PERFORMANCE CHARACTERISTICS OF MALE ATHLETES IN 35 DIFFERENT SPORTS

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Abstract

Purposes: Evaluate the KONI (Indonesian National Sports Committee) test in identifying talent in 35 sports.

Method: The study used observational design. The 170 male athletes aged 21.05±3.70 years participated in this study. Data analysis used discriminant analysis applied to 3 anthropometric tests and 6 physical condition tests in swimming, golf, fencing, bicycle racing, badminton, taekwondo, football, basketball, judo, volleyball, martial arts, rugby, boxing, equestrian, wrestling, tennis, diving, jiu jitsu, aeromodelling, softball, *tarung derajat*, kempo, weightlifting, rollerblading, sambo, dance sport, wushu, muay thai, karate, triathlon, billiards, motor racing, athletics, bridge, and petanque.

Result: discriminant analysis produces 6 variables (1 anthropometry and 5 physical conditions) that discriminate maximally in 35 different sports. Discriminant analysis resulted in 53.5% correct classification of all participants for 35 different sports. The distinguishing characteristics are briefly as follows: height for badminton and volleyball, speed for rugby and softball, leg muscle power for basketball and volleyball, VO2max for swimming and softball, arm muscle strength for *tarung derajat* and kempo, agility for badminton and tennis field. **Conclusion:** The KONI test allows identification of talent characteristics that are relevant according to their sport based on discriminant functions used a combination of test scores for height, leg muscle power, arm muscle strength, agility, speed, and VO2max. For KONI trainers who are involved in talent development programs, the use of the KONI test can be applied to evaluate KONI athletes on a regular basis.

Keywords: Sports, Athletes, Talent Identification.

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Introduction

Background

In most sports, taller and stronger kids are seen as more talented players. In team sports, those who are most visible on the court are considered to be in control of play and score the winning points. In individual sports, the best are those who are faster and stronger than their opponents. This attracts the attention of scouts or coaches, who may overlook the potential for physical development and talent. Talent refers to the successful outcome of a specific performance domain in a sport. To achieve the highest standards in a given sport, athletes rely on a mix of natural and well-developed abilities a determinant of performance. By understanding the characteristics that might predict future performance, one can gain insight into how talented individuals are detected or identified and how talent might be transferred to different domains. By knowing athletes from a variety of sports with different physical characteristics, it provided talent programs with valuable information when directing young people to the sport that suits them optimally and specifically. In line with this, Till & Baker (2020) explained that identifying talent requires decisions about the performance of adult athletes to be made for young athletes in the future which are influenced by various factors of physical development.

Talent identification is a process for identifying superior quality capabilities. It is a complex, multifaceted, multidimensional, and multi-stage process (Ahamad et al., 2013). Talent identification can be defined as predicting the future performance of young athletes who will achieve success at the national or international level. Therefore, a well-developed talent identification program can be the key to providing fair opportunities for every athlete. However, while the identification of talent in sports is often erratic and subjective, true performing talents (those with future potential) are often overlooked and not selected early. During development in sports, coaches and trainers tend to rely on their experience to select talent. Romann (2020) explains that most sports federations select young athletes based on current competition results rather than potential development. This means that many of these talent identification processes fail to integrate important indicators when assessing young talent. McCormack et al (2022) report that the subjective judgment of Rugby league and S&C coaches cannot accurately assess all aspects of a player's physical performance. This introduces bias, as ripeness can vary widely and is rarely taken into account. So it must use objective data through testing. The use of objective data based on testing as a basis for selecting athletes aims to identify and select the most promising young athletes with the potential to become superior and professional (Larkin & O'Connor, 2017).

KONI is one of the sports organizations responsible for helping manage the implementation of Indonesian sports, has an important role in coaching and developing sports. KONI needs to program and coordinate the implementation in improving sports by carrying out a talent identification program to produce quality athletes and then prepare these athletes to compete and achieve achievements. KONI fosters 35 sports and in talent identification uses testing, however the talent identification that is carried out is not yet oriented towards scientific evidence related to differences in the performance characteristics of athletes from various different sports and whether there will be a possibility of transfer between sports or not is not yet known. Therefore, in general this study was conducted to discriminate athletes using the KONI test into the sport that best suits their physical profile. So this study aims to evaluate the KONI test in identifying talent in 35 sports.

Purpose

The study purpose was evaluated the KONI test in identifying talent in 35 sports.

Materials and Methods

Study design

Researchers used a predictive observational design. This study predicted that the 9 KONI tests can discriminate athletes and allocate athletes for 35 sports based on a unique combination of test scores.

Participants

A sample of 170 male athletes aged 21.05 ± 3.70 years participated in this study. All participants are athletes fostered by KONI, competing in one of the following 35 sports: swimming (n = 3), golf (n = 1), fencing (n = 3), cycling (n = 1), badminton (n = 1), taekwondo (n = 10), football (n = 11), basketball (n = 13), judo (n = 9), volleyball (n = 5), martial arts (n = 5), rugby (n = 8), boxing (n = 8), equestrian (n = 5), wrestling (n = 6), tennis (n = 1), diving (n = 2), jiu jitsu (n = 3) , aeromodeling (n = 1), softball (n = 15), tarung derajat (n = 6), kempo (n = 6), weightlifting (n = 5), rollerblading (n = 5), sambo (n = 2), dance sport (n = 3), wushu (n = 1), muay thai (n = 3), karate (n = 7), triathlon (n = 3), billiards (n = 4), motorcycle racing (n = 4), athletics (n = 7), bridge (n = 2), and petanque (n = 1).

Procedure and measurements

The participants completed 9 KONI tests consisting of anthropometry and physical condition. Before the test is carried out, standard instructions and demonstrations according to the test guidelines are given to participants. All tests are carried out in the same place. The test was carried out in the morning and athletes were instructed not to engage in strenuous exercise the day before the test session.

Anthropometry: All subjects were measured anthropometrically: height, weight, BMI. Height was measured without shoes using a stadiometer with an accuracy of 0.1 in centimeters (cm). Body weight was measured using a scale in a state of minimal clothing in kilograms (kg). BMI is calculated using the formula $\frac{Weight}{Height \times Height}$.

Physical condition: All subjects were measured for their physical condition: abdominal muscle strength/resistance, arm strength, leg muscle power, speed, agility, aerobic power (VO2max). While the sit-up test was used as an indicator of abdominal muscle strength/resistance, the number of correct repetitions performed during the 30-second test was recorded. Push ups were used to assess arm strength, the correct number of push ups done in 30 seconds was recorded. Leg muscle power was measured by the vertical jump test. The highest achievement achieved was the leg muscle power ability as measured in centimeters (cm). After three attempts, the best results were recorded. The 40 meter run is used to judge speed. Two pairs of cones are placed in a straight line 40 meters. Subject ran from the start line with a standing attitude and ran as fast as possible. The best test result of two attempts at 10-minute intervals is recorded to the nearest 0.01 seconds. To measure the subjects agility, a 4 x 10 meter shuttle run test was carried out. Subject ran back and forth rapidly. The best test result of two attempts is recorded to the nearest 0.01 seconds. Aerobic power was assessed using a multistage fitness test. The test was carried out in an indoor court with an anti-skid floor. In accordance with the established protocol for this test, the subjects ran back and forth continuously between two lines 20 meters apart marked with cones. Recorded beeps are used, and the subject must reach the line on time for each beep. The initial velocity is 8.5 km/h and it is increasing 0.5 km/h every minute. The test was stopped if the subject was unable to run following each beep.

Statictical analysis

Discriminant analysis was used to allocate athletes for 35 different sports. Discriminant analysis interprets patterns of differences between groupings of variables as a whole in an attempt to understand the dimensions by which groups differ (Robertson et al., 2021). Descriptive statistics are used to determine the average and standard deviation. Multivariate analysis was used to distinguish 35 sports. Stepwise discriminant analysis was used to analyze data with a minimum significance set at <0.05. Using stepwise discriminant analysis, the researchers extracted a subset of variables that differentiated a maximum of 35 sports. The F-value is used to stop the discriminant analysis extraction procedure with a significance of < 0.05 to be entered. Canonical discriminant analysis was used to investigate relevant performance variables in 35 sports. Coefficient fisher's linear discriminant functions are used as discriminant functions to allocate athletes for 35 different sports. Data analysis was performed with SPSS 17.

Result

Data description

The results showed that there were multivariate differences in the anthropometric variables and physical conditions (Wilks' Lambda = .011; F = 2.505; p<0.05) (table 1). A significant univariate difference was found on the anthropometric test, namely height (Wilks' Lambda = .490; F = 4.138; p<0.05). Significant univariate differences were found in the physical condition test of leg muscle power (Wilks' Lambda = .423; F = 5.411; p<0.05), arm muscle strength (Wilks' Lambda = .658; F = 2.064; p<0.05), agility (Wilks' Lambda = .545; F = 3.309; p<0.05), speed (Wilks'Lambda = .537; F = 3.423; p<0.05), and VO2max (Wilks' Lambda = .571; F = 2.978; p <0.05) (Tables 1 & 2).

Discriminant analysis between 35 sports

Stepwise discriminant analysis showed that none of the 170 subjects were not analyzed, and 53.5% of the classification rate was correct. Based on his predictions, in Swimming there was 1 false positive case (1 tarung derajat athlete was classified as a Swimming athlete), in fencing there were 2 false positive cases (1 judo athlete and 1 triathlon athlete were classified as a fencing athlete and 1 false negative case (1 fencing athlete was classified as a cycling athlete), in badminton there was 1 false positive case (1 softball athlete was classified as a badminton athlete), in taekwondo there were 2 false positive cases (1 softball athlete and 1 karate athlete were classified as a taekwondo athlete) and 3 false negative cases (taekwondo athlete classified as equestrian, tarung derajat, and rollerblading athletes, 1 athlete respectively), in football there were 2 false positive cases (1 rugby athlete and 1 kempo athlete were classified as football athletes) and 4 false negative cases (football athletes were classified as rugby athletes, equestrian, kempo, and karate, 1 athlete respectively), in basketball there were 3 false positive cases (1 martial arts athlete, 1 softball athlete, and 1 billiard athlete classified as a basketball athlete) and 5 false negative cases (basketball athlete classified as a martial arts, diving, billiard, motorcycle racing, and petanque athlete, 1 athlete respectively), in judo there was 1 false positive case (1 rugby athlete was classified as a judo athlete) and 5 false negative cases (3 judo athletes were classified as a judo athlete). Boxing, 1 judo athlete is classified as a sambo and petanque athlete), in martial arts there are 4 false positive cases (1 softball athlete, 1 tarung derajat athlete, 1 rollerblading athlete, and 1 karate athlete is classified as a martial arts athlete) and 1 false negative case (1 martial arts athlete was classified as a rollerblading athlete), in rugby there were 5 false positive cases (1 equestrian athlete, 2 softball athletes, 1 sambo athlete, and 1 motorcycle racing athlete were classified as a rugby athlete) and 1 false negative case (1 rugby athlete classified as a softball athlete), in Boxing there were 2 false positive cases (1 tarung derajat athlete and 1 triathlon athlete classified as a Boxing athlete) and 5 false negative cases (Boxing athlete classified as a Tennis, Diving, aeromodeling, weightlifting, and triathlon athlete, 1 athlete respectively), in equestrian there were 2 false positive cases (1 weightlifting athlete and 1 karate athlete classified as an equestrian athlete) and 2 false negative cases (equestrian athlete classified as a karate and bridge athlete, 1 athlete each), in wrestling there was 1 false negative case (1 wrestling athlete was classified as a weightlifting athlete), in tennis there was 1 false positive case (1 softball athlete was classified as a tennis athlete), in jiu jitsu there were 2 false positive cases (1 weightlifting athlete and 1 motorcycle racing athlete were classified as a jiu jitsu athlete) and 2 false negative cases (jiu jitsu athlete classified as a dance sport and bridge athlete, 1 athlete respectively), in aeromodeling there was 1 false positive case (1 brige athlete was classified as an aeromodeling athlete), in softball there was 1 false positive cases (1 rollerblading athlete is classified as a softball athlete) and 2 false negative cases (2 softball athletes are classified as a triathlon athlete), in degree fight there is 1 false positive case (1 kempo athlete is classified as a darung derajat) and 2 false negative cases (2 athletes were classified as kempo athletes), in Kempo there was 1 false negative case (1 kempo athlete was classified as a petanque athlete), in Weightlifting there were 3 false negative cases (weightlifting athletes were classified as rollerblading, billiard, and motorcycle racing athletes, 1 athlete respectively), in rollerblading there were 2 false positive cases (1 motorcycle racing athlete and 1 athletics athlete classified as a rollerblading athlete), in dance sports there were 2 false positive cases (1 muay thai athlete and 1 triathlon athlete classified as a dance sport athlete) and 1 false negative case (1 dance sport athlete was classified as a wushu athlete), in wushu there was 1 false positive case (1 karate athlete was classified as a wushu athlete), in muay thai there were 2 false positive cases (2 Athletics athletes were classified as a muay thai athlete), in billiards there was 1 false negative case (1 billiard athlete was classified as a bridge athlete), in motorcycle racing there was 1 false negative case (1 motorcycle racing athlete was classified as an Athletics athlete) (Table 3).

Table 1: Multivariate test results for anthropometric and physical conditions variables.

Wilks' Lambda	F	p-value
.011	2.505	.000*

Identify relevant aptitude characteristics based on the test applied

Stepwise discriminant analysis produces 6 stepwise stages in discriminating against athletes based on a combination of test results from 35 sports. The results show that there are 6 variables (Wilks' Lambda = .021; F = 3.500; p<0.05) that discriminate against athletes which include speed for rugby and softball, body height for badminton and volleyball, leg muscle power for basketball and volleyball, VO2max for swimming and softball, arm muscle strength for darung derajat and kempo, as well as agility for badminton and tennis.

Canonical discriminant function

Based on the stepwise discriminant analysis, six canonical discriminant functions are produced. Eigenvalues describe how much variance in the dependent variable is recorded for each function. The first function accounts for 33.8% explained by the model. Discriminant function 1 and discriminant function 2 differentiate between the 35 sports in terms of their profiles, using group centroids. The cumulative effect of the six functions accounts for 100% of cases correctly classified in sport. Therefore, the model can be used for the purpose of predicting 35 sports (Figure 1).

Athlete classification model in 35 sports based on discriminant function

The athlete classification model for 35 sports is explained by the discriminant function obtained based on stepwise discriminant analysis on the coefficient fisher's linear discriminant functions. The function of 6 variables is defined, allowing researchers or coaches to classify each athlete into one of 35 sports. This is done by calculating the function for each subject. The function with the highest score is then indicated to which group each particular subject should be classified. Here are the functions:

- **Swimming athletes:** 36.291 (body height) + 4.881 (leg muscle power) + 1.251 (arm muscle strength) + 33.094 (agility) + 43.277 (speed) + 4.447 (VO_{2max}) – 3702.912
- **Golf athletes:** 35.052 (body height) + 4.185 (leg muscle power) + 1.158 (arm muscle strength) + 35.019 (agility) + 41.408 (speed) + 4.635 (VO_{2max}) – 3498.373

Table 2: Univariate test results of anthropometric and physical conditions tests.

Sport	Body height (cm) Mean (SD)	Weight (kg) Mean (SD)	*BMI* (kg/cm²) Mean (SD)	Leg muscle power (cm) Mean (SD)	abdominal muscle strength/ resistance (repetition) Mean (SD)	Arm muscle strength (repetition) Mean (SD)	Agility (seconds) Mean (SD)	Speed (second) Mean (SD)	*VO_{2max}* (mL/ kg/ minute) Mean (SD)
Swimming (n = 3)	167.33 (1.53)	63.61 (6.09)	22.70 (1.80)	51.67 (.57)	25.33 (5.03)	29.67 (2.08)	17.88 (.25)	5.29 (.25)	48.66 (1.67)
Golf (n = 1)	161.00	63.55	24.50	45.00	25.00	24.00	19.40	5.58	47.41
Fencing (n = 3)	168.00 (1.73)	63.65 (4.51)	22.57 (1.80)	43.00 (1.00)	21.00 (5.57)	28.67 (9.50)	18.79 (.30)	5.75 (.62)	47.32 (3.16)
Cycling (n = 1)	167.00	61.31	22.00	45.00	25.00	27.00	17.61	5.77	47.72
Badminton (n = 1)	169.00	60.00	21.00	47.00	23.00	20.00	19.07	5.63	47.41
Taekwondo (n = 10)	163.80 (3.61)	58.65 (4.69)	21.87 (1.55)	52.00 (3.33)	24.80 (5.45)	31.50 (8.81)	17.25 (.40)	5.33 (.29)	45.06 (3.89)
Football (n = 11)	163.45 (.82)	58.55 (3.39)	21.92 (1.29)	48.36 (1.57)	25.64 (8.79)	27.36 (9.17)	17.90 (.49)	5.62 (.47)	39.08 (4.03)
Basketball (n = 13)	169.08 (2.02)	62.90 (6.22)	21.98 (1.89)	53.38 (.77)	24.92 (6.66)	18.62 (7.09)	19.20 (.51)	5.88 (.39)	49.60 (6.75)
Judo (n = 9)	164.33 (2.24)	61.09 (5.42)	22.61 (1.88)	47.56 (5.17)	22.33 (4.42)	31.89 (11.56)	19.29 (.35)	5.84 (.33)	46.13 (4.19)
Volleyball (n = 5)	168.80 (.45)	62.39 (3.23)	21.90 (1.20)	54.20 (1.79)	22.40 (8.62)	19.80 (5.59)	18.06 (1.11)	5.62 (.06)	39.72 (1.20)
Martial arts (n = 5)	168.40 (.55)	59.01 (7.84)	20.82 (2.78)	55.20 (2.17)	25.80 (4.60)	26.80 (3.70)	17.97 (.85)	5.83 (.38)	47.22 (4.31)
Rugby (n = 8)	166.38 (2.32)	58.38 (7.96)	21.08 (2.54)	48.88 (2.42)	21.63 (5.32)	19.88 (9.93)	18.73 (.21)	5.60 (.21)	39.22 (7.89)
Boxing (n = 8)	166.50 (1.77)	63.46 (3.11)	22.90 (1.03)	49.75 (1.58)	23.38 (9.29)	33.50 (11.38)	18.99 (.59)	5.77 (.29)	44.78 (4.66)
Equestrian (n = 5)	164.60 (1.67)	58.41 (3.71)	21.58 (1.68)	44.40 (5.46)	25.20 (12.21)	27.00 (11.83)	18.61 (.62)	6.16 (.59)	35.16 (2.69)
Wrestling (n = 6)	167.00 (2.28)	60.71 (8.21)	21.77 (2.93)	55.00 (3.35)	25.00 (8.49)	34.83 (8.49)	18.21 (1.58)	6.74 (.26)	39.75 (1.01)
Tennis (n = 1)	168.00	59.00	20.90	49.00	25.00	18.00	19.23	5.50	47.41
Diving (n = 2)	168.00 (1.41)	62.00 (2.83)	21.95 (.63)	48.50 (3.54)	22.50 (3.54)	28.50 (.71)	19.67 (.77)	5.90 (.02)	48.61 (5.66)
Jiu Jitsu (n = 3)	162.33 (1.53)	58.39 (7.88)	22.20 (3.27)	48.00 (3.65)	21.33 (1.53)	20.67 (5.77)	19.94 (.17)	6.29 (.51)	40.75 (1.37)
Aeromodeling (n = 1)	165.00	61.20	22.50	45.00	26.00	21.00	19.53	6.38	37.45
Softball (n = 15)	167.60 (3.36)	59.00 (2.00)	21.04 (1.21)	50.80 (2.18)	21.07 (8.00)	23.07 (9.19)	18.29 (1.04)	5.60 (.36)	49.17 (5.67)
Tarung Derajat (n = 6)	167.00 (1.26)	58.83 (2.97)	21.10 (1.47)	51.33 (3.14)	24.83 (7.52)	30.00 (6.81)	18.38 (.86)	5.90 (.17)	46.12 (1.60)
Kempo (n = 6)	165.50 (1.76)	58.83 (6.40)	21.52 (2.75)	50.50 (2.07)	21.50 (3.21)	30.33 (2.88)	17.81 (1.08)	5.91 (.48)	48.22 (3.51)
Weightlifting (n = 5)	166.60 (1.34)	62.20 (2.86)	22.40 (.79)	48.20 (4.38)	23.00 (9.75)	24.00 (6.12)	19.08 (1.85)	6.63 (1.31)	39.65 (1.53)
Rollerblading (n = 5)	168.40 (1.34)	58.40 (4.34)	20.64 (1.70)	52.40 (4.45)	21.80 (6.46)	18.40 (4.39)	17.09 (.42)	5.63 (.43)	45.85 (9.16)
Sambo (n = 2)	162.50 (3.54)	62.00 (2.83)	23.45 (.07)	44.50 (3.54)	24.00 (5.66)	20.00 (8.49)	19.04 (.86)	5.74 (.56)	39.21 (6.29)
Dance Sport (n = 3)	162.67 (.58)	62.77 (10.05)	23.73 (4.00)	52.67 (.58)	22.00 (1.00)	22.67 (2.52)	18.87 (.89)	5.90 (.30)	41.08 (3.90)
Wushu (n = 1)	162.00	61.66	23.50	55.00	24.00	22.00	19.40	5.93	41.20
Muay Thay (n = 3)	163.67 (2.31)	63.33 (16.50)	23.57 (5.59)	56.00 (2.65)	23.33 (4.73)	34.33 (5.03)	18.99 (.61)	5.63 (.37)	40.71 (6.00)
Karate (n = 7)	164.14 (1.57)	61.18 (7.66)	22.69 (2.71)	51.57 (4.08)	21.71 (2.14)	30.86 (12.12)	17.55 (.94)	5.88 (.34)	41.62 (6.17)
Triathlon (n = 3)	164.00 (4.00)	58.33 (4.16)	21.67 (.57)	49.67 (4.93)	21.67 (6.66)	31.00 (6.08)	18.68 (.23)	5.77 (.19)	49.43 (5.84)
Billiard (n = 4)	166.25 (2.50)	62.78 (3.64	22.73 (1.49)	49.25 (5.06)	24.00 (9.83)	18.00 (1.41)	19.45 (1.13)	6.97 (1.23)	41.90 (5.84)
Motorcycle racing (n = 4)	166.00 (.82)	59.57 (10.49)	21.65 (3.89)	52.50 (5.07)	26.00 (8.60)	23.25 (3.77)	18.95 (2.40)	5.79 (.43)	39.54 (8.82)
Athletics (n = 7)	164.86 (2.48)	63.55 (6.76)	23.40 (2.54)	57.43 (1.90)	22.29 (3.50)	31.43 (7.72)	17.64 (.64)	5.30 (.31)	43.94 (7.92)
Bridge (n = 2)	164.50 (2.12)	63.17 (3.73)	23.40 (1.98)	44.50 (2.12)	23.50 (3.54)	17.50 (.71)	19.45 (.50)	6.71 (.42)	38.83 (.49)
Petanque (n = 1)	163.00	60.33	22.70	52.00	24.00	24.00	19.61	5.57	47.11
Wilks' Lambda	0.490	0.875	0.841	0.423	0.934	0.658	0.545	0.537	0.571
F (p-value)	4.138 (.000*)	0.566 (.973)	0.750 (.834)	5.411 (.000*)	0.281 (1.000)	2.064 (.002*)	3.309 (.000*)	3.423 (.000*)	2.978 (.000*)
***Signifikansi p<0.05**									

- **Fencing athletes:** 36.600 (body height) + 3.823 (leg muscle power) + 1.293 (arm muscle strength) + 34.071 (agility) + 42.870 (speed) + 4.677 (VO_{2max}) – 3732.788
- **Cycling athletes:** 36.314 (body height) + 4.122 (leg muscle power) + 1.239 (arm muscle strength) + 32.097 (agility) + 44.616 (speed) + 4.570 (VO_{2max}) – 3665.550
- **Badminton athletes:** 36.689 (body height) + 4.367 (leg muscle power) + 1.138 (arm muscle strength) + 34.631 (agility) + 42.957 (speed) + 4.684 (VO_{2max}) – 3779.914
- **Taekwondo athletes:** 35.493 (body height) + 5.070 (leg muscle power) + 1.279 (arm muscle strength) + 31.657 (agility) + 43.850 (speed) + 4.160 (VO_{2max}) – 3546.072
- **Football athletes:** 35.419 (body height) + 4.797 (leg muscle power) + 1.275 (arm muscle strength) + 32.001 (agility) + 43.670 (speed) + 4.027 (VO_{2max}) – 3519.521
- **Basketball athletes:** 36.630 (body height) + 5.292 (leg muscle power) + 1.074 (arm muscle strength) + 34.767 (agility) + 46.440 (speed) + 4.692 (VO_{2max}) – 3838.155
- **Judo athletes:** 35.773 (body height) + 4.561 (leg muscle power) + 1.316 (arm muscle strength) + 34.638 (agility) + 44.081 (speed) + 4.492 (VO_{2max}) – 3638.737
- **Volleyball athletes:** 36.420 (body height) + 5.546 (leg muscle power) + 1.158 (arm muscle strength) + 32.419 (agility) + 45.411 (speed) + 4.056 (VO_{2max}) – 3739.933
- **Martial arts athletes:** 36.453 (body height) + 5.559 (leg muscle power) + 1.210 (arm muscle strength) + 32.650 (agility) + 47.622 (speed) + 4.366 (VO_{2max}) – 3777.800
- **Rugby athletes:** 36.003 (body height) + 4.845 (leg muscle power) + 1.171 (arm muscle strength) + 33.436 (agility) + 43.022 (speed) + 4.171 (VO_{2max}) – 3644.079
- **Boxing athletes:** 36.186 (body height) + 4.836 (leg muscle power) + 1.358 (arm muscle strength) + 34.193 (agility) + 44.547 (speed) + 4.358 (VO_{2max}) – 3709.823
- **Equestrian athletes:** 35.729 (body height) + 4.465 (leg muscle power) + 1.332 (arm muscle strength) + 32.409 (agility) + 45.191 (speed) + 4.010 (VO_{2max}) – 3572.332

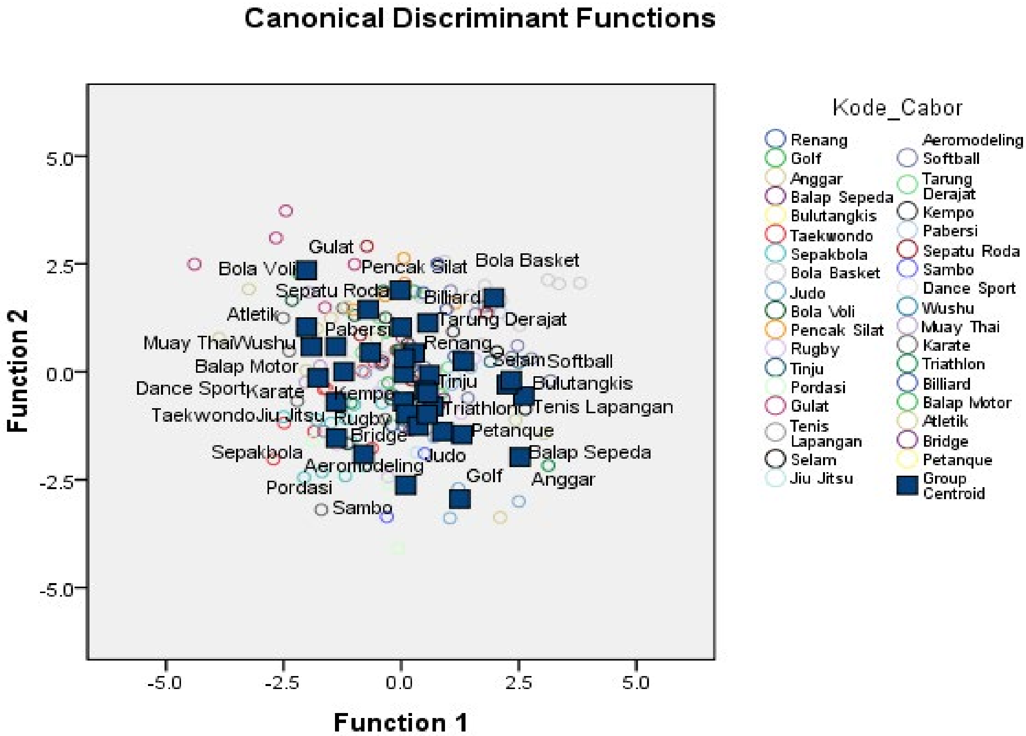

Figure 1: Differences based on canonical discriminant functions calculated from 9 KONI tests.
Note 1: The scatterplot has the coefficients of the canonical discriminant functions as its axes, with Function 1 on the x-axis and Function 2 on the y-axis.
Note 2: Functions on the group centroid, the centroid is the average discriminant score for each group. Swimming Function 1: .603, Function 2: -.071; Golf Function 1: 1.245, Function 2: -2.946; Fencing Function 1: 2.525, Function 2: -1.975: Cycling Function 1: 1.295, Function 2: -1.454; Badminton Function 1: 2.608, Function 2: -.560; Taekwondo Function 1: -1.381, Function 2: -.698; Football Function 1: -1.378, Function 2: -1.535; Basketball Function 1: 1.966, Function 2: 1.717; Judo Function 1: .878, Function 2: -1.383; Volleyball Function 1: -.697, Function 2: 1.443; Martial arts Function 1: -.019, Function 2: 1.893; Rugby Function 1: .046, Function 2: -.690; Boxing Function 1: .512, Function 2: -.426; Equestrian Function 1: -.798, Function 2: -1.910; Wrestling Function 1: -2.015, Function 2: 2.348; Tennis Function 1: 2.254, Function 2: -.296; Diving Function 1: 2.335, Function 2: -.199; Jiu Jitsu Function 1: .122, Function 2: -.977; Aeromodeling Function 1: .365, Function 2: -1.255; Softball Function 1: 1.321, Function 2: .249; Tarung derajat Function 1: .278, Function 2: .440; Kempo Function 1: .060, Function 2: -.040; Weightlifting Function 1: .067, Function 2: .314; Rollerblading Function 1: .009, Function 2: 1.034; Sambo Function 1: .097, Function 2: -2.625; Dance sport Function 1: -1.222, Function 2: .003; Wushu Function 1: -1.386, Function 2: .586; Muay thai Function 1: -1.910, Function 2: .580; Karate Function 1: -1.768, Function 2: -.142; Triathlon Function 1: .676, Function 2: -.802; Billiard Function 1: .567, Function 2: 1.134; Motorcycle racing Function 1: -.653, Function 2: .449; Athletics Function 1: -2.016, Function 2: 1.039; Bridge Function 1: .554, Function 2: -.990; Petanque Function 1: .567, Function 2: -.500.

- **Wrestling athletes:** 36.188 (body height) + 5.946 (leg muscle power) + 1.402 (arm muscle strength) + 31.675 (agility) + 52.788 (speed) + 3.981 (VO_{2max}) – 3758.510
- **Tennis athletes:** 36.428 (body height) + 4.635 (leg muscle power) + 1.089 (arm muscle strength) + 34.977 (agility) + 42.480 (speed) + 4.649 (VO_{2max}) – 3750.146
- **Diving athletes:** 36.554 (body height) + 4.609 (leg muscle power) + 1.264 (arm muscle strength) + 35.480 (agility) + 44.629 (speed) + 4.694 (VO_{2max}) – 3798.322
- **Jiu jitsu athletes:** 35.243 (body height) + 4.951 (leg muscle power) + 1.159 (arm muscle strength) + 34.785 (agility) + 46.052 (speed) + 4.348 (VO_{2max}) – 3575.176
- **Aeromodeling athletes:** 35.821 (body height) + 4.581 (leg muscle power) + 1.220 (arm muscle strength) + 33.869 (agility) + 46.069 (speed) + 4.248 (VO_{2max}) – 3632.048
- **Softball athletes:** 36.346 (body height) + 4.862 (leg muscle power) + 1.145 (arm muscle strength) + 33.475 (agility) + 44.643 (speed) + 4.594 (VO_{2max}) – 3730.031
- **Tarung derajat athletes:** 36.244 (body height) + 5.071 (leg muscle power) + 1.282 (arm muscle strength) + 33.156 (agility) + 46.491 (speed) + 4.390 (VO_{2max}) – 3722.414
- **Kempo athletes:** 35.946 (body height) + 4.933 (leg muscle power) + 1.260 (arm muscle strength) + 32.318 (agility) + 46.889 (speed) + 4.456 (VO_{2max}) – 3655.451
- **Weightlifting athletes:** 36.153 (body height) + 5.015 (leg muscle power) + 1.250 (arm muscle strength) + 33.125 (agility) + 49.217 (speed) + 4.263 (VO_{2max}) – 3714.573
- **Rollerblading athletes:** 36.390 (body height) + 5.173 (leg muscle power) + 1.084 (arm muscle strength) + 31.225 (agility) + 46.196 (speed) + 4.347 (VO_{2max}) – 3709.394
- **Sambo athletes:** 35.264 (body height) + 4.331 (leg muscle power) + 1.166 (arm muscle strength) + 33.700 (agility) + 42.178 (speed) + 4.258 (VO_{2max}) – 3502.030
- **Dance sport athletes:** 35.208 (body height) + 5.470 (leg muscle power) + 1.164 (arm muscle strength) + 33.432 (agility) + 45.860 (speed) + 4.149 (VO_{2max}) – 3560.131
- **Wushu athletes:** 35.041 (body height) + 5.818 (leg muscle power) + 1.141 (arm muscle strength) + 34.270 (agility) + 46.224 (speed) + 4.143 (VO_{2max}) – 3569.257
- **Muay thai athletes:** 35.439 (body height) + 5.803 (leg muscle power) + 1.357 (arm muscle strength) + 33.970 (agility) + 45.037 (speed) + 3.968 (VO_{2max}) – 3619.457
- **Karate athletes:** 35.567 (body height) + 5.240 (leg muscle power) + 1.305 (arm muscle strength) + 31.408 (agility) + 46.808 (speed) + 4.057 (VO_{2max}) – 3575.510
- **Triathlon athletes:** 35.676 (body height) + 4.772 (leg muscle power) + 1.259 (arm muscle strength) + 33.936 (agility) + 44.967 (speed) + 4.572 (VO_{2max}) – 3626.828
- **Billiard athletes:** 36.068 (body height) + 5.243 (leg muscle power) + 1.129 (arm muscle strength) + 33.528 (agility) + 51.509 (speed) + 4.446 (VO_{2max}) – 3739.755

Table 3: Subjects correctly classified in 35 different sports based KONI.

Actal / Prediction	**Swimming**	**Golf**	**Fencing**	**Cycling**	**Badminton**	**Taek wondo**	**Football**	**Basketball**	**Judo**	**Volleyball**
Swimming	100	0	0	0	0	0	0	0	0	0
Golf	0	100	0	0	0	0	0	0	0	0
Fencing	0	0	66.7 (n = 2)	33.3 (n = 1)	0	0	0	0	0	0
Cycling	0	0	0	100	0	0	0	0	0	0
Badminton	0	0	0	0	100	0	0	0	0	0
Taekwondo	0	0	0	0	0	70 (n = 7)	0	0	0	0
Football	0	0	0	0	0	0	63.6 (n = 7)	0	0	0
Basketball	0	0	0	0	0	0	0	61.5 (n = 8)	0	0
Judo	0	0	11.1 (n = 1)	0	0	0	0	0	33.3 (n = 3)	0
Volleyball	0	0	0	0	0	0	0	0	0	100
Martial arts	0	0	0	0	0	0	0	20 (n = 1)	0	0
Rugby	0	0	0	0	0	0	12.5 (n = 1)	0	12.5 (n = 1)	0
Boxing	0	0	0	0	0	0	0	0	0	0
Equestrian	0	0	0	0	0	0	0	0	0	0
Wrestling	0	0	0	0	0	0	0	0	0	0
Tennis	0	0	0	0	0	0	0	0	0	0
Diving	0	0	0	0	0	0	0	0	0	0
Jiu Jitsu	0	0	0	0	0	0	0	0	0	0
Aeromodeling	0	0	0	0	0	0	0	0	0	0
Softball	0	0	0	0	6.7 (n = 1)	6.7 (n = 1)	0	6.7 (n = 1)	0	0
Tarung Derajat	16.7 (n = 1)	0	0	0	0	0	0	0	0	0
Kempo	0	0	0	0	0	0	16.7 (n = 1)	0	0	0
Weightlifting	0	0	0	0	0	0	0	0	0	0
Rollerblading	0	0	0	0	0	0	0	0	0	0
Sambo	0	0	0	0	0	0	0	0	0	0
Dance Sport	0	0	0	0	0	0	0	0	0	0
Wushu	0	0	0	0	0	0	0	0	0	0
Muay Thai	0	0	0	0	0	0	0	0	0	0
Karate	0	0	0	0	0	14.3 (n = 1)	0	0	0	0
Triathlon	0	0	33.3 (n = 1)	0	0	0	0	0	0	0
Billiard	0	0	0	0	0	0	0	25 (n = 1)	0	0
Motorcycle racing	0	0	0	0	0	0	0	0	0	0
Athletics	0	0	0	0	0	0	0	0	0	0
Bridge	0	0	0	0	0	0	0	0	0	0
Petanque	0	0	0	0	0	0	0	0	0	0
Actual Prediction	Martial arts	Rugby	Boxing	Equestrian	Wrestling	Tennis	Diving	Jiu Jitsu	Aeromodeling	Softball
Swimming	0	0	0	0	0	0	0	0	0	0
Golf	0	0	0	0	0	0	0	0	0	0
Fencing	0	0	0	0	0	0	0	0	0	0
Cycling	0	0	0	0	0	0	0	0	0	0
Badminton	0	0	0	0	0	0	0	0	0	0
Taekwondo	0	0	0	10 (n = 1)	0	0	0	0	0	0
Football	0	9.1 (n = 1)	0	9.1 (n = 1)	0	0	0	0	0	0
Basketball	7.7 (n = 1)	0	0	0	0	0	7.7 (n = 1)	0	0	0
Judo	0	0	33.3 (n = 3)	0	0	0	0	0	0	0
Volleyball	0	0	0	0	0	0	0	0	0	0
Martial arts	60 (n = 3)	0	0	0	0	0	0	0	0	0
Rugby	0	62.5 (n = 5)	0	0	0	0	0	0	0	12.5 (n = 1)
Boxing	0	0	37.5 (n = 3)	0	0	12.5 (n = 1)	12.5 (n = 1)	0	12.5 (n = 1)	0
Equestrian	0	20 (n = 1)	0	40 (n = 2)	0	0	0	0	0	0
Wrestling	0	0	0	0	83.3 (n = 5)	0	0	0	0	0
Tennis	0	0	0	0	0	100	0	0	0	0
Diving	0	0	0	0	0	0	100	0	0	0
Jiu Jitsu	0	0	0	0	0	0	0	33.3 (n = 1)	0	0
Aeromo deling	0	0	0	0	0	0	0	0	100	0
Softball	6.7 (n = 1)	13.3 (n = 2)	0	0	0	6.7 (n = 1)	0	0	0	40 (n = 6)

Tarung Derajat	16.7 (n = 1)	0	16.7 (n = 1)	0	0	0	0	0	0	0
Kempo	0	0	0	0	0	0	0	0	0	0
Weightlifting	0	0	0	20 (n = 1)	0	0	0	20 (n = 1)	0	0
Rollerblading	20 (n = 1)	0	0	0	0	0	0	0	0	20 (n = 1)
Sambo	0	50 (n = 1)	0	0	0	0	0	0	0	0
Dance Sport	0	0	0	0	0	0	0	0	0	0
Wushu	0	0	0	0	0	0	0	0	0	0
Muay Thai	0	0	0	0	0	0	0	0	0	0
Karate	14.3 (n = 1)	0	0	14.3 (n = 1)	0	0	0	0	0	0
Triathlon	0	0	33.3 (n = 1)	0	0	0	0	0	0	0
Billiard	0	0	0	0	0	0	0	0	0	0
Motorcycle racing	0	25 (n = 1)	0	0	0	0	0	25 (n = 1)	0	0
Athletics	0	0	0	0	0	0	0	0	0	0
Bridge	0	0	0	0	0	0	0	0	50 (n = 1)	0
Petanque	0	0	0	0	0	0	0	0	0	0

Actual Prediction	Tarung Derajat	Kempo	Weight lifting	Roller blading	Sambo	Dance Sport	Wushu	Muay Thai	Karate	Triathlon
Swimming	0	0	0	0	0	0	0	0	0	0
Golf	0	0	0	0	0	0	0	0	0	0
Fencing	0	0	0	0	0	0	0	0	0	0
Cycling	0	0	0	0	0	0	0	0	0	0
Badminton	0	0	0	0	0	0	0	0	0	0
Taekwondo	10 (n = 1)	0	0	10 (n = 1)	0	0	0	0	0	0
Football	0	9.1 (n = 1)	0	0	0	0	0	0	9.1 (n = 1)	0
Basketball	0	0	0	0	0	0	0	0	0	0
Judo	0	0	0	0	11.1 (n = 1)	0	0	0	0	0
Volleyball	0	0	0	0	0	0	0	0	0	0
Martial arts	0	0	0	20 (n = 1)	0	0	0	0	0	0
Rugby	0	0	0	0	0	0	0	0	0	0
Boxing	0	0	12.5 (n = 1)	0	0	0	0	0	0	12.5 (n = 1)
Equestrian	0	0	0	0	0	0	0	0	20 (n = 1)	0
Wrestling	0	0	16.7 (n = 1)	0	0	0	0	0	0	0
Tennis	0	0	0	0	0	0	0	0	0	0
Diving	0	0	0	0	0	0	0	0	0	0
Jiu Jitsu	0	0	0	0	0	33.3 (n = 1)	0	0	0	0
Aeromodeling	0	0	0	0	0	0	0	0	0	0
Softball	0	0	0	0	0	0	0	0	0	13.3 (n = 2)
Tarung Derajat	16.7 (n = 1)	33.3 (n = 2)	0	0	0	0	0	0	0	0
Kempo	16.7 (n = 1)	50 (n = 3)	0	0	0	0	0	0	0	0
Weightlifting	0	0	0	20 (n = 1)	0	0	0	0	0	0
Rollerblading	0	0	0	60 (n = 3)	0	0	0	0	0	0
Sambo	0	0	0	0	50 (n = 1)	0	0	0	0	0
Dance Sport	0	0	0	0	0	66.7 (n = 2)	33.3 (n = 1)	0	0	0
Wushu	0	0	0	0	0	0	100	0	0	0
Muay Thai	0	0	0	0	0	33.3 (n = 1)	0	66.7 (n = 2)	0	0
Karate	0	0	0	0	0	0	14.3 (n = 1)	0	42.9 (n = 3)	0
Triathlon	0	0	0	0	0	33.3 (n = 1)	0	0	0	0
Billiard	0	0	0	0	0	0	0	0	0	0
Motorcycle racing	0	0	0	25 (n = 1)	0	0	0	0	0	0
Athletics	0	0	0	14.3 (n = 1)	0	0	0	28.6 (n = 2)	0	0
Bridge	0	0	0	0	0	0	0	0	0	0
Petanque	0	0	0	0	0	0	0	0	0	0

Actual Prediction	**Billiard**	**Motorcycle racing**	**Athletics**	**Bridge**	**Petanque**
Swimming	0	0	0	0	0
Golf	0	0	0	0	0
Fencing	0	0	0	0	0
Cycling	0	0	0	0	0
Badminton	0	0	0	0	0
Taekwondo	0	0	0	0	0
Football	0	0	0	0	0
Basketball	7.7 (n = 1)	7.7 (n = 1)	0	0	7.7 (n = 1)

Judo	0	0	0	0	11.1 (n = 1)					
Volleyball	0	0	0	0	0					
Martial arts	0	0	0	0	0					
Rugby	0	0	0	0	0					
Boxing	0	0	0	0	0					
Equestrian	0	0	0	20 (n = 1)	0					
Wrestling	0	0	0	0	0					
Tennis	0	0	0	0	0					
Diving	0	0	0	0	0					
Jiu Jitsu	0	0	0	33.3 (n = 1)	0					
Aeromodeling	0	0	0	0	0					
Softball	0	0	0	0	0					
Tarung Derajat	0	0	0	0	0					
Kempo	0	0	0	0	16.7 (n = 1)					
Weightlifting	20 (n = 1)	20 (n = 1)	0	0	0					
Rollerblading	0	0	0	0	0					
Sambo	0	0	0	0	0					
Dance Sport	0	0	0	0	0					
Wushu	0	0	0	0	0					
Muay Thai	0	0	0	0	0					
Karate	0	0	0	0	0					
Triathlon	0	0	0	0	0					
Billiard	50 (n = 2)	0	0	25 (n = 1)	0					
Motorcycle racing	0	0	25 (n = 1)	0	0					
Athletics	0	0	57.1 (n = 4)	0	0					
Bridge	0	0	0	50 (n = 1)	0					
Petanque	0	0	0	0	100					

- **Motorcycle racing athletes:** 35.907 (body height) + 5.392 (leg muscle power) + 1.211 (arm muscle strength) + 33.651 (agility) + 45.079 (speed) + 4.102 (VO_{2max}) – 3669.633
- **Athletics athletes:** 35.628 (body height) + 5.830 (leg muscle power) + 1.274 (arm muscle strength) + 32.286 (agility) + 44.804 (speed) + 4.020 (VO_{2max}) – 3619.477
- **Bridge athletes:** 35.724 (body height) + 4.598 (leg muscle power) + 1.150 (arm muscle strength) + 33.482 (agility) + 48.185 (speed) + 4.364 (VO_{2max}) – 3626.223
- **Petanque athletes:** 35.367 (body height) + 5.139 (leg muscle power) + 1.147 (arm muscle strength) + 35.417 (agility) + 43.232 (speed) + 4.501 (VO_{2max}) – 3607.029

Discussion

The study results indicated that the KONI test can be used to differentiate athletes consists of 6 variables, namely body height, speed, leg muscle power, VO2max, arm muscle strength, and agility. Characteristics of talent that are relevant to sports based on these 6 variables are badminton identified by body height and agility variables, volleyball identified by body height and leg muscle power variables, rugby identified by speed variables, softball identified by speed and VO2max variables, basketball identified by leg variables muscle power, swimming is identified with the VO2max variable, tarung derajat and kempo are identified with the arm muscle strength variable, and tennis is identified with the agility variable. Based on the results of this study, 9 KONI tests consisting of 3 anthropometry (body height, weight, BMI) and 6 physical conditions (leg muscle power, sit-ups, arm muscle strength, agility, speed, and VO2max) can only distinguish 9 sports . Although not all sports can be distinguished based on the 6 resulting variables, none of the 170 cases analyzed in this study were missing. Discriminant functions are also generated for 35 sports using these 6 variables, and predict athletes in 35 sports with a correct classification rate of 53.5%. Unlike the previous study which identified 9 different sports using the FSC (Flemish Sports Compass) test which consisted of 22 anthropometric tests, measurements of physical fitness, and motor coordination, the FSC results were able to divide the sample with a correct classification rate of 96.4% which indicated the level of high consistency in the classification scheme (Pion et al., 2014). When compared with previous studies, the percentage of correct classification rates from the KONI test was much lower than the FSC test. The different in the results of this study may be because the tests used by KONI are only 9 tests while the FSC consists of 22 tests, so the tests and measurements applied provide more complex results because they can provide a more specific athlete profile. On the other hand, because the KONI test is applied to distinguish 35 sports with 9 tests while the FSC is applied to distinguish 9 sports with 22 tests.

The results of the stepwise discriminant analysis revealed that body height is a relevant talent characteristic for badminton and volleyball athletes. Elite male badminton players are taller than their sub-elite counterparts (Ooi et al., 2009). Phomsoupha & Laffaye (2019) also explains that top-ranked players are taller (+5 cm) than lower-ranked players. The thin stature and height of badminton players are advantageous when maintaining intense and aerobic efforts. Previous studies have also shown that volleyball players are significantly taller than handball players. A taller body with a low body fat percentage is a better advantage for volleyball players at a high level (Masanovic, Gardasevic, & Bjelica (2021).

Leg muscle power is a talent characteristic that is relevant for basketball and volleyball athletes. Leg muscle power in this study was assessed using a jump. Jumping is an important element in volleyball, this is supported by the fact that better volleyball players have higher jump rates. The increase was greater between the 3 jumps for volleyball players with an average increase of 4.72 cm between SJ and CMJ and 16.56 cm between CMJ and CMJas jumps (Peña et al., 2018). In basketball players, the height of the vertical jump plays a role in a different position, in which the center player has a higher vertical jump power than the guard player. This aims to reduce the risk of injury and allows for more powerful rebounds, shooting, and shuffling (Ostojic, Mazic, & Dikic, 2006).

Arm muscle strength is a talent characteristic for tarung derajat and kempo athletes. Tarung derajat and kempo are martial arts, both of which require strength characteristics in a fight. Muscle strength in the upper limbs is very important for a fighter and is one of the keys to success. Because in tarung derajat and kempo there are punches, and punches are short actions and require a dynamic level of performance so that the development of good upper limb muscle strength is required (Chaabène et al., 2015).

Agility is a talent characteristic for badminton and tennis athletes. The findings of Singh et al (2011) show that agility is an important variable for better performance in badminton. The performance of badminton players will decrease with reduced agility (Cinthuja et al., 2015). The characteristic of agility is needed by badminton athletes because the shuttlecock is hit every 5 seconds or even less, meaning that the player has about 2-3 seconds to move and get a good position for the shot, then at the same time, the player has about 1 second. to return to the center of the court in the starting position and prepare for the next shot (Gabriela & Traian., 2019). For tennis players, Leone et al (2006) reported that tennis player agility is very specific so it must be assessed and developed in conditions related to different tennis players. The agility score of the tennis division I athletes was 5.62% higher than the tennis division II athletes, indicating a statistically significant difference between the two divisions. A tennis player needs to perform in different regions of the court by moving in different directions so that he can hit the Divinga match ball. Thus, agility is considered as one of the physical characteristics and determinants of the action of the game that most influences the level of competition in tennis players (Kaya & Karahan, 2019).

Speed is a talent characteristic for rugby and softball athletes. In rugby, a successful team is likely to have lower higher-speed running demands and is likely to have fewer physical collisions than a less successful team, although they are likely to exhibit more acceleration and deceleration and likely have a higher average metabolic power. Successful teams are more likely to gain more territory in attack, are more likely to have more possessions, and are more likely to make fewer mistakes (Kempton et al., 2017). Speed in rugby is related to the position of the player. Backs achieves greater maximum running speed (8.6 ± 0.7 m/s), completes greater number of sprints (18 ± 6), has less time between sprints (3.2 ± 1.1 minutes), achieves greater total sprint duration (44.7 ± 9.1 seconds), and covered a longer sprinting distance (321±74 m) than the forwards (6.8 ± 0.7 m/s, 11 ± 5, 5.2 ± 2.2 minutes, 25.8 ± 9.2 seconds, and 153 respectively ± 38 m) (McLellan et al., 2011). Additionally, there is a difference between competitive standards at the elite level, which is the fastest athlete (10 m: RU (Rugby Union) forwards ~1.87 sec, backs ~1.77 sec; 10 m RL (Rugby League) forwards ~1.9 sec, backs ~1.83 sec). Well-developed speed characteristics are essential for elite performance, differentiating between competitive levels and therefore important determinants of elite status in rugby (Brazier et al., 2020). In softball, players need to develop running speed because they can score and win games (Sintara & Sonchan, 2015). Running speed is important in softball for moving between bases and in fielding.

VO2max is a talent characteristic for swimming and softball athletes. Cardiorespiratory fitness in terms of maximum oxygen uptake (VO2max) is needed by Swimming athletes. This is because the extraordinary cardiorespiratory capacity is a great adaptation to swimming. While the mean VO2max was related to lean body mass on the pulling test, the average VO2max peswimming was significantly higher than that of runners (p less than 0.01). Maximum heart rates achieved while pulling are 95% of maximum running by runners and 96% by peSwimming with no significant difference between them. Their mean oxygen pulses were nearly the same for maximal running but swimmers had significantly higher oxygen pulses than runners for maximal pulling (p less than 0.01). Swimmers can achieve about 79% of their running VO2max by pulling while runners use up 53% of their running VO2max (Corry & Powers, 1982). In softball, aerobic fitness parameters have a correlation with throwing skill tests of softball players. This relates to the need for anaerobic and aerobic energy systems in softball games. A good foundation of aerobic endurance serves as the basis for developing the anaerobic energy that softball athletes need. In addition, aerobic endurance is an important fitness component of softball players because it reduces the fatigue effect of Divinga over long playing periods (Singh et al., 2017). In comparison with sports with hitting concepts such as cricket, the average value shows that all physiological variables such as resting heart rate, vital capacity, and cardiovascular endurance of softball players are better than cricket players (Akhtar & Beg, 2022).

Conclusion

The results of this study concluded that the KONI test can identify relevant talent characteristics for 35 sports based on discriminant functions using a combination of body height, leg muscle power, arm muscle strength, agility, speed, and VO2max test values. For KONI trainers who are involved in talent development programs, the use of the KONI test can be applied to evaluate KONI athletes on a regular basis.

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