APPLIED SCIENCES／原著論文

Anthropometric and physiological characteristics of junior Japanese elite male basketball players

バスケットボールの男子ジュニア日本代表選手の身体的及び体力的特徴

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Abstract

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The Japanese men's national basketball team last participated in the Montreal Olympic Games in 1976. Improving basketball players' performance and training young basketball players are both necessary to ensure Japan's participation in future Olympics. An understanding of the anthropometric and physical fitness characteristics of elite basketball players is needed to develop training programs and guide talent identification. The aim of this study was to understand the anthropometric and physiological characteristics of junior Japanese elite male basketball players. For this, we used anthropometric and physical fitness measurements to compare junior Japanese elite male basketball players with senior Japanese elite basketball players. Thirteen junior Japanese elite male basketball players (age 15.6 ± 0.5 years) and ten senior Japanese elite male basketball players (age 24.7 ± 2.6 years) were measured for body size and weight, aerobic fitness, lower body muscular power, and leg muscle strength. We found that body weight (76.0 ± 8.0 vs. 92.3 ± 14.6 kg) and lean body weight (67.7 ± 5.7 vs. 79.7 ± 12.3 kg) greatly differently between junior and senior players, respectively. Meanwhile, standing height (186.3 ± 8.7 vs. 191.6 ± 11.1 cm), $\dot{V}O_{2peak}$ (58.8 ± 3.9 vs. 55.4 ± 5.7 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$), counter movement jump height, and maximal knee extension and flexion torques at angular velocities of $60°{\cdot}s^{-1}$ and $180°{\cdot}s^{-1}$ were not significantly different between the groups, respectively. Coaches and national federation can compare our data with data from other national and international elite male basketball players to determine individual weaknesses, design training programs and guide talent identification.

Key words: talent identification, Olympic Games, field-based team sports, intermittent exercise, training program.

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I. Introduction

Identifying talented young athletes and training them from an early age is essential for their development into elite adult athletes. The last time the Japanese men's basketball team participated in the Olympic Games was in 1976 (Montreal, Canada). Improving the performance of basketball players and training young players are necessary to ensure that Japan can participate in future Olympic Games.

The Japanese elite junior male basketball team participated for the first time in the International Basketball Federation Under-17 World Championship in Dubai in 2014. However, the Japanese team ranked 14th out of the 16 teams participating. Improving the performance of junior elite male basketball players in Japan is necessary to maximize their chances of winning medals at the 2020 Olympic Games in Tokyo.

Basketball is an intermittent high-intensity sport that employs aerobic and anaerobic energy systems to varying degrees [2, 3, 4, 13, 14, 15]. Professional male basketball players cover ≈6000 m during a 40-min game with movements such as dribbling, jumping, running, and changing direction [19]. As a result, basketball players must draw upon several physical fitness components: muscle power, speed, agility, and aerobic power. To develop a successful junior Japanese basketball team, comparison with their senior counterparts is needed. Understanding the anthropometric and physical fitness characteristics of junior basketball players is needed to develop training programs for competition at the international level. Thus, the aim of the present study was to understand the anthropometric and physiological characteristics of Japanese elite junior male basketball players. To develop a clear understanding of the characteristics of junior players, we compared their data with those of Japanese senior elite basketball players.

II. Methods

1. Experimental approach

This study was designed to compare the anthropometric and physical-fitness measurements of junior and senior Japanese elite male basketball players. Tests were undertaken at the Japan Institute of Sports Sciences (Tokyo, Japan).

2. Participants

Thirteen junior elite male basketball players (age (mean ± standard deviation (SD)): 15.6 ± 0.5 years) and 10 senior elite male basketball players (24.7 ± 2.6 years) from Japan participated in this study. All participants were recruited from junior or senior squads while attending national basketball training camps. Written consent to participate was obtained from all participants after informing them of the purpose of the procedures and possible risks of our study. The study protocol was approved by the Human Subjects Committee of the Japan Institute of Sports Sciences.

3. Anthropometric measurements

Anthropometric measurements were standing height, body weight, percentage body fat, and lean body weight. Standing height was measured using a stadiometer (DC-250; Tanita, Tokyo, Japan). Body weight and percentage body fat were measured using a calibrated digital weighing scale and air-displacement plethysmograph (BOD POD; Cosmed, Rome, Italy), respectively.

Lean body weight was calculated as body weight minus body fat.

4. Aerobic fitness

Aerobic fitness was evaluated using the blood lactate concentration ($[La]_b$) curve test and a maximal graded exercise test. These tests were done using a treadmill to determine the $[La]_b$ curve and maximal oxygen uptake ($\dot{V}O_{2peak}$). Participants undertook the $[La]_b$ curve test followed by a minimum 10-min rest, after which the maximal graded exercise test commenced. Participants warmed up, then running speed was adjusted to 180 $m \cdot min^{-1}$ and increased by 30 $m \cdot min^{-1}$ every 3 min until they exceeded an $[La]_b$ of 4 $mmol \cdot L^{-1}$ in the $[La]_b$ curve test. Participants were allowed to rest for 1 min between stages. At each rest period (between stages) in the $[La]_b$ curve test, blood samples (0.3 μL) were collected from one fingertip to measure $[La]_b$ using the lactate oxidase electrode method (Lactate Pro 2 LT-1730; Arkray, Kyoto, Japan). The running velocity of $[La]_b$ at 4 $mmol \cdot L^{-1}$ (running velocity at the onset of blood lactate concentration (OBLA-v)) was calculated.

The initial running speed of the maximal graded exercise test was adjusted by the OBLA-v of the individual using the $[La]_b$ curve test (240–270 $m \cdot min^{-1}$) and increased by 10 $m \cdot min^{-1}$ every 1 min until exhaustion. The test was terminated if a participant could not maintain the required running speed despite vigorous encouragement. Breath-by-breath values of respiratory gas exchange (minute ventilation ($\dot{V}E$), oxygen uptake ($\dot{V}O_2$)) were measured using an automated gas analysis system (Vmaxs229; SensorMedics, Yorba, CA, USA) and averaged every 30 s. Maximal values were recorded for the maximal graded exercise test. $\dot{V}O_{2peak}$ was defined as the highest $\dot{V}O_2$ attained during the maximal graded exercise test. The gas-analysis system was calibrated before each test using a mixture of known O_2 and CO_2 concentrations. The volume transducer was calibrated before each test using a 3-L syringe. Heart rate (HR) was monitored (RS800; Polar Electro, Kempele, Finland) and averaged every 5 s during the test.

5. Muscle power in the lower body

Muscle power in the lower body was evaluated by a counter movement jump (CMJ) test with arm swing using a switch mat system (Multi Jump Tester: DKH, Tokyo, Japan). The CMJ test was started from a standing position, allowing for countermovement, with the arms free to move. Players undertook a vertical jump by pushing upwards, and kept their legs straight throughout the jump. Players carried out two trials separated by a 1-min rest. The better of the two test results was used for analysis.

6. Strength of leg muscles

Strength in leg muscles was evaluated as the isokinetic concentric strength of extensors and knee flexors in the knee using an isokinetic ergometer (System 4; Biodex Medical Systems, New York, NY, USA). All measurements were made from a seated position with the hip flexed at ≈85°. Stabilization straps were applied across the trunk, waist and distal femur of the right leg. Extensor and flexor muscles of the knee of the right leg were measured concentrically at two velocities: $180° \cdot s^{-1}$ (three repetitions) and $60° \cdot s^{-1}$ (two repetitions). First, participants undertook the $180° \cdot s^{-1}$

repetitions followed by a 30-s rest, and then the 60°·s^{-1} repetitions commenced. Peak torque values measured for flexors andextensors of the right knee over two or three consecutive contractions for each tested muscle group were used in data analyses.

7. Statistical analyses

Statistical analyses were carried out using SPSS v22.0 (IBM, Armonk, NY, USA). Independent *t*-tests were used to assess the significance of between-group differences for all measurements. $P < 0.05$ was considered significant.

III. Results

Measurements of anthropometry, aerobic fitness, muscle power in the lower body, and strength in the right leg are presented in Tables 1–3. Body weight and lean body weight differed significantly between junior and senior players. Standing height, percentage body fat, $\dot{V}O_{2peak}$, OBLA-v, CMJ height, and strength of extension and flexion in the knee at angular velocities of 60°·s^{-1} and 180°·s^{-1} between junior and senior players were not significantly different.

Table 1. Anthropometric characteristics of junior and senior Japanese elite male basketball players.

	Standing height (cm)	Body weight (kg)	Percentage body fat (%)	Lean body weight (kg)
Junior (n = 13)	186.3 ± 8.7	76.0 ± 8.0	10.7 ± 5.7	67.7 ± 5.7
Senior (n = 10)	191.6 ± 11.1	92.3 ± 14.6	13.6 ± 3.3	79.7 ± 12.3
Significance	N.S.	*	N.S.	*

Values are expressed as means ± standard deviations. * Denotes a significant difference ($P < 0.05$) between junior and senior Japanese elite male basketball players.

Table 2. Aerobic fitness characteristics of junior and senior Japanese elite male basketball players.

	$\dot{V}O_{2peak}$ (mL·kg^{-1}·min^{-1})	OBLA-v (m·min^{-1})
Junior (n = 13)	58.8 ± 3.9	267 ± 14
Senior (n = 10)	55.4 ± 5.7	255 ± 15
Significance	N.S.	N.S.

Values are expressed as means ± standard deviations.

Table 3. Muscle power in the lower body and strength in leg muscles characteristics of junior and senior Japanese elite male basketball players.

	CMJ (cm)	Ext 60° ($N{\cdot}m{\cdot}kg^{-1}$)	Flex 60° ($N{\cdot}m{\cdot}kg^{-1}$)	Ext 180° ($N{\cdot}m{\cdot}kg^{-1}$)	Flex 180° ($N{\cdot}m{\cdot}kg^{-1}$)
Junior (n = 13)	45.9 ± 5.0	2.8 ± 0.3	1.7 ± 0.2	2.1 ± 0.2	1.2 ± 0.2
Senior (n = 10)	46.1 ± 3.7	2.6 ± 0.3	1.5 ± 0.2	2.1 ± 0.2	1.3 ± 0.1
Significance	N.S.	N.S.	N.S.	N.S.	N.S.

Values are expressed as means ± standard deviations. CMJ, countermovement jump; Ext 60°, knee extension at an angular velocity of $60°{\cdot}s^{-1}$; Flex 60°, knee flexion at an angular velocity of $60°{\cdot}s^{-1}$; Ext 180°, knee extension at an angular velocity of $180°{\cdot}s^{-1}$; Flex 180°, knee flexion at an angular velocity of $180°{\cdot}s^{-1}$.

IV. Discussion

This is the first study to investigate the anthropometric and physiological characteristics of junior elite male basketball players from Japan. Major findings of the present study were that junior elite male basketball players were lighter and had less lean mass than senior elite male basketball players. Standing height, $\dot{V}O_{2peak}$, CMJ height and extension and flexion strength in the knee were not significantly different between groups.

In theory, a greater standing height should be an advantage for basketball players but standing height was not significantly different between groups (Table 1). This result is consistent with the results of studies that reported that standing height was not significantly different between Spanish professional basketball players and national players aged <18 years [1], or between Greek national players and players aged <16 years [8]. Tall standing height could be important when selecting national basketball squads (even for the junior category).

Body weight and lean body weight of junior players were less than that of senior players (Table 1). Scanlan and workers found that the mean weight of Australian elite male basketball players was heavier by >10 kg than that of Australian sub-elite male basketball players [18]. That finding could be attributable to a change in the physiological demands of basketball. Frequencies of high-intensity activities (e.g., positioning) have been shown to be higher at the international competitive level for male basketball players than at the national competitive level [3]. Also, the rules of basketball have been modified repeatedly to make it more aggressive [3, 6]. Senior basketball players must adapt to the requirements of basketball to be competitive at the highest level. Hence, by being selected for the national team, players require greater mass to maintain their position (e.g., screening or rebounding) during the game.

In our study, $\dot{V}O_{2peak}$ was not significantly different between groups (Table 2). Mean $\dot{V}O_{2max}$ of professional basketball players has been reported to be 51–61 $mL \cdot kg^{-1} \cdot min^{-1}$ [3, 6, 14, 15, 17]. $\dot{V}O_{2peak}$ values of junior and senior players in the present study were similar to those reported for elite male basketball players of other countries. Thus, the aerobic fitness of junior elite male basketball players was similar to that of professional senior basketball players.

CMJ values were also not significantly different between groups (Table 3). However, values from the present study were lower than those observed in elite male basketball players of other countries [7, 16]. Additionally, leg-muscle strength in the present study was lower than that reported for elite professional male basketball players from Bosnia and Herzegovina [5]. Hoffman *et al.* [10] reported that anaerobic leg power (including CMJ) was a determinant of successful basketball performance. Anaerobic power is dependent on the strength of relevant muscle groups [11, 12]. Therefore, it can be expected that leg-muscle strength is an important factor for playing basketball successfully [5, 9]. Improved power and leg-muscle strength in Japanese elite male basketball players—regardless of their playing category—could contribute to improved overall performance.

Our study had two main limitations. First, our measurements were limited because we did not measure sprint speed or muscle strength in the upper body. Second, the relatively small sample size meant that we could not compare measurements according to playing position. Thus, further study is required to clarify the physical fitness characteristics of Japanese elite male basketball players using other parameters and a larger sample size.

V. Practical applications

The present study provides, for the first time, data on the anthropometric and physiological characteristics of Japanese junior elite male basketball players. These players had high aerobic fitness, but had a lower lean body weight and less power and strength in leg muscles than their senior counterparts. Anthropometric data and physical fitness are not the only determinants of success in basketball, but coaches and national federations can compare our data with studies from other national and international elite male basketball players to determine individual weaknesses, design training programs, and guide talent identification. Specifically, Japanese junior elite male basketball players should conduct training to increase muscle strength in the lower body to compete more successfully at the international level

VI. References

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要　旨

バスケットボール男子ジュニア日本代表選手の身体的及び体力的特徴

日本のバスケットボール男子ジュニア選手の身体的及び体力的特徴を明らかにするために, バスケットボール男子ジュニア日本代表選手と男子シニア日本代表選手との体力測定データを比較した．**方法**：バスケットボール男子ジュニア日本代表選手 13 名（Junior）と男子シニア日本代表選手 10 名（Senior）の身長，体重，除脂肪体重，有酸素性能力, 下肢筋パワー, 及び脚筋力を測定した. **結果**:体重及び除脂肪体重は, Junior と Senior との間に有意な差があった．身長，最高酸素摂取量，下肢筋パワー及び脚筋力は，Junior と Senior との間に有意な差はなかった．**結論**：これらのデータは，日本のバスケットボール男子選手の強化において有益な知見となる．

キーワード: タレント発掘，オリンピック競技大会，ゴール型球技，間欠的運動，トレーニングプログラム