BODY MASS INDEX PATTERN AMONG SEVEN YEARS OLD SCHOOL CHILDREN

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Abstract

Body mass index (BMI) is one of the indices regularly used to evaluate the level of body mass. Recently, there has been a concerning increase in total number of obese children in Malaysia. This study aims to predict the trend of obese children in Malaysia, especially in Kuala Lumpur. This study involved primary schools in Kuala Lumpur, Malaysia. A total of 4970 seven year old primary school children were involved in this study. Data were collected by the SEGAK test performed by the physical education teacher in the primary schools. In this study, weight and height were the variables that were used for BMI calculation. Underweight, normal, overweight, and obese were used to classify the children’s BMI following the WHO BMI index for Asians. Descriptive statistics, Normality test, and Discriminant Analysis were used for the statistical analysis. The result found that the BMI was distributed normally according to P-P and Q-Q plot graph, and discriminant analysis found that there were 231 children (4.65%) of the total sample of the children predicted to have an increase in BMI and a total of 236 (4.74%) predicted from normal BMI to underweight. The result predicted that there would be a slight increase in children concerned about the potential of becoming obese. Action should be taken regarding the prediction of the percentage as the number can increase either suddenly or slowly.

Keywords: Body Mass Index, Pattern, Primary school children, Malaysia, Kuala Lumpur

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Introduction

The body mass index (BMI) is a commonly utilized measure for evaluating overweight and obesity in both children and adult populations. It serves as a measure of an individual's adiposity and is commonly employed as a determinant for the likelihood of the emergence or prevalence of various health concerns [1]. Furthermore, its application is extensively employed in formulating public health strategies [2]. BMI can be changed due to several factors. According to some research, several factors that contribute to BMI changes are diet, exercise habits, biological factors, psychological factors, socioeconomic factors, and specific medical applications, and they usually work in combination with several factors to contribute to BMI changes [3,4]. In the past years, Southeast Asia has shown an increasing trend in the prevalence of obesity for men and women [5]. In 2019, WHO stated that there were approximately 340 million overweight or obese children and teenagers between the ages of 5 and 19 [6]. Moreover, WHO statistics 2016 reported that children in Malaysia have suffered from obesity and Malaysia has the second-highest prevalence of obesity among children and adolescents aged five to 19 after Brunei [7]. Also, data from the National Health Morbidity Surveys (NHMS) showed that the prevalence of obesity among Malaysian children aged less than 18 years had increased dramatically from 6.1% in 2011 to 11.9% in 2015 [8].

This problem is quite concerning, especially for urban children, as recent research indicates that increasing urbanization may leading to significant changes in dietary practices and levels of physical activity, which have been related to increased vulnerability to childhood obesity [9] as several researches have proven urban children have poorer physical fitness than rural children [10,11]. The increased

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consumption of high-calorie foods and a sedentary lifestyle, which includes inactivity and excessive screen time, are linked to rising trends in obesity in children. Furthermore, the amount of physical activity in the context of the residential areas revealed urban children were less active than in rural area [11]. Sports opportunities and other forms of physical activity are less accessible in highly urbanized locations. Inner-city families choose to keep their kids home playing on a computer or watching television because of inadequate walking and outdoor playing spaces nearby [12]. After a certain age, the child becomes accustomed to an inactive lifestyle and this may leads to difficulty in socializing [13].

To address this issue in Malaysian schools, BMI monitoring has been implemented through Standard Pengukuran Indeks Jisim Badan (SPI), which went into force in the 2022/2023 school year and specifies appropriate intervention based on the children's BMI category [14]. Besides, the Malaysian Ministry of Education has launched a BMI 5-9T program in order to observe primary school students. The objective of this program is to know their own BMI status, practice healthy and safe eating, practice a healthy and active routine in everyday life, and engage in frequent physical activity to reach a certain degree of physical fitness. Before the establishment of SPI, Standard Kecergasan Fizikal Kebangsaan Untuk Murid Sekolah Malaysia (SEGAK) tests were applied to Malaysian school students. SEGAK is a standard test battery of physical fitness to measure the physical fitness level of students based on health with the standardized norm of the student regarding age and sex and also a standardized physical fitness component for primary schools and secondary schools [15]. Several studies have reported the results of monitoring BMI through the application of the SEGAK test, which demonstrate a poor change pattern throughout the SEGAK test [16,17,18]. Furthermore, the issue of extreme obesity has become increasingly prevalent among children in Malaysia [19].

In 2020, WHO announced a pandemic situation due to the COVID-19 disease that spread worldwide during that time. Various measures were implemented by the authorities, such as the closure of schools, implementation of lockdowns, enforcement of quarantine measures, and issuance of social distancing recommendations. These measures were put in place with the objective of mitigating the spread of the virus and alleviating the strain on healthcare systems [20,21]. The measures have led people to consume more preserved and processed food and tend to practice more sedentary behaviours and screen time, as well as decreased physical activity. This could be associated with obesity [22,23]. Enforcement of quarantine also leads to several families having difficulties gaining income as income is one of the factors in securing food sources and good mental health, which affects eating habits and physical activity application [24,25]. From this, it has created a circumstance where there is a trend of increasing body weight globally, either children or adults [26]. Research from Institut Public de Sondage d'Opinion Secteur (IPSOS) reported that 56% of respondents in Malaysia stated that they are doing less or do not do direct physical activity throughout the Movement Control Order (MCO) implemented during the Covid-19 pandemic [27]. Research states that the Malaysian rate of healthy lifestyle practice has declined during MCO [28]. There was an increasing trend of a sedentary lifestyle, unhealthy food consumption, unbalanced diet practice, and screen time on gadgets and also reported the decreasing pattern of sleep quality and the intensity of physical activity during the MCO [29–32]. Those circumstances have created a consequence of increasing weight and BMI in Malaysia [33,34,35]. Obesity tends to track into adulthood, which means obese children are more likely to become obese adults, and it is crucial to tackle obesity early [8,36]. Hence, the researchers have selected children at the age of 7 as the participants for this study, primarily because they are in the concrete operational phase according to Piaget's Theory stating in this phase, children start to gain a better understanding of mental operations [37]. Therefore, it is imperative to implement an early proactive measure aimed at assessing the level of physical activity in children. Additionally, it is crucial to prioritize the engagement of primary school students in active physical activities. Despite the existence of numerous previous studies investigating the correlation between physical activity and health levels, there is a scarcity of research specifically focusing on students aged 7 to 12 years old [38]. This study aims to predict the BMI pattern of 7 years old primary school children in Kuala Lumpur, Malaysia. 

Methodology
Study design
The study’s purpose is to predict the movement in BMI pattern of 7 years old primary school children in Kuala Lumpur, Malaysia. Quantitative data were gathered and statistical data analysis were performed. The purpose of this ex post facto study is to establish a functional link between the variables in order to ensure that human characteristics cannot be altered [39].

Sample study
A total of 4970 children from the primary schools in Kuala Lumpur, Malaysia participated in this study. The total of participants was sufficient to be applied in this study as G Power with effect size F 0.15, power level 0.95, and the total number of predictors are 2, which suggests the total sample size required for this study is 107 participants.
Area of study
This study takes place in the government’s primary schools in the Kuala Lumpur area and includes all three zones in Kuala Lumpur (Bangsar-Pudu, Keramat, and Sentul). This study only takes place in government primary schools based on the consistency of procedures and the implementation of the SEGAK test conducted in each government primary school, as well as to respond to the government's initiative to monitor the physical condition of school students.

Data availability
Researchers obtained the data from the SEGAK test result from the physical education teacher in Kuala Lumpur primary schools. The data that were obtained were weight (kg) and height (cm), and no other data and details were acquired.

Body Mass Index (BMI)
Following the researcher’s measurements of weight and height, the reading will be computed using the method above and placed into their class using the WHO classification for Asian. The BMI cutoffs for underweight was <18.5 kg/m². The BMI cutoffs for overweight/obesity as per the Asian and WHO classifications were ≥23, and ≥25 kg/m² [40,41].

Statistical Analysis
This study applied three different statistical analyses and calculated by XLSTAT add-ins. The analyses were descriptive statistics, normality test, and discriminant analysis. Calculating descriptive statistics is an essential initial step in doing research and should always come before performing inferential statistical comparisons since they are used to summarise data in an ordered manner by defining the connection between variables in a sample or population [42]. For this study, qualitative data and BMI range data were included. Qualitative data applies the mode, mode frequency, categories, and frequency per category. In this study, researchers also applied the Shapiro-Wilk test as the method of normality test. Proposed by Shapiro and Wilk [43], the test gives better results for the size of the small sample, and the accuracy for sample size is claimed from 3 to 5000 [44]. Normality tests were used to examine the pattern of BMI categories for children described by P-P and Q-Q plot graphs and histogram graphs to see if negative, positive or flat trends were formed.

Discriminant analysis is a method that enables the investigation and simultaneous description of differences between two or more groups that are mutually exclusive with regard to various continuous variables [45]. From the BMI data, researchers use this analysis method to create a cross-validation confusion matrix, which is used later to predict the children's BMI status and whether it could rise or decline. This analysis were performed with three models that are Stepwise (forward and backwards), forward, and backwards. The researcher choose a model that produces a high precision percentage to be interpreted in the result section.

Results and findings
Descriptive statistics
Table 1 shows the descriptive statistics of the BMI class, showing the mode, mode frequency and frequency of the BMI class from 4970 participants. The table found that most participants were classified in the normal BMI class, followed by second most is overweight BMI class. Participants classified in underweight BMI class were the least followed by the second least is obese BMI class.

<table>
<thead>
<tr>
<th>Number of observations</th>
<th>Mode</th>
<th>Mode frequency</th>
<th>Categories</th>
<th>Frequency per category</th>
</tr>
</thead>
<tbody>
<tr>
<td>4970</td>
<td>Normal</td>
<td>3512</td>
<td>Normal</td>
<td>3512</td>
</tr>
<tr>
<td></td>
<td>Obese</td>
<td>581</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overweight</td>
<td>589</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Underweight</td>
<td>288</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Moving onto the normality test in Table 2, the Shapiro-Wilk test was carried out, resulting in the p-value calculated being lower than the significance alpha (0.05). Therefore, researchers have decided the normality test was significant for this study. Figure 1 and Figure 2 show the P-P plot and Q-Q plot graph; the P-P plot graph shows a flat pattern according to the point that follows a straight line in the shape of an S curve, but the Q-Q plot graph shows there is skewness in the graph, showing the children’s BMI pattern was more focusing on normal BMI as also showed in the distribution histogram bar chart in figure 3.
Figure 3. Histogram bar graph of BMI category

**Discriminant analysis (DA)**

For the last analysis method, researchers carried out DA to predict the BMI class. Researchers have used the Stepwise (Forward) model as the model, giving the highest precision percent among other models. Table 2 below shows the analysis results by reporting the confusion matrix for cross-validation results. The table shows a high precision percentage of 90.52%, and the table also predicts there is movement from children with a normal BMI to potentially becoming overweight, obese, or underweight. The analysis predicted 100 children potentially becoming overweight for the normal BMI children group. In the overweight BMI children group, 100 children predicted going from normal to obese and 131 children predicted going from overweight to obese. From that prediction, about 4.63% of the children based on this study’s total sample predicted potentially changing their BMI toward obesity. Meanwhile, there was also movement from the normal BMI to the underweight BMI group. There were 236 children (4.74%) with a normal BMI predicted as an underweight BMI group child.

**Table 2. Confusion matrix of cross-validation result**

<table>
<thead>
<tr>
<th></th>
<th>Underweight</th>
<th>Normal</th>
<th>Overweight</th>
<th>Obese</th>
<th>Total</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>52</td>
<td>236</td>
<td>0</td>
<td>0</td>
<td>288</td>
<td>18.06%</td>
</tr>
<tr>
<td>Normal</td>
<td>0</td>
<td>3508</td>
<td>4</td>
<td>0</td>
<td>3512</td>
<td>99.89%</td>
</tr>
<tr>
<td>Overweight</td>
<td>0</td>
<td>100</td>
<td>489</td>
<td>0</td>
<td>589</td>
<td>83.02%</td>
</tr>
<tr>
<td>Obese</td>
<td>0</td>
<td>0</td>
<td>131</td>
<td>449</td>
<td>581</td>
<td>77.41%</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>3844</td>
<td>624</td>
<td>449</td>
<td>4970</td>
<td>90.52%</td>
</tr>
</tbody>
</table>

**Discussion**

This study aims to predict the movement in the BMI pattern of 7 years old primary school children in Kuala Lumpur, Malaysia. From the analysis that has been carried out, both have achieved this study objective. In the normality test, both plot graphs showed a trend that seven years old primary school children were more centralized in the normal BMI group. Still, the discriminant analysis showed there were several children predicted to potentially rise and drop their BMI index to become overweight, obese, or underweight. As for the normality test, the graphs show skewness to the right, which means seven years old primary school children’s BMI category tended to be normal weight. This result also shows similar results to past studies stating the trend of the children’s BMI category were more tended to normal weight [46,47]. According to some past studies, the clinical data and physiologic investigations of weight management and weight growth demonstrate that the more someone weighs, the simpler it is to acquire additional weight, are compatible with the growing skewing of the distribution of BMIs over time and become increasingly skewed over time [48,49]. Also,
urban green spaces in Kuala Lumpur recently had a positive impact on influencing diet patterns and physical activity the children and adults [50,51] and this shows it may influence the positive skewness of the BMI since urban children have taken physical activity more critically as the sports facilities in Malaysia and green spaces, especially in Kuala Lumpur, are growing rapidly, but citizens are unable to fully access them due to the Covid-19 quarantine [52,53].

For the last analysis result, it was found that several children from the normal BMI category predicted to have some movement to become overweight and underweight. Even while it only accounts for a small fraction, it will become quite concerning since if it is not stopped, it will only get worse. As a result, the risk variables may have had an impact [3,4]. Several past researches stated children in Kuala Lumpur who are picky eaters consume fewer vegetables, whole grain products and fish but more dairy products, snacks, and fast foods have a higher risk of gaining weight and increasing or decreasing their BMI [54,55]. Another study confirmed through a nationwide survey in Malaysia reported a 16.1% and 20.0% prevalence for stunting and at risk of stunting, respectively. Additionally, severe and moderate wasting were observed in 4.0% and 6.1% of the population, while 21.1% were underweight, and the prevalence of at risk of overweight and overweight was 14.2% and 7.3%, respectively. Also, undernutrition was found to be associated with risk factors such as poor dietary intake and feeding difficulties [56]. Household income may also affect BMI changes as a study has proven household income has a significant relationship with nutrition status [57]. In Kuala Lumpur, findings indicate that a significant proportion of school children (86.5%) exhibited suboptimal practices in relation to the preparation of nutritious meals, as the majority of household income was included in Bottom 40% group (B40) as classified by the Department of Statistics Malaysia and it is in line with the studies that state low income families [25,58].

Conclusion

This study aims to predict the movement in the BMI pattern of 7 years old primary school children in Kuala Lumpur, Malaysia. Findings revealed a positive skewness in normal distribution, and there were some predictions of the BMI category among children from normal BMI to overweight and underweight. Recalling from the discussion, an early-life intervention to prevent childhood obesity is a priority for public health, global health, and clinical practice.

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References


