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Development of Motor Performance Index: A Preliminary Study Among 7 Years Old Malaysian Kids

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Abstract

The development of technology has increasingly reduced the practice of physical and motor activity use and it can lead to some health-related quality life problems such as social dysfunction and disease problems. The purpose of this research is to identify the development of motor performance index among 7 years old Malaysian kids. Datasets were collected from 1998 participants in research aged 7 years old in primary schools all around Malaysia. The participants completed multiple physical fitness tests (anthropometrics, standing broad jump, twenty-meter speed, sit and reach and hand wall toss). Data interpretation was carried out using Principal Component Analysis (PCA), Discriminant Analysis and Machine Learning. It was found that there is a small number of male kids that only have high physical fitness performance but female kids have a huge number that have a high physical fitness performance, also male kids have a dominant in some physical motor component and anthropometric and also female dominate some of the physical motor component. As a result, these models have the potential to reduce the number of kids with poor motor development. Furthermore, time and efforts can be saved because it is much easier to have concentrated parameters or those that have been extensively $AQ1$ proven.

Keywords

1. Introduction

Motor performance is comprised of components linked to fitness as well as basic motor abilities. Children and adolescents' motor performance also crucial to their psychological and social development, and it has been acknowledged as a significant predictor of both their present and future health [1, 2]. An important health measure that is favorably correlated with physical activity and may possibly be connected to injuries is motor performance [3, 4]. From this statement, motor performance is a crucial part that needed to get a high attention from authorities that contributes to children's health development. At age 7, the development of motor skills is at its peak, but it is dependent on a number of things, including the quantity of training and learning the person has received [5].

Nowadays, children live through multiple encounters with children of the previous generation. Important inequalities can be seen in terms of increased experimentation opportunities, more time spent on television and video games, and lack of humanistic self-growth due to the rapid and widespread development and access to new media technology due to the internal setting [6]. Unrestricted overuse of technology among kids can lead to negative things such as social media app addiction and online games [2]. Throughout the disabled, children are becoming less active because of a sedentary lifestyle and lead to low efficiency of exercise [7]. Low fitness efficiency can lead to a variety of diseases, and obesity is one of today's key disease issues among children.

Worldwide, nearly 170 million kids are obese [8]. 12.7% of children in Malaysia are obese and Malaysia is the second-highest in Asia after Brunei. [9]. Obesity has short-term and long-term impacts mostly on health and social problems [10]. Since this risk of childhood obesity is less likely, childhood obesity problems can lead to a number of health concerns as children grow up. A big concern, leading to chronic disease, disability and post-hearing death, is the obesity epidemic.

In Malaysia, obesity among school students has shown a large gap in obesity among students living in urban and rural areas, where the average obesity among rural students is lower. Another study found that male primary school students were even more overweight than female students. In addition, students who still practice and compete in school sports showed lower rates of overweight and obesity than students who do not practice and do not participate in school sports [11].

Obesity also giving the consequences effect on the health-related quality life. Obesity in childhood and adolescence can decrease the quality of health-related quality life and lead to an inimical effect on their life including their social function [8, 9]. Beauchamp & Anderson [10] stating social function is described as the way a person functions through social skills and interactions with others in a social setting. Interference on the social function because of obesity will make the person become psychological distress, social isolation and reduced self-esteem and with the interference to the social function will possibly lessen the individual quality of social life [12].

It is important to understand how motor performance developments works in daily life especially children. A few studies stating that showing the relation between motor performance and physical activity levels as well as healthy weight status in children, improving motor performance and this relation may be beneficial to health [13, 14, 15, 16]. Motor performance is not only developed for only better physical health but also in mental health as stated from research stating children who engaged in more motor performance activities in childhood had better cardiovascular and skeletal muscle health, less adiposity, and improved levels of anxiety, depression, and academic achievement [17] as the children development is strongly emphasized on two aspects of health, physical and mental health.

By developing motor performance index, it will help the authorities that responsible to take care of the children's health especially teachers at the school and the child's parent on monitoring the children's health by creating a statistical baseline that can help those authorities to monitor the children's weight status and motor performances. The objective of this study is to develop a motor performance index among 7 years old Malaysian kids based on their anthropometry and the result of a physical fitness test.

2. Methodology

2.1. Area of Study

This study examined Malaysia's Physical Fitness Among kids results. This included 217 primary schools in peninsular Malaysia, with 370 primary schools participating in Malaysia Borneo. Such schools include National Schools (SK), Religious Schools (SA), Chinese National Type Schools (SJK(C)) and Tamil National Type Schools (SKJ(T)). The age of these kids is 7 years old. There are 786 males in peninsular Malaysia, 213 in Malaysia Borneo, 806 females in peninsular Malaysia, 193 in Malaysia Borneo.

2.2. Participating and Testing Procedure

Out of 587 primary schools in Malaysia, total of 1998 kids (999 males and 999 females) were participated in this research. Several anthropometric components are tested (weight, height, and BMI) and four motor subscales are tested, such as power, flexibility, coordination, and speed. Procedures for kid's anthropometric measurements and motor fitness tests were conducted as follows.

Parents, guardians, school administrators, and participants are granted this type of consent to clarify certain issues like study methods, research goals, and others. Participants agreeing to participate must voluntarily assist in data collection research. Some of the main components to be fulfilled by the parents under the consent form include participants personal data and contact details; emergency contact information; health information and parent consent assurance. It is only for research purposes that this knowledge is available. Not all sensitive information is disclosed by the investigator.

2.3. Ethic Clearance

Informed written consent from participants was obtained by the writers. Participants were mandatory due to the requirement of physical education subject in Malaysia's school teaching and learning session. The authors value human subjects' privacy rights as an ethical research team. Therefore, the data submitted does not classify participants and has been entirely anonymous and contains no data to identify participants.

2.4. Anthropometrics

The instruments used are like a stadiometer and a weighting scale for the simple weight and height measurement [18]. The height feature was calibrated to the nearest 0.1 cm and kg was calibrated for the weight feature. When standing on the flat wall with the rear position and the arms crossed with the palms facing the researcher, the height is determined by the foot to the head. The stadiometer is the instrument needed.

2.5. Standing Broad Jump (SBJ)

The participants will be standing on the ground behind a line of slightly separated legs. With the arms swinging back and the knees bent rhythmically to about 90 degrees forward, a two-footer departure and landing was used [2]. Without falling backwards, participants must attempt to jump to their feet [19]. If the participants make a double jumping error before jumping, this test (SJB) will be cancelled. Three trials were accepted and the most far-reaching variables were taken into account.

2.6. Sit and Reach (SAR)

The participants are seated on the floor with straight legs, with heels flat against the sitting area and touching the rack and the investigator keeps both sides of the knees flat against the floor, if need be. In the case of hands-on tops and palms facing each other, it is then possible to approach the participants easily with fingertips that move the measuring glass as far as possible across the measuring line [20]. The investigator must guarantee that there are no twitching movements and that the fingertips stay parallel to the thighs. It is appropriate to take readings of 0.5 cm in multiples.

2.7. Hand Wall Toss (HWT)

The gap is approximately 1 m from the ground between the markers. Behind the marker line, the participants will stand straight, facing the wall. The ball is thrown with one hand by pressing the underarm against the wall and attempting to catch the ball with the opposite hand. Then the ball is thrown back to the wall and first-hand caught. This test proceeds with 10 attempts. It will register the number of shots captured.

2.8. Twenty-Meter Speed Test (20MR)

A reported chance for participants to run a single maximum sprint over a given length. The gap was 20 m between the start and the finish. Time started to count when either foot had reached the starting point, and either foot had hit the finishing point. Before the experiment, participants must ensure that the starting position is consistent without any modification, starting from a stationary pose with a foot back to the floor [10]. The time required for each split distance (20 m) to run was measured using a stopwatch [6].

2.9. Principal Component Analysis (PCA)

In this study, researchers used PCA to reveal essential motor performance components for kids. The components selected by researchers include weight, height, BMI, power, flexibility, coordination and speed for males and females. The researcher used PCA to eliminate the less important variables with a lower load factor. The attribute is considered non-significant if it has a separate eigenvalue of the data set. Factor scores results after the varimax rotation will be used for evaluating motor performance index for kids. The research is planned to classify the most important among 7 years old Malaysian kids. This analysis will assist researchers in identifying key sources of physical fitness by the scope of the study. The research would be carried out separately, based on gender differences.

2.10. Index

An index is a method of structured monitoring of the results of any group of properties. Indexes are often produced for the calculation of other financial or economic data such as interest rates, inflation or output from development. Variables that formed high factor loading will be used in index analysis. Range, score and clustering will appear as an index result. The index can also be used to monitor 7 years old kid's motor performance. From the result of PCA after varimax rotation, factor scores for every observation in the dominant factors and the variability percentage of variance will be used to determine the motor performance for kids. After that, the negative score will transform to positive scores without changing the patterns with maximum value 1. The scores split up into three groups (high, low and moderate) by using univariate clustering.

Determine Motor Performance Index Score.

$$(a_1n \times b_1) + (a_2n \times b_2)$$

a = Factor scores after varimax rotation

b = Variability percentage of variance after varimax rotation

n = Sample of observation.

2.11. Discriminant Analysis

Based on index analysis, researchers need discriminant analysis to validate index results that were formed. Index result as the dependent variable while the independent variable was including age, weight, height, BMI, power, flexibility, coordination and speed. Based on the independent variable above, DA will discriminate them into three subgroups which are low, moderate and high. Variables are counted step by step in the forward step mode, starting with the greatest significant variable until no significant adjustments have been made. In the step-by-step reverse mode, variables are removed step by step starting with the least important variable until no significant changes have been achieved. The correct percentage of classification will be determined based on results from the confusion matrix table. From this table, the researcher will find the most dominant factor for this research.

2.12. Machine Learning

Machine learning is an evolving branch of computational algorithms that are designed to emulate human intelligence by learning from the surrounding environment [21]. The machine learning method is way easier to use, low costs and can analyze more specific data samples. From the result of Discriminant Analysis, Machine Learning will establish group prediction and differentiate the F-value from the group. Machine learning also will notify the researcher which kids have the potential to move from the actual group to the predicted group.

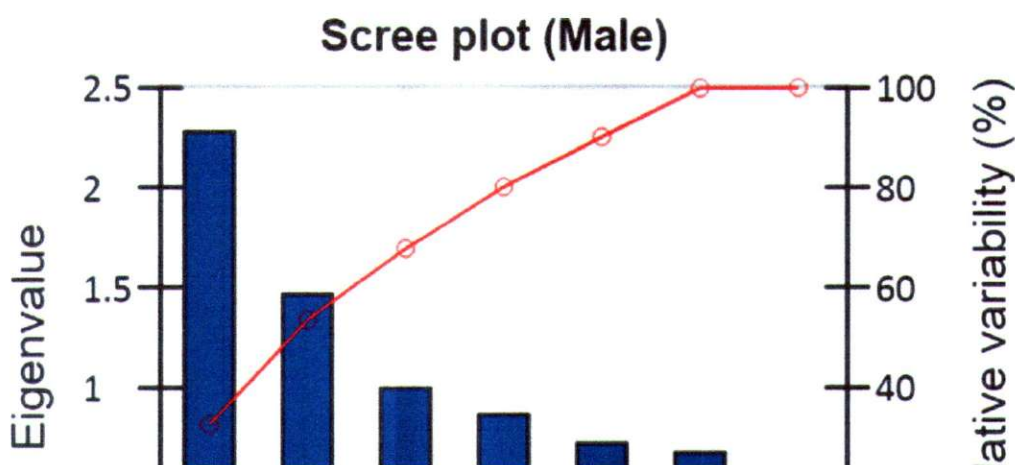
Several machine learning models were chosen such as kNN, Tree, Random Forest, SVM, Logistic Regression, Naive Bayes, and Neural Network as to identify the kids motor performance potential based on their class. Any model that can show highest precision will be chosen to be reported in this research findings.

3. Results

The outcome of this research will be to predict a gender-based motor performance index for Malaysian children aged 7 years. The PCA was evaluated to test the necessary components with a value greater than 1 (eigenvalue >1.0) prior to the main analysis. Figures 1 and 2 indicate that, due to higher own values (>1), PCA identified two components as the most important. For varimax rotation, further research was performed by adding two additional latent variables to the necessary understanding.

Fig. 1

Scree plot of descriptive eigenvalue for male



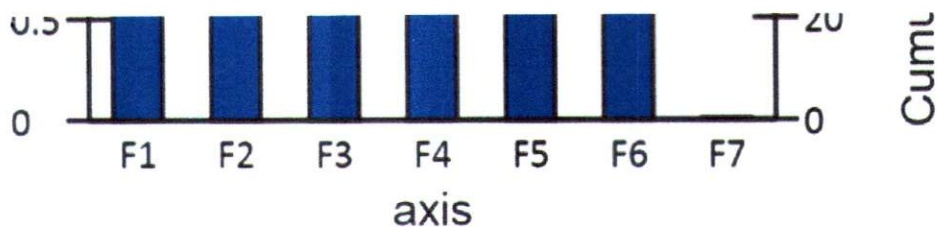
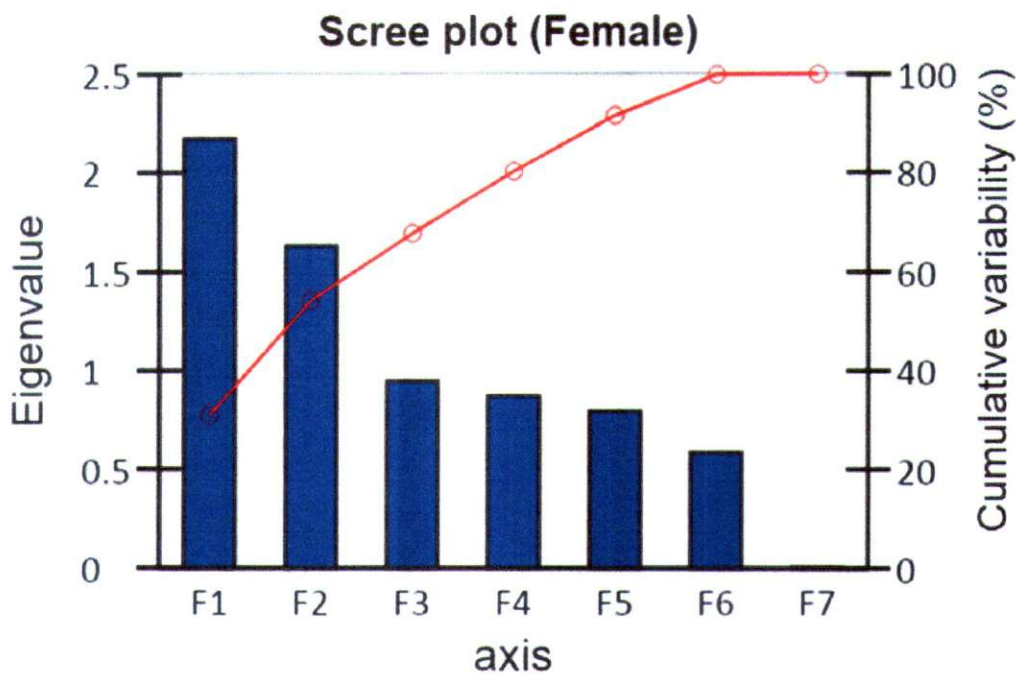


Fig. 2
Scree plot of descriptive eigenvalue for female



The PCA pattern for males is seen in Table 1 after the varimax rotation, while the PCA pattern for females is shown in Table 2. With a combined variance of 53.49 percent, the result of the variance can be seen at 32.60 percent for D1 and D2 (20.89 percent). Males and females each have three main components that surpass the physical characteristics of the loading threshold factor (loading threshold factor >0.65), which is weight, height, and BMI. The three-factor represents a powerful achievement in the exercise. The health output of children was important to evaluate because it was correlated with weight, height and BMI values. The epidemic of obesity can lead to a number of health issues as children grow up, according to previous studies. While the various components are described as the domain's motor fitness attribute, the power and speed of the second factors are clarified. This outcome demonstrates the success factors in gender, weight, height and BMI for fitness. Based on the cumulative variance percent in the factor loading pattern after varimax rotation in the table below, showing that the value is 54.2% and it can still relevant because in the humanities science field, the explained variance is generally set as low as 50–60%, so based on the range set, the cumulative variance percent is still can be accepted [22] (Table 2).

Table 1
Factor loading pattern after Varimax rotation (factor loading set at >0.65) for male

	• D1	• D2
• WEIGHT (kg)	• 0.9899	• -0.0487
• HEIGHT (cm)	• 0.6750	• 0.0895
• BMI (kg/m ²)	• 0.8611	• -0.0988
• POWER (cm)	• -0.2271	• 0.7142
• FLEXIBILITY (cm)	• 0.0120	• 0.4267
• COORDINATION (no.)	• 0.1253	• 0.5764
• SPEED (sec)	• 0.0183	• -0.6744
• Eigenvalue	• 2.2818	• 1.4624
• Variability (%)	• 32.5965	• 20.8916
• Cumulative %	• 32.5965	• 53.4880

Table 2

Factor loading pattern after Varimax rotation (factor loading set at > 0.65) for female

	- D1	- D2
- WEIGHT (kg)	- 0.9933	- 0.0014
- HEIGHT (cm)	- 0.6227	- 0.0904
- BMI (kg/m ²)	- 0.8623	- 0.0492
- POWER (cm)	- 0.0967	- 0.7913
- FLEXIBILITY (cm)	- 0.1585	- 0.4613
- COORDINATION (no.)	- 0.0722	- 0.5538
- SPEED (sec)	- 0.1079	- 0.6889
- Eigenvalue	- 2.1704	- 1.6297
- Variability (%)	- 31.0051	- 23.2821
- Cumulative %	- 31.0051	- 54.2872

Furthermore, further study was calculated by the acquisition of the fitness index by incorporating the performance of the PCA. Three separate categorical fitness sets are shown in Table 3, including a low, moderate and high fitness index for males based on the most dominant components. 187 male children are in an index-dependent high health index group, while 490 male children are in a moderate group and 322 male children are in a population with a low fitness index. The disparity in exercise intensity of the participants was further assessed based on the results of the health index. Based on the most dominant components, Table 4 reveals three distinct categorical fitness sets, including a low, moderate and high female fitness index. A high health index group based on an index is 158 female children, while a moderate group is 458 female children and a low fitness index group is 383 female children.

Table 3

Index status of fitness index for male

Status	Freq	Cum.Freq	%	Cum.%	Group Range	Group
0.00	322	322	32.23	32.23	0.00 ≤ Low ≥ 0.43	Low
0.44	490	812	49.05	81.28	0.44 ≤ Moderate ≥ 0.60	Moderate
0.60	187	999	18.72	100	0.60 ≤ High ≥ 1.00	High

Table 4

Index status of fitness index for female

Status	Freq	Cum Freq	%	Cum. %	Group range	Group
0.00	383	383	38.34	38.34	0.00 ≤ Low < 0.39	Low
0.39	458	841	45.85	84.19	0.39 ≤ Moderate < 0.58	Moderate
0.58	158	999	15.82	100.00	0.58 ≤ High ≤ 1.00	High

The precision of the above studies is presented in this section and the classification of training samples is given (N = 1998). To reiterate, the training dataset was used to match the model as the reference. Training dataset classification findings were obtained by discriminant analysis. Malaysian children in the high, moderate, low range of 7-year-old classes were treated as dependent variables, whereas relative success variables were treated as independent variables.

The specificity of the training dataset classification among the male group analyzed (N = 999) was shown in Table 4 below. The regular DA mode allocated 187, 322 and 490 males in the high, low and intermediate grades, with 91.79% of classification correctness (seven discriminant variables) respectively. Forward stepwise DA mode allocated 143, 297 and 559 males in the strong, low and moderate groups, respectively, with a classification correctness of 95.30% (seven discriminant variables). Finally, the DA backward mode allocated 143, 297 and 559 males in the high, low and moderate groups, respectively, with the correctness of the classification being 95.30% (seven discriminant variables). Results had confirmed the ability of newly developed motor performance index to classify male according to their parameters.

The specificity of the training dataset classification among the female group analyzed (N = 999) was seen in Table 5 below. The regular DA mode allocated 458, 383 and 158 females in the strong, low and moderate groups, respectively, with a classification correctness of 93.39% (seven discriminant variables). DA's forward stepwise mode allocated 508, 365, and 126 females in the strong, medium, and moderate grades, with 95.60% of classification correctness (seven discriminant variables) respectively. Stepwise DA mode allocated 508, 365 and 126 females in the strong, low and moderate grades, respectively, with a classification correctness of 95.60% (seven

discriminant variables). The newly created motor performance index's ability to distinguish females according to their parameters was verified by the findings (Table 6).

Table 5

Confusion matrix results for male

DA mode	Category	High	Low	Moderate	Total	% Correct
Standard	High	141	0	46	187	75.40
	Low	0	292	30	322	90.68
	Moderate	2	4	484	490	98.78
	Total	143	296	560	999	91.79
	High	121	0	22	143	84.62
Forward stepwise	Low	0	281	16	297	94.61
	Moderate	5	4	550	559	98.39
	Total	126	285	588	999	95.30
	High	121	0	22	143	84.62
Backward stepwise	Low	0	281	16	297	94.61
	Moderate	5	4	550	559	98.39
	Total	126	285	588	999	95.30

Table 6

Confusion matrix results for female

DA mode	Category	High	Low	Moderate	Total	% Correct
Standard	High	450	8	0	458	98.25
	Low	26	357	0	383	93.21
	Moderate	232	0	126	158	79.75
	Total	508	365	126	999	93.39
	High	499	9	0	508	98.23
Forward stepwise	Low	15	350	0	365	95.89
	Moderate	20	0	106	126	84.13
	Total	534	359	106	999	95.60
	High	499	9	0	508	98.23
Backward stepwise	Low	15	350	0	365	95.89
	Moderate	20	0	106	126	84.13
	Total	534	359	106	999	95.60

Table 5454 shows the evaluation result of machine learning based on the selected model for both gender. It shows that for male evaluation, logistic regression model shows the highest precision with value 0.982, and for female also showing logistic regression model as having the highest precision with value 0.986 (Tables 7 and 8).

Table 7

Evaluation result of machine learning model for male

Model	AUC	CA	F1	Precision	Recall
Logistic regression	0.999	0.982	0.982	0.982	0.982
Neural network	0.999	0.980	0.980	0.980	0.980
SVM	0.995	0.943	0.943	0.943	0.943
Random forest	0.959	0.856	0.856	0.857	0.856
kNN	0.931	0.824	0.823	0.827	0.824
Tree	0.854	0.808	0.808	0.808	0.808
Naive Bayes	0.908	0.768	0.770	0.775	0.768

Table 8

Evaluation result of machine learning model for female

Model	AUC	CA	F1	Precision	Recall
Logistic Regression	0.999	0.986	0.986	0.986	0.986
Neural network	0.999	0.982	0.982	0.982	0.982
SVM	0.996	0.948	0.948	0.948	0.948
Random forest	0.961	0.869	0.869	0.873	0.869
kNN	0.949	0.856	0.855	0.858	0.856
Tree	0.866	0.815	0.815	0.815	0.815
Naive Bayes	0.929	0.800	0.802	0.806	0.800

Based on the Machine Learning Confusion Matrix Table on the male table, the overall prediction accuracy is 99% and for female, the overall prediction accuracy is 97%. For male prediction, there is only one kid from moderate class motor performance predicted that are potentially to achieve a high motor performance capability. For female prediction, there is one kid predicted that are potentially dropped her motor performance from high performance to low performance but also there is one kid also predicted that potentially increase her motor performance level from low performance to high performance (Tables 9 and 10).

Table 9

Result of male prediction in machine learning

		Predicted			Σ
		High	Low	Moderate	
Actual	High	186	0	1	187
	Low	0	322	0	322
	Moderate	0	0	490	490
	Σ	186	322	491	999

Table 10

Result of female prediction in machine learning

		Predicted			Σ
		High	Low	Moderate	
Actual	High	457	1	0	458
	Low	1	382	0	383
	Moderate	0	0	158	158
	Σ	458	383	158	999

Table 8 shows the analysis of differences and significance between the seven variables (weight, height, BMI, power, flexibility, coordination and speed). All variables for males and females were significant respectively with the group high, low and moderate. Based on the ANOVA result, there is a significant difference between males and females. Male significantly dominate females in the physical attribute for weight with f-value (242.638), height (617.784), BMI (329.497), coordination (88.058) and speed (59.167) while female significantly dominate male in physical attributes for power with f-value (89.405) and flexibility (69.529) (Table 11).

Table 11

Summary statistics of motor performance index for male and female

	Male (f-value)	Female (f-value)
Weight (kg)	242.638*	181.722*
Height (cm)	617.784*	567.779*
BMI (kg/m ²)	329.497*	293.355*
Power (cm)	36.925*	89.405*
Flexibility (cm)	27.646*	69.529*
Coordination (no.)	88.058*	71.238*
Speed (sec)	59.167*	49.961*

	Male (f-value)	Female (f-value)
SIGNIFICANT	(p = 0.000, N = 999)	(p = 0.000, N = 999)

As shown in Table 9, the researchers managed to prove the prediction on the development of motor performance index among 7 years old Malaysian kids by using PCA, Index, DA and Machine Learning to monitor 7 years old kids. This would also help to improve the development of motor performance among 7 years old. Therefore, these models can decline the population of kids who have low development of motor performance. Moreover, the time and energy consumed can be reduced as it is much easier to have focused parameters or the ones which have been significantly proven [23,24].

4. Conclusion

Based on this study, the expansion of the motor performance index of 7-year-old Malaysians shows that the ability of the newly developed motor performance index to classify both sexes depend on its parameters. This study will help parents or school authorities to improve motor skills at the age of 7 years. Therefore, these models have the potential to reduce the population of children with low motor performance development.

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