The Application of Principal Components Analysis to Recognize Essential Physical Fitness Components among Youth Development Archers of Terengganu, Malaysia

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Abstract

Objectives: To numerous individuals, archery is not generally seen as a sport demanding high levels of fitness in spites of long hours it takes during training and competition. Nonetheless, archers need to achieve a specific level in various aspects of fitness to permit them to perform the activity of shooting with exactness and have the capacity to repeat the activities without exhaustion. Determining the essential fitness attributes could help archers to reduce their long training hours by paying attention to the most mattered components. This study aims to identify the most essential physical fitness components needed for successful performance of archery. **Methods/Statistical Analysis**: A total of 17 youth archers with mean age ± 16.9 were repeatedly measured on basic physical fitness components, their scores were recorded, and Principle Components Analysis (PCA) was utilised to ascertain the most essential variables. **Findings**: The initial PCA identifies two components with higher Eigen value (>1). Moreover, PCA after varimax rotation indicates two components containing four and two varifacators (VF). The First VF revealing age (-0.69), BM1 (-0.71), 1 Minute sit-ups (0.75) and Predicted VO_{2max} (0.78) recognising the need for endurance while, the second VF discloses V-sit and reach (0.75) and Maximum push-ups (0.76) identifying the requirement for upper muscular strength in the game. **Application/Improvement**: The current study has successfully identified the most needed physical fitness variables in the productive performance of archery game.

Keywords: Archery, Physical Fitness Components, Principal Components Analysis, Youth Archers

1. Introduction

Archery is seen as a sport that involves driving arrows with a bow to the target in the course of shooting[1]. It can also be seen as a relatively still sport that requires strength and endurance of the upper body, specifically the forearm and the shoulder girdle. In the game of archery, competitors contest for points by shooting a set number of arrows within a stipulated time frame. Traditionally, archery has been utilised for chasing and battle. Presently it has turned into a recreational activity as well as a game. In the Olympic outdoor archery competition, archers are expected to perform outside in any climatic condition aside from thunder. Competitors in this way must,

therefore, take the wind, downpour, or other climate conditions into thought while shooting every arrow at the recommended period. However, under the current modifications to the rules, one arrow has been further lessened to 30 seconds as the athletes shot consecutively in the rounds of the Olympic Games. As a result of this modification of the rules, it led to an adjustment in the style of shooting; While formerly competitors could take as much time as necessary over every arrow, they now focus on promptly and shoot over a brief timeframe. It along these lines seems likely that diminishing the time required by a competitor to shoot would have a significant bearing on enhancing the competitive nature of the game and hence needed more physical fitness abilities to be able to adjust to the changed rule which could render the archer to have an edge over the opponent[2].

The possession of certain physical fitness variables such as age, body flexibility, body mass index, core body strength, upper body strength, as well as endurance might be factors that could determine outcomes of performance in the sport of archery[3,4]. Harmoniously, the nature of archery involves interval aerobic and anaerobic activities[5]; as as result of this, therefore, all the major muscle groups are activated during the shooting. However, these related physical fitness parameters serve as the vital prerequisite for efficient delivery of performance through the improvement of body resistance and consequently tailored to the adaptation of the shooting techniques involve in the game[6].

Principal Component Analysis (PCA) is a robust statistical technique that involves recognition of pattern from an observed group or any given parameters. It offers insights into the most essential components through considering the spatial and temporal variability that explains an entire data set and consequently excluding the less essential components without loss of the original information from the data[7,8]. PCA is extremely important in extracting the most needed information from a large volume of the data set. This can assist in saving time, cost and energy since the original information is often retained.

Even though, several researchers have endeavored to offer insight into need for the archers to possess certain physical fitness variables, to date, there has been little effort to investigate the most crucial physical fitness variables that could play a role in the successful performance of the game and to determine the less paramount fitness variable in the execution of the game which can serve as the basis for restructuring the training program to suit the need of the game. In view of this background, the current study aims to identify the most essential physical fitness variables necessary for a successful performance of archery among youth archers.

2. Material and Methods

2.1 Participants

A total number of 17 archers were recruited to participate in this study. The participants were male and female youth archers between the ages range of 13-19 (16.9 ± 2.0) drawn from Terengganu sports council, Malaysia. The archers are under development program for training and subsequently, targeted to be promoted to state and national archers respectively. The coaches and the stakeholders of the council were informed about the purpose of the research. Written approval was obtained, and all the archers signed consent forms. All the procedures, protocol and apparatus for this study were permitted by the Research Ethics Board of the Terengganu Sports Institute (ISNT) with a reference number 04-04/T-01/Jid 2.

2.2 Archers Fitness Measurements

2.2.1 Core Muscle Strength

The test was executed according to the recommended method for physical fitness tests[9]. Participants lay on their back with their knees bowed at around right edges while both feet were situated level on the floor. They put their hands against their chest where they should stay throughout the test. In the test process, a supporter held the participants' feet put on the ground. Participants sat up until they touched their knees to both elbows; then, they came back to the floor. The movement was frequented as many times as possible under the period for 60s. The aide totalled and recorded the quantity of right finished sit-ups. The test was measured just once attributable to the impact of exhaustion.

2.2.2 Upper Muscle Strength

The participants assumed a prone position on the floor with the hands directly underneath the shoulders, legs extended and together, and toes tucked under so they are in contact with the floor, (push up position). The participants then push with the arms until they are fully extended

and then lower their body until the chin or chest touches the floor. At this point, the line from the head to the toes was straight. All of these movements were executed only by the arms and shoulders. The score was determined by the number of push-ups while maintaining correct form, completed within one minute. The test was also administered ones to avoid fatigue.

2.3 Endurance Capacity Test

The multistage 20-m shuttle run test was implemented to acquire the participant's maximal oxygen uptake[10]. Every archer kept running for whatever length of time he/she could afford until could no more keep pace with the velocity of the tape. Test results for every participant were expressed as an anticipated VO_{2max} accomplished by checking the last level and ended shuttle number at the time when the participant voluntarily resigned from the test. The predicted VO_{2max} was determined using the formula (ml/min /kg) = Multi-Stage Shuttle Run 20 m (MSR20 m) level 1 distance (meters) × 0.0084 + 36.4 as suggested[11].

2.4 Body Flexibility

The flexibility of the lower back and hamstrings were determined by the sit and reach test. The athletes performed two trials, and the best one was recorded for further analysis as suggested by the previous researchers[12].

2.5 Anthropometric Test

Standard anthropometric testing was conducted which constitutes of weight, height, sitting height, and body fat %. Standing height was measured with a wall-mounted wooden stadio-meter to the nearest 0.5 cm. Body weight was evaluated with a standardised electronic digital scale to the nearest 0.01 kg. Sitting height was tested from the vertex of the head to the seated buttocks and was recorded to the nearest 0.5 cm 12. Skin fold callipers were used to measure the triceps, biceps, sub scapular and suprailiac to the nearest 0.1 mm, whereas medial upper arm circumference (muac) and calf circumference (cc) were measured via measuring tape. From these characteristics, the body mass index was then computed by dividing the body mass (kg) and body height square (m²)[13]. All the measurements were executed in accordance with ISAK protocol[14]. The measurements were obtained twice, and the mean value was generated as the final score.

3. Results

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was displayed in Table 1. This test was implemented to determine the adequacy of the sampling to quantify as well as to make a reasonable interpretation based on the data gathered[15]. Similarly, the test was conducted to ensure that the variables are not related to each other. The KMO value shows 0.70 which contributed for 70% sampling adequacy is shown in Table 1. Therefore, based on this results it is apparent that there is no multi-co-linearity observed among the original variables and that enabled us to proceed further with the analysis having satisfied the measure of the sampling adequacy. The eigen value for the initial PCA was revealed in Figure 1. From the figure, it can be observed that the PCA identified two components as the most essential due to their higher eigen values greater than 1(>1). These components were retained and used as an input variable for further analysis. The PCA after varimax rotation was disclosed in Table 2. It can be seen from the table that from VF1 four components fulfilled the 0.65-factor loading threshold although, Age and BMI show negative factor loadings, it means that the components are inversely associated with archery physical fitness related performance components. Likewise, the VF2 identifies two components with a positive higher factor loading. The most significant components after varimax rotation were projected in Figure 2. Furthermore, the contribution of each varifactor within the components as well their variability is shown. It can be observed from the figure that VF1 and VF2 contributed to about 64.36% of the total data set and the variability of 37.11% and 27.25 % respectively.

Table 1. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy

Variables	Values
Age	0.60
BMI	0.80
V sit and reach (cm)	0.63
Max push up	0.74
1 Minute sit up	0.68
Predicted VO2max	0.70
KMO	0.70
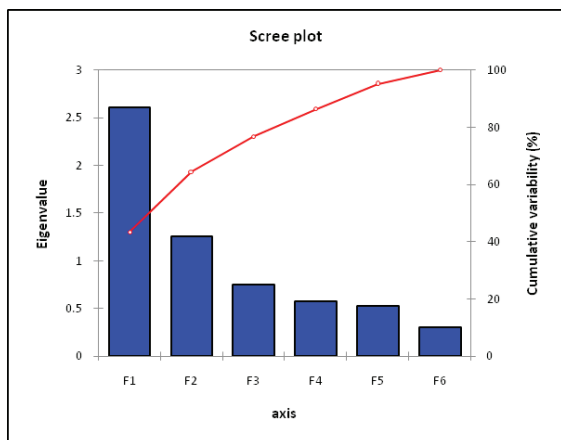
Figure 1. Scree plots for PCA.

Table 2. Factor loading after varimax rotation

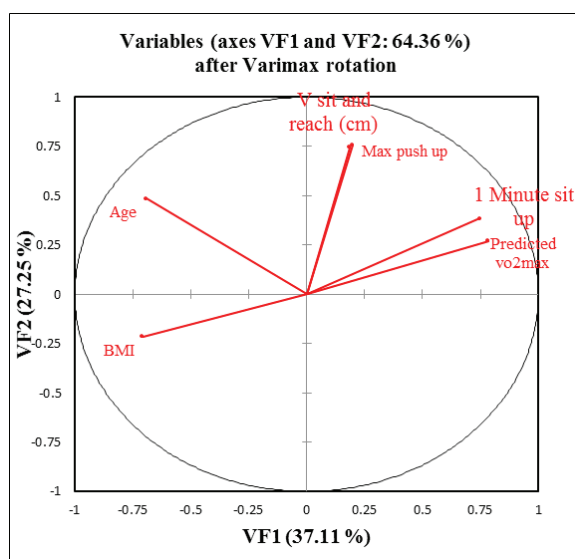| Variables	VF 1	VF 2
Age	**-0.69**	0.49
BMI	**-0.71**	-0.21
V sit and reach (cm)	0.19	**0.75**
Max push up	0.20	**0.76**
1 Minute sit up	**0.75**	0.38
Predicted VO2max	**0.78**	0.27
Eigenvalue	2.60	1.26
Variability %	43.39	20.97
Cumulative %	43.39	64.36

Figure 2. Factor loading plot after varimax rotation.

4. Discussion

This study aims to identify the physical fitness variables that are most essential in the performance of youth archers. To achieve the aim of this study, we employed 17 youth archers from Terengganu sports council in Malaysia. We subjected the archers to standard anthropometric, fitness variables related performance testing repeatedly. We utilised PCA to determine the most crucial variables pertinent to the requirement of the game. In the current study, VFs with absolute values greater than 0.65 were standardised as the selection threshold due to the fact that these values are considerably solid and stable, which indicates moderate to strong loadings on the extracted factors. It has been revealed that six variables satisfied the 0.65-factor loading threshold is shown in Table 2 and Figure 2. These variables are then classified as the essential physical components that are mainly required for the performance in youth archers. However, each of these components contained varifactors associated to it.

The VF1 contributes for about 43.39% of the variation in the physical fitness performance variables data. It has high positive and negative loadings from four variables, which are age (-0.69), BMI (-0.71), 1-minute sit up (0.75), and predicted VO_{2max} (0.78) is shown in Table 2. Considering the nature of these seven components, they can be interpreted as endurance due to the considerable higher positive factor loading generated from the predicted VO_{2max}. However, the negatives signs observed from age and BMI shows an inverse relationship between these variables with the successful performance of archery. In other words, it explains that the age of an archer, as well as body mass index, could not predict his/her actual performance in the game. Nonetheless, the finding has stressed the importance of endurance in the game. Cardiovascular endurance involves the ability of an individual to sustain longer time in executing physical activities. The nature of archery involves long hours for training and competition with a lot of movement forth and back which demands a lot of energy and endurance. This result is in agreement with the previous researchers who explained that cardiorespiratory endurance is essential in the game of archery since the archers are required to last the full 288 arrows shot for a FITA round competition[16,17]. During the game, the archers are anticipated to do a lot of work either with or without the arrows. They will make a repeated movement, shot

the expected arrows within the stipulated period, check their scores, and cope with the weather and so on. The energy required to achieve this motive is supplied aerobically, which requires the heart, lungs and blood system to provide oxygen to the working muscles all through the shooting period[18]. Therefore, endurance is a fundamental necessity in the game of archery[19].

The VF2 from Table 2 accounted for about 20.97% of the variability in the physical fitness performance variables data. It demonstrates positive higher factor loadings from v sit and reach (0.75) and maximum push up (0.76). These variables can be interpreted as upper muscle strength. This finding is in concord with preceding author who revealed that upper muscle strength is an essential component in executing an archery skill[20]. Anybody may perform a correct archery skill or any other upper body strength demanded sport when he/she has adequate arms muscle strength to draw and hold the bow[21]. To be able to complete an accurate archery skill, an archer must be able to feel and regulate his/her technique well. A regulation of the technique is achievable when the archer is in a comfort zone, meaning that he/she must be in calm state (not undergoing extreme muscle tension) hence, the point of concentration shall be emphasis more on the archery technique. Adequate strength of upper muscles may herald an athlete into a comfort zone, because at the time of drawing the bow, arms muscles in contraction do not experience too much tension because a high load of the bow being drawn is far lesser than the maximum threshold of muscles strength[22]. Based on these reasons, it is established that there is a direct influence of upper muscle strength with an efficient performance of archery game.

5. Conclusion

The current study has successfully identified the most needed physical fitness variables in the productive performance of archery game. Endurance and upper muscular strength are discovered to be the necessary prerequisite fitness variables essential for the successful execution of archery game. Coaches and trainers could pay attention to this fitness related components when developing a training program for youth archers. Moreover, the trainers might find the current finding useful in structuring training programs to suit the need of the game in relation to the fitness attributes identified.

6. Acknowledgements

7. References

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