Pattern Recognition on Anthropometric and Fitness Components Relative Birth-month Quartiles among Malaysian Boys and Girls

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Abstract*: Biasness selection during talent identification program in sports may occurred due to the chronological age system applied nowadays. The aim of this study is to recognize pattern on anthropometric and fitness components relative birth-month quartiles among studied population. A total of 39372 boys (aged 7.36 ± 0.29 year) and 33723 girls aged (7.34 ± 0.29 year) were classified into four chronological birth-month groups which is first quartile (Q1 - Jan to March), second quartile (Q2-Apr to June), third quartile (Q3 - July to Sept) and fourth quartile (Q4 - Oct to Dec) involved in this study. Multiple analysis of variance (MANOVA) revealed significant difference of F(18, 111336), p < 0.0001, p < 0.05 and F (18, 95358), p-value < 0.0001, alpha=0.05 between four birth-month quartiles for boy and girl participants, respectively. Tukey (HSD) follow up test of analysis of variance revealed that studied population are significantly difference in body weight, standing height, explosive leg power, hand-eye coordination and speed for all the contrast with p-value < 0.0001, alpha=0.05. However, result found no significant different for flexibility within all the contrast for boys and girls. Present study also revelaed a stronger influence of RAE among boys as compared to girls. The information of evidence-based of anthropometric and fitness performance according birth-month quartile would able to reduce RAE that may cause bias and subjective decision making for talent identification in sports.

***Index Terms*: Anthropometric; Fitness; Quartile; Relative Age Effect; Talent Identification.**

I. INTRODUCTION

Cut off criterion was practically used to the public school system in almost all sporting activities. Commonly, schoolchildren are clustered according to chronological age to ensure they undergo appropriate training by age, to avoid bias, and provide equal opportunities. Such way has led to the existence of relative age effect. The possible relationship between relative age and participation in sports has been widely discussed for decades [1-2]. It reflects the highly significant relationship between relative age and achievement in sports. Researchers supported the existence of competitive advantage that has occurred among children who born in the second half quartile with children who born in the first half quartile in the year. Past research had shown concrete evidence on the occurrence of a large distribution of birthdate among ice hockey players either in an adolescent hockey league and professional hockey league [1]. Players who born in the early month of the year are more advantageous than players born in the late months in the same year [3]. They suggest that the unfair distribution is the result of the cutoff date, which is the age group in small hockey were determine on 1st January.

Previous studies also showed that players born in the first quartile in the year are more possible to be selected in the development program of the athlete. Hence, it would increase their opportunity of getting involved in higher levels of competition, owing to their physical maturity [4]. This is also due to the difference in terms of experience they have and the motivations that the players produce. A supportive study also revealed significant variables that different characteristics between the birth-month quartile among children under twelve-year-old [5]. At this stage, children who born early of the year had tendency to overrepresented children who born end of the year. Besides, previous research also claimed that physical assessments including fitness performance is a key indicator during player selection in team sports and is closely related to age chronology [6]. An explanation of physical maturity is very convincing that the difference in age between 1 to 2 years can greatly contribute to the big difference in the physical assessment of players in the early sport program. [3-7]. In addition to height and body weight, performance differences can also be seen in other disciplines such health-related, where there is significant correlations are reported even in the age range of just 1 year [8]. It is important to note that the steps of the center for physical growth tend to be complemented by variability [9-10]. The anthropometric variants and individual fitness of male players are between 13 and 15 years old, while for female players is a bit earlier.

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Therefore, it is necessary to take into account different age factors according to the birth-month quartiles and late maturity factors. This is because it makes it almost impossible for young players to compete in a healthy way.

Common practice in sports development program interpreted fitness tests through percentile based categorization [11] and development of fitness index [12-13]. Henceforth, present study would propose an analytical baseline of anthropometric and fitness profile for each birth-month quartile. Such finding would be an aid tool in sports talent identification especially in selection process among schoolchildren.

II. MATERIALS AND METHODS

A. Participants

A total of 39372 boys (aged 7.36 ± 0.29 year) and 33723 girls (aged 7.34 ± 0.29 year) from Malaysia National Talent Identification (MyTID) program were involved in this study. The raw data was converted into a single matrix formed by 6 variables (2 anthropometric components and 4 physical tests) with 39372 boys and 33723 girl participants. All the participants were classified into four chronological birth-month groups as first quartile (Q1-1st January until 30th March), second quartile (Q2-1st April until 30th June), third quartile (Q3-1st July until 30th September) and fourth quartile (Q4-1st October to 31st December).

B. Anthropometric Measurements and Fitness Test

Participants underwent anthropometric measurements which is body weight (BW) and standing height (SH), and fitness test included standing broad jump (SBJ) to measure explosive leg power, sit and reach (SAR) test to measure flexibility, 20 meter sprint (20MS) to measure speed and hand wall toss (HWT) test to measure hand-eye coordination. Participants were divided into groups with rest periods of up to three minutes between fitness tests.

Table 1: Summary statistics of anthropometric and fitness variables relative birth-month quartiles

Boys								
Variables	Q1 (*n* = 10186)		Q2 (*n* = 9751)		Q3 (*n* = 10362)		Q4 (*n* = 9073)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BW (kg)	23.28	4.56	22.78	4.48	22.15	4.38	21.55	4.19
SH (cm)	121.5	5.2	120.4	5.1	119.0	5.2	117.6	5.0
SBJ (cm)	109.3	17.5	107.1	17.1	105.0	17.3	102.7	16.6
SAR (cm)	26.7	4.4	26.6	4.4	26.6	4.4	26.4	4.3
HWT (no.)	6	3	6	3	5	3	5	3
20MS (s)	4.77	0.47	4.81	0.49	4.87	0.48	4.94	0.49
Girls								
Variables	Q1 (*n* = 8903)		Q2 (*n* = 8412)		Q3 (*n* = 8769)		Q4 (*n* = 7639)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BW (kg)	22.33	3.83	21.60	3.61	20.87	3.25	20.25	2.96
SH (cm)	120.8	5.3	119.4	5.2	118.0	5.0	116.8	4.7
SBJ (cm)	96.6	15.4	95.29	15.0	93.7	14.8	92.2	14.8
SAR (cm)	27.0	4.5	27.0	4.5	26.5	4.4	26.5	4.4
HWT (no.)	5	3	5	3	4	3	4	3
20MS (s)	5.09	0.47	5.16	0.53	5.21	0.54	5.25	0.54

C. Data Analysis

Preprocessing data: A matrix set of boy participants contain 236,232 matrices data (6 variables × 39,372 participants) while matrix set of girl participants contain 202,338 matrices data (6 variables × 33,723 participants) were computed in this study. Before performing the main analysis in this study, all missing data and outliers were examined then followed by checking the normalization of the data [14-15]. The nearest neighbor method was applied using XLSTAT 2014 add-in software to estimate missing that very small (~ 3%) compared to the overall data recorded [16-17]. It is the simplest methods, where the endpoints of the gaps are used as approximations of all missing values.

Multivariate Analysis of Variance (MANOVA): Furthermore, an appropriateness of a MANOVA also was test by applying sequences of Pearson correlations were test between all of the independent variables in order to test the assumption that the dependent variables would be correlated with each other, at least in the moderate range. Additionally, covariance matrices were test to homogeneity for the purpose of the MANOVA [17]. Multivariate Pillai Trace test was used to test the hypothesis that there would be one or more mean differences between birth-month quartile (Q1, Q2, Q3 and Q4) and motor related. Based on the current research, follow up test via Tukey HSD test was applied to examine the groups mean differences comparisons across all three level of cut-off birth-month which is (Q1*Q2), (Q2*Q3) and (Q3*Q4).

III. RESULT

The statistical characteristics for boys and girls are shown in Table 1. All the participants were divided into their birth-month quartile. Among 39372 boy participants, there are a total 10186 participants in Q1 group, 9751 participants in Q2 group, 10362 participants in Q3 group and 9073 participants in Q4 group. Meanwhile, among 33723 girl participants, Q1 consist of 8903 participants, Q2 consist of 8412 participants, Q3 consist of 8769 participants and Q4 consist of 7639 participants.

Over all, participants from Q1 tend to have higher mean based on their physical and motor fitness level compared others.

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The outcomes of the multivariate test for the boys and girls participant showed Wilk's Lambda value 0.886 and 0.896 respectively. Table 2 indicate that there is significant difference between four groups of birth-month quartiles on anthropometrics and fitness performance.

Table 2: Multivariate test for different birth-month quartiles

Gender	Lambda	F (Observed value)	F (Critical value)	DF1	DF2	p-value
Boys	0.886	269.541	1.604	18	111336	< 0.0001
Girls	0.898	204.768	1.604	18	95358	< 0.0001

Among boys, Tukey (HSD) follow up test (Table 3) of analysis of variance at a confident level of 95%. From the table, it can be observed that BW (p<0.0001), SH (p<0.0001), SBJ (p<0.0001), HWT (p<0.0001) and 20MS (p<0.0001) are significant parameters that differentiates the related performance among all the birth-month quartile in which dominated by Q1. However, SAR test for flexibility is not the significant parameter among two contrast with a p-value of p=0.797, p=0.259 and p=0.110 for contrast between Q1*Q2, Q2*Q3 and Q3*Q4, respectively.

Among girls, Tukey (HSD) follow up test of analysis of variance at a confident level of 95%. It can be observed that BW (p<0.0001), SH (p<0.0001), SBJ (p<0.0001), HWT (p<0.0001) and 20MS (p<0.0001) are significant parameters that differentiates the related performance among all the birth-month quartile in which dominated by Q1. However, SAR test for flexibility is not the significant parameter among two contrast with a p-value of p=0.999, p=0.986 and p=0.989 for contrast between Q1*Q2, Q2*Q3 and Q3*Q4, respectively.

IV. DISCUSSION

The effect of RAE cut-off point on the motor fitness performance has been fully investigated in the present study. The result clearly showed the RAE effect among boy gradually increased with in-creasing age. This result is in concordance with the previous study that observed the RAE among youth soccer gradually increased with age of the soccer players from 7 to 18 years [18]. Besides, the occurrences of RAE also may contradict. For example, among the top expert soccer league in Germany, researcher discovered that the RAE gradually decreased with increasing age [19]. While another study reported that RAE among young player is not apparent before the age of 12 [20]. All the different pattern of RAE occurred could due to the difference approaches applied in chronological system and the characteristics of studied population. Present finding also revealed the pattern of RAE among girls, on the other hand, showed at least one significant parameter was able to distinguish for each grouping. Since the exact point at which an RAE begins to operate was still under question. This result indicated that the RAE effect mainly occurred right from the early age of children. Moreover, the previous study has also recognized that RAE ensues very early, before age 10, in ice hockey [21].

Table 3: Tukey (HSD) analysis of the differences birth-month quartiles with a confidence interval of 95% among boy and girl participants in MyTID program

Variables	Contrast	Difference	Standardized difference	Critical value	Pr > Diff
Boys					
BW	Q1 vs Q2	0.637	13.877	2.569	< **0.0001**
	Q2 vs Q3	0.743	16.250	2.569	< **0.0001**
	Q3 vs Q4	0.695	14.907	2.569	< **0.0001**
SH	Q1 vs Q2	1.190	16.796	2.569	< **0.0001**
	Q2 vs Q3	1.447	20.510	2.569	< **0.0001**
	Q3 vs Q4	1.489	20.710	2.569	< **0.0001**
SBJ	Q1 vs Q2	1.854	7.466	2.569	< **0.0001**
	Q2 vs Q3	1.946	7.867	2.569	< **0.0001**
	Q3 vs Q4	2.366	9.388	2.569	< **0.0001**
SAR	Q1 vs Q2	0.059	0.916	2.569	0.797
	Q2 vs Q3	0.117	1.831	2.569	0.259
	Q3 vs Q4	0.203	3.112	2.569	0.110
HWT	Q1 vs Q2	0.316	8.292	2.569	< **0.0001**
	Q2 vs Q3	0.363	9.562	2.569	< **0.0001**
	Q3 vs Q4	0.424	10.951	2.569	< **0.0001**
20 MR	Q1 vs Q2	0.037	5.688	2.569	< **0.0001**
	Q2 vs Q3	0.054	8.196	2.569	< **0.0001**
	Q3 vs Q4	0.071	10.692	2.569	< **0.0001**
Girls					
BW	Q1 vs Q2	0.726	13.862	2.569	< **0.0001**
	Q2 vs Q3	0.729	13.882	2.569	< **0.0001**
	Q3 vs Q4	0.621	11.529	2.569	< **0.0001**
SH	Q1 vs Q2	1.377	17.975	2.569	< **0.0001**

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	Q2 vs Q3	1.406	18.282	2.569	**< 0.0001**
	Q3 vs Q4	1.172	14.862	2.569	**< 0.0001**
SBJ	Q1 vs Q2	1.317	5.765	2.569	**< 0.0001**
	Q2 vs Q3	1.627	7.098	2.569	**< 0.0001**
	Q3 vs Q4	1.508	6.414	2.569	**< 0.0001**
SAR	Q1 vs Q2	0.001	0.021	2.569	0.999
	Q2 vs Q3	0.023	0.34	2.569	0.986
	Q3 vs Q4	0.007	0.097	2.569	0.989
HWT	Q1 vs Q2	0.288	7.394	2.569	**< 0.0001**
	Q2 vs Q3	0.333	8.502	2.569	**< 0.0001**
	Q3 vs Q4	0.311	7.743	2.569	**< 0.0001**
20 MR	Q2 vs Q1	0.065	8.081	2.569	**< 0.0001**
	Q3 vs Q2	0.049	6.078	2.569	**< 0.0001**
	Q4 vs Q3	0.046	5.537	2.569	**< 0.0001**

BW=Body Weight; SH=Standing Height; SBJ=Standing Broad Jump; SAR=Sit and Reach; HWT=Hand Wall Toss; 20MS=20 Meter Sprint

The result of no significant different of flexibility parameter for both boy and girl were contrary with previous finding that revealed the growth pattern for flexibility is differs [22]. Past study indicated that average scores of sit and reach test are constant and are likely to decrease during childhood. Then, it increases during adolescence, afterward reach a plateau at about 14–15 years in girls. For boys, flexibility are decline from childhood through mid-adolescence and then increase [23-24]. Hence, stronger influence of RAE among boys as compared to girls are found. Current findings are in line with the previous study which reported less and non-significant RAEs among females when distinguishing between different genders. The researcher described that the earlier maturation of girls and the large variation of the maturity rate of boys resulted in a higher RAE among male athletes. It is also worth to mention that the RAE at school is also higher for boys when compared to that of girls [25].

Numerous studies, hence, recognized the RAE completely to the fitness advantages of the comparably athletes who born in first and second birth-month quarters [26-27]. Recent studied centered on anthropometric and fitness components appear particularly likely provided that 1- or 2-month age difference. As a consequence, the large difference in the growth development of children occurred among participants in talent identification programs [28]. Besides, it already confirmed that in particular sports, there are relatively strong age effect causing many players were dropout and lose in sports. Miserably, they were turn to other sports where they are more easily selected without interest. As the consequence, players who are repeatedly rejected may disappear in sports field. In line with the process of identifying sports talent, this effect will also reduce the quality of developing potential and highly competitive athletes. Therefore, it is important to consider possible solutions to reduce the impact of relative age.

V. CONCLUSION

This study presented the pattern recognition on anthropometric and fitness variables among children relative birth-month quartiles. The obtained results provide a clearer insight into the pattern difference in the investigated variables. Children in different quartile of birth-month differ in body weight, standing height, explosive leg power, speed and hand-eye coordination. The information provided from this study may help coaches to evaluate performance of children in talent identification program fairly, assist the selection for development program and reduce the RAE problematic.

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