, Google scholar and ScienceDirect to search on the current literature. The search strategy (Figure 1) was a process where the author filtered and identified the studies relevant to the study. Several keywords (classroom, anthropometry, furniture, school) were used to refine the search parameters. In no specific order, several combinations of the keywords (classroom and anthropometry or furniture and anthropometry) were used to obtain as many relevant studies as possible. Firstly, the results from the search excluded any duplicates of publications. Studies were then evaluated for further exclusion based on title. The studies with irrelevant titles were excluded. The

abstracts and/or complete texts of the studies were then evaluated by the independent author for further review and further exclusion based on subjects' chronological age, testing protocols and the variables involved in the study. The author also examined the reference lists of the studies for any other related publications.

### Inclusion and Exclusion Procedures

The studies that were included focused on the availability of data about 6-12 years old students' anthropometric measurements, dimensions of furniture and the evaluation of the desk-student and seat-children match.

Studies were excluded if (a) subjects' age were below 6 and above 13 (b) subjects were non-primary school/non-grade 1-6 students (c) furniture measurements were not taken (seat height, seat depth, seat slope, desk height, desk slope and desk clearance) (d) students' anthropometric measurements were not taken (stature, Elbow height, upper arm length, Knee Height, Popliteal height and Buttock-Popliteal length) and (e) study focus included other variables (e.g. ethnicity)

Studies which were included in review were split into the two types of findings they provided: (a) dimensions of desk/s leading to the study's evaluation of the match or mismatch between the individual dimensions and their corresponding anthropometric measurement of the students and (b) dimensions of seat/s leading to the study's evaluation of the match or mismatch between the individual dimensions and their corresponding anthropometric measurement of the students.

Extraction of information from the studies included was based on the (a) research setting and design, (b) characteristics of the sample, and (c) major findings.

### Assessment of Quality

All the publications that fulfilled the criteria for inclusion were reviewed in full by the single independent author. Downs and Black (1998)'s Quality Index (QI) assessment tool was used to assess the quality of the publications that were included in the review. Even though it was hard to use some items in this index considering the nature of this review, this QI was still considered to be valid over a wide array of fields. The QI has several sections in which studies can be scored on, such as reporting, internal validity, external validity and power. For each section, the QI will provide a relevant set of questions and the studies will be rated accordingly. The ratings will be totalled up at the end. The maximum score of the QI is set at 32 points.

### Determining Mismatch

All studies involved used equations to measure the match/mismatch between students' anthropometry and

furniture features. Table 1 below shows the equations used as the criteria for a match of mismatch between a furniture feature and corresponding anthropometric measurement.

Furniture Feature	Equations used in studies for parameter match
Seat Height (SH)	$(PH+2) \cos 30^\circ \leq SH \leq (PH+2) \cos 5^\circ$
Seat Width (SW)	$1.1HB \leq SW \leq 1.30HB$
Seat Depth (SD)	(a) $0.8PBL \leq SD \leq 0.99PBL$ (b) $0.8PBL \leq SD \leq 0.95PBL$
Backrest Height (BH)	$0.6 * ShH \leq BH \leq 0.8 * ShH$
Desk Height (DH)	$SEH + ((PH+2) \cos 30^\circ) \leq DH \leq ((PH+2) \cos 5^\circ) + (0.8517SEH) + (0.1483ShH)$
Desk Clearance (DC)	$KH + 2 \leq DC$

Table 1. shows equations used for matching of parameters

## RESULTS

As shown below in Table 2, 82 potential studies were identified through the online databases. Of the 82 studies, 61 were excluded based on screening of the title. The abstracts of the remaining 21 studies were then read for further inclusion or exclusion. Out of the 21 studies left, 11 studies were excluded due to a difference of the chronological ages of the subjects. The remaining 10 studies were then reviewed in full. 4 studies out of the 10 were excluded due to a difference in testing protocols or variables. 3 studies were excluded as they only recorded students' anthropometric data without collecting furniture dimensions data. 1 study was excluded as it involved an additional variable (Ethnicity).

A total of 6 studies were included in the systematic review. The earliest study of the 6 studies was published by Panagiotopoulou et al in 2004 and 3 studies (Lim, Ewe, Effendi, & Muhamad, 2017; Herga & Fošnaric, 2017; Yanto, Lu, & Lu, 2017) were published most recently in 2017. Due to the numerous types of features/measurements being collected in the studies, the findings for the 6 studies were assigned into 2 main categories: (a) the mismatch between student anthropometry and desk dimensions and (b) the mismatch between student anthropometry and seat dimensions to provide clearer breakdown about the mismatches.

The QI scores of the involved studies varied between 14 and 23 with a mean of 16.17 points. For the reporting section, all the studies had similar scores but only 2 studies reported exact p-values in their study. All 6 studies provided estimates of the random variability in the data collected. The 6 studies scored similarly for their external validity. For internal bias, all 6 studies scored well but did not blind their subjects or researchers. Only 1 study, Yanto, Lu, & Lu (2017) scored well for the power section while all the rest of the studies performed poorly.

Study (by publication date)	Quality Score	Research Design	Sample, age, country
Panagiotopoulou et al (2004)	14	Measurement of (c) dimensions of 3 table types and 3 chair types (d) subjects' anthropometry in a sitting position using a measuring tape, anthropometer and "Brodin" goniometer Examination of match between anthropometry and respective furniture dimensions	180 students, 90 males, 90 females, 7-12 yrs old, Thessaloniki, Greece
Gouvali & Boudolos (2006)	14	Measurement of (c) dimensions of 3 table types and 3 chair types (d) subjects' anthropometry using a special anthropometric chair Examination of match between anthropometry and furniture dimensions for 2 situations	274 students, 6-18 yrs old, 3 age groups (6-9, 9-12, 12-18) Athens, Greece
Habibi, Asaadi, & Hosseini (2011)	16	Measurement of (c) dimensions of 2 table types and 2 chair types (d) subjects' anthropometry in a sitting position Examination of match between anthropometry and respective furniture dimensions	982 students, 493 males, 489 females, 7-12 yrs old, Iran
Lim, Ewe, Effendi, & Muhamad (2017)	14	Measurement of (c) dimensions of 3 table types and 3 chair types (d) subjects' anthropometry on their own chairs using a measuring tape Examination of match between anthropometry and respective furniture dimensions	390 students, 7-12 yrs old, Malaysia
Herga & Fošnaric (2017)	16	Measurement of (e) dimensions of 1 table type and 1 chair type (f) subjects' anthropometry in a sitting position Examination of match between anthropometry and respective furniture dimensions	192 students, 89 males, 103 females, 11-13 yrs old, Slovenia
Yanto, Lu, & Lu (2017)	23	Measurement of (e) dimensions of 2 table types and 2 chair types (f) subjects' anthropometry in a sitting position with an adjustable chair Examination of match between anthropometry and respective furniture dimensions	1146 students, 584 males, 562 females, 6-12 yrs old, Jakarta, Indonesia

Table 2. Summary of 6 studies and quality of assessment.

## Desk Dimensions and Students' Anthropometric Measurements

Study (arranged by publication date)	Relevant Findings (Percentage of match & comments)			
	Desk Height (DH)	Desk Clearance (DC)	Desk Width (DW)	Desk Depth (DD)
Panagiotopoulou et al (2004)	3.3-53.3% match, DH was too high	73.3-100% match	-	-
Gouvali & Boudolos (2006)	6-9yr % match: Boy: 0%, Girl: 6.7% 9-12yr % match: Boy: 8.6%, Girl: 20.6%	6-9yr % match: Boy: 74.2%, Girl: 80% 9-12yr % match: Boy: 62.9%, Girl: 64.7%	-	-
Habibi, Asaadi, & Hosseini (2011)	Old: 0-25.7% Match New: 31.4-63.4% Match DH was too high	Old: 42.1-83.2% Match New: 53.5-85.3% Match	-	-
Lim, Ewe, Effendi, & Muhamad (2017)	DH was too high		DW too wide	DD too deep
Herga & Fošnaric (2017)	2.1% match 97.9% too high	3.6% Match 96.4% too deep	-	-
Yanto, Lu, & Lu (2017)	6-9yr % match: 11.1%, 67.7% 9-12yr % match: 1%, 32.3%	6-9yr % match: 4.5%, 43.3% 9-12yr % match: 23.1%, 92.3%	-	-
	DH was too high. The percentage of mismatch decreased as grade level increased for boys and girls DC: Grade 6 girls were outliers at 92.3% Percentage of mismatch increased as grade level increased (chi square: 66.84, p= 0.00)			

Table 3. Summary of mismatch between students' anthropometric data and desk.

6 studies shown in Table 3 evaluated the match between the dimensions of the students' desk and the students' anthropometric measurements to see if the desks were suitable for primary school students.

All 6 studies found that DH was mismatched with primary school students as seen in Table 2. Gouvali & Boudolos found that more than 90% of subjects used desks which were above acceptable limits (AL). There was a 100% mismatch for the 6-9 years old boys.

4 studies (Gouvali & Boudolos, 2006; Herga & Fošnarič, 2017; Panagiotopoulou et al, 2004; Yanto, Lu, & Lu, 2017) used DC as one of the features to investigate. Out 4 studies, 2 studies (Gouvali & Boudolos, 2006; Panagiotopoulou et al, 2004) stated that the DC was of acceptable match levels. The other 2 studies (Yanto, Lu, & Lu, 2017; Herga & Fošnarič, 2017) found that DC was inappropriate for the students (96.4%, 56.7%-95.5% mismatched).

One study (Lim, Ewe, Effendi, & Muhamad, 2017) reported on DW and DD but not DC. It found that DW and DD were above AL for primary school students.

### Seat Dimensions and Students' Anthropometric Measurements

6 studies, shown in Table 3, compared the anthropometric data and dimensions of seats to see if the seats were appropriate for students from primary school.

Study (arranged by publication date)	Relevant Findings (Percentage of match & comments)							
	Seat Height (SH)		Seat Depth (SD)		Seat Width (SW)		Backrest Height (BH)	
Panagiotopoulou et al (2004)	5-53.3% match, SH was too high		0-71.1% match, SD was too deep		-		-	
Gouvali & Boudolos (2006)	6-9yr % match	9-12yr % match	6-9yr % match	9-12yr % match	6-9yr % match	9-12yr % match	6-9yr % match	9-12yr % match
	Boy: 25.8% Girl: 16.7%	Boy: 31.4% Girl: 32.4%	Boy: 54.8% Girl: 43.3%	Boy: 80.0% Girl: 64.7%	Boy: 25.8% Girl: 13.3%	Boy: 51.4% Girl: 52.9%	Boy: 54.8% Girl: 46.7%	Boy: 65.7% Girl: 70.6%
	Mismatches were mostly above AL		Too deep for 6-9 yrs old; Too shallow for 9-12yrs old		Too wide for students		Mismatch cases were all above AL	
Habibi, Asaadi, & Hosseini (2011)	Old: 8.5-30.9% Match New: 43.4-59.2% Match		Old: 2.1-7.9% Match New: 43.4-59.2% Match		Old: 10.2-51.8% Match New: 26-49.7% Match		Old: 9.4-74.2% Match New: 31.4-63.4% Match	
	SH was too high		SD was too shallow		SW was too wide		BH was too high, with exception of grade 2-4 students	
Lim, Ewe, Effendi, & Muhamad (2017)	SH was too high		SD was too deep		SH close to acceptable limits		-	
Herga & Fošnarič (2017)	0.5% match 99.5% too high		61.4% Match 37% too deep 1.6 too shallow		91.1% Match 8.9% too small			
Yanto, Lu, & Lu (2017)	6-9yr % match	9-12yr % match	6-9yr % match	9-12yr % match	6-9yr % match	9-12yr % match	6-9yr % match	9-12yr % match
	2.4% 36.6%	1% 27.3%	62.9% 92.4%	49.1% 88.5%	96.6% 100%	100%	64.9% 92.4%	41.8% 90.4%
	<b>SH:</b> Mismatch significantly decreased with higher grade level <b>SD:</b> Too deep or shallow Mismatch between SD and buttock-popliteal length significantly increased following grade levels <b>BH:</b> Found to be too high for grade 1,2 girls and grade 1-3 boys Found to be too low for grade 4-6 students							

**Table 3.** Summary mismatch between students' anthropometric data and seat features.

All 6 studies investigated potential mismatch between SH and PH as well as between SD and BPL. 6 studies (Gouvali & Boudolos, 2006; Herga & Fošnarič, 2017; Habibi, Asaadi, & Hosseini, 2011; Lim, Ewe, Effendi, & Muhamad, 2017; Panagiotopoulou et al, 2004; Yanto, Lu, & Lu, 2017) found that SH was too high for students. Yanto, Lu, & Lu (2017) also found that SH had a higher mismatch with PH in decreasing grade level.

5 studies (Gouvali & Boudolos, 2006; Herga & Fošnarič, 2017; Lim, Ewe, Effendi, & Muhamad, 2017; Yanto, Lu, & Lu, 2017; Habibi, Asaadi, & Hosseini,

2011; Panagiotopoulou et al, 2004) found SD to be either too deep or too shallow for students.

5 studies (Gouvali & Boudolos, 2006; Herga & Fošnarič, 2017; Habibi, Asaadi, & Hosseini, 2011; Lim, Ewe, Effendi, & Muhamad, 2017; Yanto, Lu, & Lu, 2017) looked into SW. 3 studies (Yanto, Lu, & Lu, 2017; Lim, Ewe, Effendi, & Muhamad, 2017; Herga & Fošnarič, 2017) found SW to have a low mismatch. Contrastingly, 2 studies (Gouvali & Boudolos, 2006; Habibi, Asaadi, & Hosseini) found that there was a mismatch between SW and the HB of students.

2 studies (Yanto, Lu, & Lu, 2017; Gouvali & Boudolos, 2006) also included findings of the potential mismatch of BH. Yanto, Lu, & Lu (2017) found that the BH was too high for a lot of students in the lower grades: grade 1 (21.1% boys, 35.1% girls), grade 2 students (7.6% boys, 9.3% girls) and grade 3 boys (11.0%) and too low for grade 4-6 students, ranging from a mismatch percentage of 9.6% to 58.2%. The highest mismatch percentages were found in grade 6 students (58.2% boys, 38.5% girls).

Gouvali & Boudolos (2006) found similar results where BH was significantly higher in grade 1-3 students (45.2±17.5% boys, 53.3±17.9% girls). Thus, these 2 studies found that that lower primary school students or grade 1-3 students were sitting on seats which had a higher backrest than recommended.

## DISCUSSION

The furniture being investigated in the studies for potential mismatch were based on the classroom furniture design standards of the country in which the study was conducted in. Hence, this knowledge could be useful for relevant members of authority, educators and parents to take note of when selecting or buying furniture for primary school students.

### Desk Dimensions

Lim, Ewe, Effendi, & Muhamad (2017) stated that the maximum acceptable DH for grade 1-3 students and 4-6 students should be 45.51cm and 51.09cm respectively. However, it was found that students were using desks that were too high for them. Gouvali & Boudolos (2006) also found similar results where 100% of the boys aged 6-9 years old, 93.93% of the girls aged 6-9 years old, 91.4% of the boys aged 9-12 years old and 79.4% of 9-12 years old girls using desks above AL. The other studies (Herga & Fošnarič, 2017; Habibi, Asaadi, & Hosseini, 2011; Yanto, Lu, & Lu, 2017) also found similar results where the DH was too high for the students. All 6 studies found that DH was too high for primary school students, especially for younger students in grade 1-3, aged between 6-9 years old.

1 study (Yanto, Lu, & Lu, 2017) further stated that the percentage of mismatch decreased as grade levels increased. This could be supported with the findings

from another study (Gouvali & Boudolos, 2006) where match percentage increased as grade level increased.

Desks of inappropriate height could force students who are developing physically to adopt unnatural neck and shoulder posture. Desks that are too low would result in students bending their necks over to look down while reading and writing for prolonged periods of time while desks that are too high would force students to raise their shoulders for prolonged periods to place their elbows on the desk in order to read and write. Bearing in mind the amount of time students sitting at their desks in school, this could put excessive tension on the shoulders and neck, potentially lead to musculoskeletal disorders in the long term.

Findings for DC however were split. 2 out of the 4 studies (Gouvali & Boudolos, 2006; Panagiotopoulou et al, 2004) found that DC was of acceptable match levels for students. Gouvali & Boudolos (2006) found the match levels for DC were acceptable at 74.2% match for boys and 80% match for girls aged 6-9 years old, 62.9% match for boys and 64.7% match for girls aged 9-12 years old. Panagiotopoulou et al (2004) found that DC matched 100% of grade 2 students, 98.3% (older desk model) and 100% (newer desk model) for grade 4 students, 73.3% (older desk model) and 98.3% (older desk model) for grade 6 students.

The other 2 studies (Herga & Fošnarič, 2017; Yanto, Lu, & Lu, 2017) found contrasting data that stated that DC was below AL. Herga & Fošnarič found that DC was too low for students in Slovenia. Yanto, Lu, & Lu (2017) found that the percentage of mismatch for grade 1-3 students ranged from 56.7% to 95.5%

The studies displayed a trend that the DC mismatch for older students was higher than the younger ones. The percentage of mismatch between DC and KH increased as grade levels increased, implying that the mismatch of DC would increase with increasing age. This could be supported with Panagiotopoulou et al (2004), which showed a decrease in percentage match between grade 2,4,6.

A low DC would imply a low lower limb mobility and increased contact between the thighs and the underside of the desk, potentially resulting in a cramped feeling in legs or even injuries. It is inevitable that older students will face this issue due to physical growth. Hence, this highlights a potential concern for schools which provide only one type of furniture of fixed dimensions throughout 6 years of primary school. It would be detrimental for the older students if there is only one fixed desk size for all 6 grades/levels of primary school education.

### **Seat Dimensions**

All 6 studies found that SH was too high for students. Gouvali & Boudolos (2006), which found that there was a 25.8% match for boys and 16.7% match for girls aged 6-9 years old and a 31.4% match for boys and

32.4% match for girls aged 9-12 years old, supported this with their data that >70% of the mismatch was above AL. Herga & Fošnarič (2017) found that there was a 99.5% mismatch with SH being too high for students and Panagiotopoulou et al (2004) found that SH had 95% mismatch with PH with SH being above AL as well. Yanto, Lu, & Lu (2017) also supported the finding that SH was too high for students but also went one step further and found that the mismatch decreased significantly as grade level increased. This additional finding could be supported by the data provided by Gouvali & Boudolos (2006)'s study.

Seats which are higher than AL could result in excessive pressure on the posterior of the thighs, poor blood circulation and poor development of posture. If SH is too high, the feet of some students might not be in contact with the ground while sitting and this would lead to an increased pressure on the thighs. Increased pressure on the posterior of the thighs could result in a decrease in blood circulation in the same area.

The findings for SD were similar among the 6 studies as well. They found that there was a mismatch between SD and BPL. 3 studies (Herga & Fošnarič, 2017; Lim, Ewe, Effendi, & Muhamad, 2017; Yanto, Lu, & Lu, 2017) found that SD was too shallow or too deep for primary school students. Gouvali & Boudolos (2006) also supported this with its finding that SD only matched 54.8% of the boys and 43.3% of girls aged 6-9 years old and 80.0% of boys and 64.7% of girls aged 9-12 years old. It also went on to further state that the seats were too deep for 6-9 years olds but too shallow for 9-12 students. The reason for this could be explained with Yanto, Lu, & Lu (2017)'s finding where the mismatch between SD and buttock-popliteal length significantly increased following grade levels.

Seats which are too deep would result in the edge of the seat cutting into the back of the knee, reducing blood circulation to body parts below the knee. Seats which are too shallow would ensue that students would be sitting on the edge of their seats, placing their weight on their thighs and their elbows which are resting on the desk. If the SH and SD are too high and too deep, students would lean forward on the edge of their seats, with their legs dangling in the air which results in a slumped posture (Panagiotopoulou et al, 2004). Thus, the importance of SH and SD cannot be underestimated here.

The findings for SW revealed that 3 out of 5 studies (Lim, Ewe, Effendi, & Muhamad, 2017; Herga & Fošnarič, 2017; Yanto, Lu, & Lu, 2017) agreed that SW was not mismatched with HB. The other 2 studies (Habibi, Asaadi, & Hosseini, 2011; Gouvali & Boudolos, 2006) found SW to be mostly above AL cases. Hence, there was no clear trend observed here.

### **Overall Trend and Recommendations**

Based on the relevant studies, there was a common agreement from all 6 studies that desks and seats were

too high for students. Additionally, 6 studies also found that seats were also too deep or shallow. This would imply that there is potential health risk and it needs to be addressed.

One recommendation was to equip students with desks and seats of adjustable heights. This would be the ideal solution to address above AL DH and SH. However, bearing in mind the high cost and feasibility of such desks, it is unlikely governments will implement such a plan due to the heavy financial cost.

Bearing in mind the cost efficiency, Gouvali & Boudolos (2006)'s study suggested providing different sizes of furniture based on grade levels or even based on splitting between upper and lower primary. This could increase the match percentage between students' anthropometry and furniture features, increasing students' productivity and minimizing potential adverse health consequences.

### **LIMITATIONS**

One limitation in this systematic review is the lack of a gold standard scoring index for quality assessment. Compared to experienced researchers, the lack of expertise of the independent researcher could have influenced the scoring of the quality assessment.

The studies included in the review have not investigated extensively into some of the other furniture features such as desk slope, desk width and desk depth. Thus, further research still needs to be done involving these aspects especially desk slope as the angle of the desk could affect the how students read and write.

### **CONCLUSION**

In conclusion, this review focused on examining the current literature and determining the possibility of any mismatch trends in the existing schools around the world. A review of the included studies concluded that there were mismatches between furniture features and students' anthropometry with all 6 studies finding mismatches for DH, SH and SD. As the anthropometry of students vary over a large range, one recommendation would be to increase the variety of sizes for furniture as this could be a feasible and relatively cost-efficient method of ensuring an appropriate desk and seat for primary school students.

Also, this review does present a question for schools in Singapore with regards to the mismatch or match fit between furniture features and primary school students' anthropometric measurements in Singapore.

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### **REFERENCES**

- Agha, S. R. (2010, Mar). School furniture match to students' anthropometry in the Gaza Strip. *Ergonomics*, 53(3), 344-354.
- Cardon, G., De Clercq, D., De Bourdeauhuij, I., & Breithecker, D. (2004). Sitting habits in elementary schoolchildren: a traditional versus "Moving school". *Patient Educ. Couns.*, 54, 133-142.
- Castellucci, H., Arezes, P., & Molenbroek, J. (2015, Jan). Analysis of the most relevant anthropometric dimensions for school furniture selection based on a study with students from one Chilean region. *Applied Ergonomics*, 46, 201-211.
- Castellucci, H., Arezes, P., Molenbroek, J., de Bruin, R., & Viviani, C. (2017, Jan). The influence of school furniture on students' performance and physical responses: results of a systematic review. *Ergonomics*, 60(1), 93-110.
- Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *Journal of Epidemiology & Community Health*, 52(6), 377-384.
- Gouvali, M., & Boudolos, K. (2006, November). Match between school furniture dimensions and children's anthropometry. *Applied Ergonomics*, 37(6), 765-773.
- Habibi, E., Asaadi, Z., & Hosseini, S. M. (2011). Proportion of elementary school pupils' anthropometric characteristics with dimensions of classroom furniture in Isfahan, Iran. *Journal of Research in Medical Sciences: The Official Journal of Isfahan Uni*, 16(1), 98-104.
- Herga, N. R., & Fošnarič, S. (2017, March). Coordination of School Science Classroom Furnishings with Anthropometric Parameters for 11-12 Year-Old Children. *Journal of Elementary Education*, 10(1), 99-113.
- Lim, S. S., Ewe, H. J., Effendi, M. S., & Muhamad, F. R. (2017). Anthropometric evaluation and recommendation for primary schools classroom furniture design in Perlis. *AIP Conference Proceedings*. 1885. AIP Publishing.
- Macedo, A. C., Morais, A. V., Martins, H. F., Martins, J. C., Pais, S. M., & Mayan, O. S. (2015, Feb). Match between classroom dimensions and students' anthropometry: Re-equipment according to European educational furniture standard. *Human Factors*, 57(1), 48-60.

Murphy, S., Buckle, P., & Stubbs, D. (2007). "A cross-sectional study of self-reported back and neck pain among English schoolchildren and associated physical and psychological risk factors. *Applied Ergonomics*, 36(6), 797-804.

Musa, A. I., & Ismaila, S. O. (2014, Mar). Student anthropometric data and furniture mismatches in selected institutions in Abeokuta, Ogun State, Nigeria. *Theoretical Issues in Ergonomics Science*, 15(2), 205-213.

Panagiotopoulou, G., Christoulas, K., Papanckolaou, A., & Mandroukas, K. (2004, March). Classroom furniture dimensions and anthropometric measures in primary school. *Applied Ergonomics*, 35(2), 121-128.

Troussier, B., Tesniere, C., Fauconnier, J., Grisons, J., Juvin, R., & Phelip, X. (1999). Comparative study of two different kinds of school furniture among children. *Ergonomics*, 46, 516-526.

Yanto, Lu, C.-W., & Lu, J.-M. (2017, July). Evaluation of the Indonesian National Standard for elementary school furniture based on children's anthropometry. *Applied Ergonomics*, 168-181.

Yeats, B. (1997). Factors that may influence the postural health of schoolchildren (K-12). *Work*, 9(1), 45-55.