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Prevalence and Determinants of Fatigue among Private High School Students in Bogor Tengah Sub-District, Indonesia, 2016

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Abstract

Background: Student performance determines learning achievement and how students absorb lessons in class. One of the factors that cause student performance to decline is physical fatigue, which arises because of the classroom's physical environment that does not support the teaching and learning process. **Purpose**: This study was conducted to determine the relationship between classroom's physical environmental conditions and fatigue among high school students. **Methods**: The study design used was cross-sectional. Data collection included measurements of physical environmental parameters (humidity, temperature, lighting, noise, air flow, ventilation, temperature control, room capacity, room area ratio per person, and school location) and measurements of fatigue among students using the Subjective Self Rating Test in the form of questionnaire. Total sample was 448 students in 10 private high schools, with inclusion criteria: the students are not sick in the last two weeks and 10th and 11th grade students from 10 private high schools. **Results**: The research showed classroom's physical environmental factors that affect fatigue among student's included temperature, relative humidity, air flow, and air conditioner. While the most dominant indicator that was related to the occurrence of students' fatigue was sex. **Conclusion**: Further research is needed on other factors that may cause fatigue among students in the classroom to support the conclusion of this research.

Keywords: Fatigue, Physical Environment, Private High School

1. Introduction

The physical environmental condition of a room can be measured and controlled so that the room becomes comfortable for people inside it. The physical environmental factors of a room comprise of: room capacity, ratio of space needed per person, temperature, relative humidity, lighting, noise level, air flow, availability of air conditioning tools (fan or air conditioner), and ventilation. Physical and external environmental indicators have an impact on user comfort, including comfort in indoor air quality, thermal comfort, visual comfort, acoustic comfort and ergonomic comfort[1].

The need to achieve a good level of comfort in commercial buildings and education is very important, because in fact, some people spend more than 90% of their time indoors, and about 30% of their time at school[2]. A study in England explored the environmental conditions of classrooms in newly built secondary schools. Indicators used in this study were indoor air quality, thermal comfort and acoustic performance. This study showed that in schools with mechanical ventilation, there was still a level of internal environmental noise, while the thermal comfort was acceptable, but the temperature tended to be much higher in practice, compared to what was desired[3].

The physical environmental condition of a school is an important matter and becomes one of the determining factors that can affect the health condition, behavior, and student achievement[4,5]. The poor quality of classroom's indoor environment was thought to affect students' health, comfort, attendance and academic performance[6]. Standard physical environment parameters in Indonesia related to classroom include: a minimum ratio of 2m^2 class area/learner, lighting (a minimum

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of 100 Lux), a maximum noise level of 85 dB, good ventilation holes at least 15% of the floor surface area of the room, temperature 18°C to 28°C, air humidity 40%–60% (RH), air flow ≥ 0.15 m/s, room capacity <30 people, air conditioner, school location[7-9].

Another study focused on understanding the perceptions of thermal comfort and behavior characteristics of students in the classroom. Thermal comfort surveys were carried out on 4866 primary and secondary school students in Australia for two summers. Research showed that students who hadbeen placed in air-conditioned classrooms were more likely to choose air conditioning as an air source for maintaining their comfort, compared to those accommodated in classrooms without air conditioning[10].

According to M. Kuru and G. Calis, the physical environmental condition of a room could lead to weariness or fatigue[11]. Fatigue is a physiological phenomenon arises after an activity that requires concentration or physical effort. It is a mechanism for protecting the body to avoid further damage and usually will recover after a break[12-14]. Fatigue can be classified into three types: weakening activities, weakening motivation, and physical fatigue[15,16]. For students, fatigue can lead to a decline in school performance, negative health outcomes, and refusal to attend school[17].

One commonly used measurement of fatigue is the Subjective Self Rating Test (SSRT), which comprises of a number of questions asking about symptoms or feelings that are subjective to someone[14,18]. A study involving elementary and junior high school students about the relationship of cognitive function with the prevalence of fatigue amongstudents,was conducted. It is known that the development of cognitive functions that depend on values can influence the severity of fatigue among students[19].

The purpose of this article was to identify determinants related to fatigue among private high school students and to determine the possibility of subgroups in the population that needed a program focus given the importance of supporting comfortable classroom's physical environmental condition in the teaching and learning process. Specifically, this article was to explorethe potential role of the learning space's physical environmental condition to reduce the level of fatigue amongstudents during the learning process in the classroom.

2. Methods

This article was the results of data analysis in the 2016 Health-guided Research Study (RISBINKES). The study locations were 18 classrooms from 10 Private High Schools in Bogor Tengah sub-district, with 487 students as respondents. The study was conducted from April to December 2016. This research was conducted during the dry and rainy seasons, in naturally ventilated buildings using the adaptive approach, in accordance with ASHRAE 55/2004, ISO 7730 and ISO 10551. The research design used was cross-sectional. The data used were data from measurements of temperature, humidity, light intensity, noise, air flow, ventilation, availability of air conditioner, room capacity, ratio of room area per person, school location. Temperature, humidity and air flow were measured using an Anemometer[20]. The intensity of light was measured using Lux Meters[21]. Noise was measured using a Sound Level Meter. Measurements of length, width and height of the room were done using a Digital Meter.

Measurement of fatigue among students was done using a scale questionnaire issued by the International Fatigue Research Conference (IFRC) or called the Subjective Self Rating Test (SSRT) which contained 30 questions related to symptoms of fatigue. The answers to the IFRC questionnaire were divided into 4 large categories, which were frequent (SS) with a score of 4, often (S) with a score of 3, sometimes (K) with a score of 2, and never (TP) with a score of 1. To determine the level of fatigue, the answers to each question were summed then matched with a certain category, a score of 52 (not tired), a score of 53–75 (mild fatigue), a score of 76–98 (moderate fatigue), and a score of 9–120 (severe fatigue)[16]. Data were analyzed using univariate, bivariate and multivariate statistical models to determine the description, relationship and physical environment factors that affected fatigue among students the most. In the analysis of fatigue, it was categorized into two, not tired and tired categories (mild fatigue, moderate fatigue, severe fatigue).

3. Results

Based on the results of data analysis, there were 39 people (8%) from the total sample obtained during the data collection. While student's with healthy condition were 448 people (92%) of the total sample. So that respondents

who can be used in the data analysis were 448 people. Based on these data (Table 1) female students were 241 people (52.8%), with the dominant nutritional status was not obese as many as 385 people (85.9%). Student's behavior in consuming drinking water in class was carried out by 319 people (71.2%). The picture of fatigue among students was dominated by students with fatigue condition as many as 252 people (56.2%), where fatigue was divided into two categories, 237 people (52.9%) with mild fatigue and 15 people (3.3%) with moderate fatigue.

Table 1. Student population characteristics based on sex, nutritional status, breakfast behavior and Drinking water behavior at school (N = 448).

Factors	Number (N)	Proportion (%)
Sex		
Boys	207	46.2
Girls	241	53.8
Nutritional status		
obese (≥ 25.0 Kg/m^3)	57	12.1
not obese (< 25, 0 Kg/m^3)	391	87.3
Breakfast behavior		
No	20	4.5
Yes	448	95.5
Level of student fatigue		
Tired	252	56.2
Not tired	196	43.8
Drinking water behavior at school		
No	129	28.8
Yes	319	71.2

Water consumption behavior showed that students who consumed 550 ml of water up to 1000 ml for 7–8 hours in school were 319 people (71.2%), while the number of students who didnot consume drinking water and drink water less than 550 ml were 129 (28.8%). Students who did not eat breakfast were 20 people (4.5%), the reason why they did not to eat breakfast was that there was no food at home, I could not eat too early and I had no time for breakfast.

The minimum surface area of a classroom in the physical environmental characteristics of the classroom (Table 2) was 35.98 m^2. This area was still below the minimum standard recommended by the Indonesian government, which was 64 m^2. The lowest temperature of 18 classrooms was 27.2^{0}C, at this temperature the classroom was cool, while the highest temperature was 31.3^{0}C, which means the room had started to get hot. The lowest value of moisture of the classroom was 59.4%, where the space was moister and cool, while the highest humidity was 84.37, which means the room was getting hotter. The average noise level of 18 classrooms in 10 high schools in the central Bogor sub-district was 77.75 dBA. The lowest noise was 72.2 dBA, it was still below the maximum noise threshold value of 85 dBA, while the highest noise was 87.18, which means that the classroom noise value exceeded the maximum noise limit value of 85 dBA. The level of lighting in the study room shows that the median level of lighting in 18 classrooms in 10 high schools in Bogor Central district was 128.01 Lux. The lighting level was 26.31, at this lighting level the study room was far below the recommended standard lighting level of 300 Lux.

The air flow shows that the average air rate of 18 classrooms in 10 high schools in Bogor Tengah District was 0.07 m/s. the lowest air rate was 0.01 m/s, where the air flow value caused an increase in temperature and humidity so that the air became hot and stuffy, the recommended standard air rate was 0.15 m/s. In areas with a warm climate, research on thermal comfort indicated that air flow should vary from 0.2 m/s to 1.5 m/s. Air comfort was obtained from air velocities below 0.2 m/s in the standard ASHRAE 55[22]. The need for a ratio of surface area per student in (Table 2) shows that the average ratio of study space per person in 18 classrooms in 10 high schools in Bogor Central District was 1.73 m^2/person, this area was still below the minimum standard recommended by Indonesian government which was 2 m^2/person. The lowest ratio of study space per person was 1.12 m^2/person, the small ratio of the learning space will affect the lack of movement of students, so that it will interfere with the comfort of student learning.

Table 2. Characteristics of Physical Environmental Condition in classrooms in private high schools in Bogor District, Bogor City (N = 18)

Factors	Mean	Median	Std. Deviation	Min.-Max.
Surface area (m^2)	47.53	43.79	8.05	(35.98, 61.85)
Temperature (^{o}C)	29.55	29.67	1.14	(27.42, 31.32)

Relative Humidity (%)	70.78	9.40	6.67	(59.40, 84.37)
Light Intensity (Lux)	128.01	109.11	83.62	(26.31, 312.67)
Noise Level (dBA)	77.80	76.30	4.67	(72.20, 87.18)
Air flow (m/s)	0.07	0.06	0.05	(0.01, 0.18)
Study room ratio per person (m^2/ person)	1.73	1.67	0.36	(1.12, 2.54)

Table 3 presents the risk factors associated with fatigue. Fatigue was significantly lower among students who stayed in rooms with temperature less than 28°C, good air flow, adequate air conditioner, and the compatibility of the classroom ratio with the standards set. Opportunities for fatigue were significantly greater among female compared to male. Students with 550 ml to 1000 ml of water consumption behavior for 7–8 hours at school had a significantly lower fatigue than those who did not consume water.

Table 3. Odd Ratio (OR) for risk factors for fatigue among private high school students in central Bogor sub-district of Bogor (N = 448)

Factors		Fatigue (%)	N	Unadjusted (Bivariate)			Adjusted (Multivariate)		
				OR	95% CI	p	OR	95% CI	p
Sex	Girls	66.4	160	2.47	(1.68, 3.62)	0.000003	2.67	(1.78, 3.99)	0.000001
	Boys	44.4	92						
Nutritional status	≥ 25.0 kg/m^3	59.6	34	1.17	(0.67, 2.06)	0.68			
	< 25, 0 kg/m^3	55.8	218						
Relative humidity	> 60 %	36.8	7	0.44	(0.17, 1.14)	0.13	0.30	(0.11, 0.84)	0.022
	40–60 %	57.1	245						
Temperature	> 28°C	58.6	229	2.09	(1.19, 3.68)	0.014	2.25	(1.24, 4.08)	0.008
	≤ 28°C	40.4	23						
Lighting Level	< 300 Lux	57.6	19	1.060	(0.52, 2.17)	1			
	≥ 300 Lux	56.1	233						
Noise Level	> 85 dBA	69.1	56	1.95	(1.17, 3.27)	0.014			
	≤ 85 dBA	53.4	196						
Air flow	< 0.15 m/s	52.4	207	0.19	(0.09, 0.43)	0.0005	0.29	(0.13, 0.66)	0.004
	≥ 0.15 m/s	84.9	45						
Ventilation Size	< 15% Floor Area	55.9	33	0.98	(0.57, 1.71)	1			
	≥ 15% Floor Area	56.3	219						
Air conditioner	No	47.7	62	0.61	(0.41, 0.93)	0.026	0.71	(0.46, 1.08)	0.109
	Yes	59.7	190						
Classroom Capacity	30–40 person	59.1	123	1.25	(0.86, 1.81)	0.294			
	< 30 person	53.8	129						
Ratio of space needs per person	< 2 m^2/person	58.5	227	1.974	(1.14, 3.43)	0.021			
	≥ 2 m^2/Person	41.7	25						
School location	main roadside	56.8	205	1.118	(0.69, 1.79)	0.729			
	residential area	54.0	47						
Breakfast behavior	No	65.0	13	1.469	(0.57, 3.75)	0.564			
	Yes	55.8	239						
Drinking water behavior at school	No	63.6	82	1.529	(1.00, 2.33)	0.047			
	Yes	53.3	170						

The multivariate analysis indicated that four variables were significantly associated with fatigue, namely sex, temperature, relative humidity, and air flow. While the variable air conditioner acted as the controlling variable. The results of multivariate analysis found that the OR value of the temperature variable was 2.25, meaning that students who occupied a room with temperature more than 28°C would risk fatigue 2.25 times higher than students who occupied a room with temperature less than 28°C, after being controlled by sex, relative humidity, air flow, and air conditioner variables. Mean while the most dominant variable related to the occurrence of fatigue among students was the sex variable. No substantial interactions were found between the related variables.

4. Discussion

An ideal classroom is a room that is comfortable and has a temperature of 18-28 °C. Whereas a room with a temperature more than 28 °C has the risk of developing discomfort, sweat and stuffy feeling, due to heat that arise with the increasing room temperature. Statistically, the results shown in (Table 3) prove that there is a significant relationship between room temperature more than 28 °C and the level of fatigue among students (p = 0.008). While the value of OR 2.24, indicates that students who study in a room with a temperature more than 28 °C has a chance of 2.24 times more exhausted compared to those who study in a room with a temperature of 18-28 °C. This result is in accordance with the results of a study on workers which stated that increasing the air temperature to 28°C or above could reduce workers' performance by a minimum of 1.5% during both seasons[23]. According to the research conducted in India, classroom temperature can be accepted by 85% of students in the range of 26.9-30.8 °C, with a comfortable temperature of 29°C[24]. The operating temperature of the room favored by students in Australia is 22.5°C, but in summer, the room temperature ranges from 19.5°C to 26.6°C[25]. Based on the study of human muscle contractionsat different temperatures in ischemic conditions, greater levels of fatigue and faster onset was found at 37°C compared to 22°C[26].

Maintaining adequate ventilation and thermal comfort in classrooms could significantly improve academic achievement of students[27]. Comfortable temperature depends on the value of relative humidity and air flow[11]. Most people feel comfortable when indoor air temperature is between 20°C and 27°C and relative humidity ranges between 35% and 60%. Relative humidity is the amount of water vapor contained in the air-water mixture in the gas phase. Classrooms with relative humidity above 60% statistically have a significant relationship with fatigue among students. This study is consistent with previous studies that show most students feel tired (97.2%), have a lower concentration (96.8%) and feeling drowsy (94.1%) for at least one hour each day when the room temperature is ≥ 32°C[28]. A study[29] found that the most common weekly symptom felt by students as a result of poor indoor environmental quality (IEQ) is fatigue (7.7%), nasal congestion (7.3%), and headache (5.5%)[29]. IEQ factors most frequently reported to cause daily discomfort in the classroom is noise (11. 0%) stuffy air/bad indoor air quality (IAQ) (7.0%) temperature and rate of ventilation of the room.

The lack of air circulation in classrooms leads to an increase in temperature. High temperature causes discomfort and contributes to fatigue. This is proven by the discovery of a significant relationship between the rates of air circulation with fatigue. These results are consistent with previous article stating some short-term illness that can happen due to poor indoor air quality, including fatigue, poor concentration, nausea, loss of focus and memory disorders[30]. Researchers also have been investigating the relationship between indoor air quality and important issues not traditionally thought of as related to health, such as student performance in the classroom and productivity in occupational settings[31,32].

Our study shows that sex is associated with fatigue among students. This study is consistent with earlier studies regarding fatigue prevalence that have reported women have higher fatigue levels than men[33,34]. In contrast to our present results, earlier studies generally report more fatigue with advancing age[35,36]. Physical activity is related to fatigue. Graded exercise therapy has proven useful in the treatment for some forms of chronic fatigue syndrome[37,38]. The lack of physical activity can partly express itself as fatigue. On the other hand, a fatigued person is probably less likely to be physically active for the apparent reason that fatigue negatively influences vitality and motivation[39].

Health dangers related to poor indoor air quality can be treacherous and in stern cases, fatal. Both adults and children who are exposed to these lethal air surroundings in schools are prone to exhibiting physical signs associated to poor indoor air quality. Nevertheless, the effects of poor indoor air quality on children's health might be

more adverse than it is to the grownups. Children have weaker health defense mechanism than adults. Therefore, their body would not withstand poor indoor air quality challenges on health[40]. Schools can use the source control strategy, with effective and inexpensive approach that seeks to eliminate sources of pollution. Another strategy that can be used by schools is improving ventilation systems to assist in regulating the circulation of air in classrooms. Schools can also use air purifier to improve indoor air quality. Air purifier helps eliminate airborne pollutants from the air conditioning pollutants.

5. Conclusion

The most important finding of this study was that there was a strong relationship between physical environment variables (air conditioning, temperature, relative humidity, ratio of space requirements per person and air flow) and the incidence of fatigue among private high school students in Bogor Tengah sub-district. The most related indicators to fatigue among students was sex. There is an interaction between sex and air conditioner variables on fatigue, this can be the basis in determining the type of air conditioner based on student sexratio. There is no meaningful relationship between breakfast behavior and water consumption behavior at school with the occurrence of fatigue among private high school students in Bogor Tengah sub-district.

6. Ethical Clearance

This study used biological subject, which was human. The number of ethical approval was made by the ethical research committee from National Institute of Research and Development. The number is LB.02.01/5.2/KE.007/2016.

7. Conflict of Interest

The authors declare no conflict of interest.

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