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Body Structure and Operation Features of Mongolian High Ranked Male Athletes

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Objectives: The purpose of this study is to determine the level of morphological and functional indicators depending on sports specializations among high-ranked Mongolian male athletes. **Methods:** Our study involved 218 athletes aged 18 - 34 in six sports and measured body composition by anthropometry and bioelectrical impedance. Physical performance was assessed by Harvard test, spirometry and physical fitness testing. **Results:** Sports specializations affect the indicators of physical development and body composition of athletes, which revealed significant differences between them. Martial arts athletes are stronger, more flexible, and more balanced than in team sports. As the ranks increase, body composition and performance get better. According to the Harvard test, 89.2 % (99) of team sports athletes and 98.2 % (55) of martial arts athletes received good and excellent marks. By the spirometry test, team sports groups have higher lung function results. **Conclusion:** Mongolian high-ranked male athletes have different body compositions in different sports types and it can create a profile of athletes within specific sports. Many years of training can improve the athlete's performance. The cardiovascular function of athletes involved in martial arts quickly returns to normal after training. In team sports group, lung function is more adapted during a long period of training.

Keywords: Professional Athlete, Team Sports, Human Activities, Body Composition, Anthropometry, Body Measures

Introduction

The current trend of global sport development is aiming at scientifically improving the training and coaching techniques of high-class athletes who have the potential to compete for Olympic medals. In our country, modern sports are organized based on the rich history and cultural heritage of our country, in accordance with the laws and trends of global development, and with advanced methods adapted to the nature, seasons, and features of Mongolian physical development and mentality. The selection of young people for regular training and the perfect development of skills arise from the needs of society. However, in some sports, there is a lack of scientific research on the theory and methodology of sports science for today's physical

education and sports professionals, coaches, teachers, doctors, athletes and students.

In order to be successful in modern sport games, it is essential to constantly and comprehensively train athletes, and above all, systematically train athletes and coaches [1, 2]. Physical education activities will be most successfully conducted in the long term by considering features of human body structure and age. In addition, the most crucial modern issue in this industry is the study of some changes in the physical structure and function of the next generation of (children, teenagers and youth who are growing under the influence of various ecological, social and economic factors [3, 4]. In this study, we tried to study some features of physical structure, there function, also their age, gender, ecology, and sports characteristics of high-ranking Mongolian athletes, in relation to the influence of various factors.

Athletes' body structure, functional characteristics, nervous system, speed, strength, and endurance were first studied at the end of the last century. Accordingly, it is important to use the above research indicators to choose professional sport types and select athletes. Because in the circumstance of increasing competitiveness and maximizing the strength of athletes, this study is important to detect talents in the sport field and based on that, to select children with the ability to succeed in any sport from the very beginning [5 - 8]. It is also essential to develop and use a high-level athlete model in a comprehensive study to accurately and objectively monitor the coaching process and to modify and correct the coaching plan as needed [9].

There are works that included the anthropometric and morphological characteristics of Mongolian athletes. Such as, Tarvaa N et al. who studied some indicators of physical development of Mongolian martial artists and found that the physical development of athletes differs depending on the type of sport and coaching situation, and the main physical indicators of athletes are better than those who do not participate in sports.

Zagdsuren D et al. compared the average physical fitness of athletes in their study named "Some morphophysiological indicators of Mongolian athletes' performance" with the survey of Mongolian men between the age of 18 - 49 by Nyamdorj Ya et al. and found that they differed by 10.64 cm in height, 12.58 kg in body weight and 9.76 cm in chest circumference [10].

Researcher Altantsetseg Ya et al. showed in "Study of physical development of young athletes related to sport types" that the physical measurements of 18 - 20-year-old university students significantly increased compared to 26 years ago. It proved that wrestler's back strength is greater and heavier in weight, where sport game athletes are taller. Skiers, skaters and long-distance runners have better lung capacity [11].

Researcher Bolormaa Sh et al. showed in "Study of some morphophysiological parameters of freestyle wrestlers aged between 16 – 19 " that compared to the results of 5 years ago, height, sitting height, chest circumference, back strength, chest circumference and lung capacity decreased [12].

Researcher Gerelchimeg Ch et al. showed in "Study of judo wrestlers' body structure features according to their titles and years of training" that the higher rank athletes have, the more their BMI and muscle mass increases, whereby the amount of body water decreases. In addition, muscle mass increases and amount of body water decreases with each year of training [13].

Researcher Bolorchimeg D et al. in "Results of genealogical and dermatoglyphic studies of high-class athletes" found that delta index, 10 finger loop patterns, loop patterns directed to the little finger and number of finger print patterns are more common in high-grade athletes than in non-athletes [14].

Lastly, researcher Bat-Ireedui Kh et al. reported in "Mongolian National Martial Arts Athletes 'Body Structure Survey" that successfully studying body composition, which includes body muscle size, body protein and fat content, intracellular and extracellular water, minerals, body mass index, trunk and limb muscle weight relating to sport type and gender is significant to improve sport success and monitor training and coaching [15].

These studies mainly focused on judo, freestyle wrestling and boxing athletes. Zagdsuren D et al. studied the men's volleyball team of the Mongolian national team, where Altantsetseg Ya et al. studied sport games student-athletes [10, 11]. An advantage of our study is including martial arts and team sport groups which include basketball and football players.

Our study is a comprehensive analysis of the formation of morphological and functional characteristics of Mongolian high-ranked athletes and was carried out on extensive material (218 examined), depending on the sports specialization, using modern complex methods. The novelty of our study is that the external body structure of Mongolian athletes was determined with anthropometric equipment, the internal structure with bioimpendensiometric equipment, the function performance with Harvard test, and physical performance and lung function

by seperately studying in their sport type, degree, and rank.

The obtained basic parameters of athletes will be used in the development of training programs for sports training for young and adult highly qualified athletes in Mongolia, to increase the effectiveness of training control over the physical development and sports preparedness of those involved, for an integrated approach in the selection of individuals for professional sports, for monitoring the physical condition of the population of Mongolia, for writing teaching aids, and will also be included in the content of a number of academic disciplines.

The purpose of this study is to determine the level of morphological and functional indicators depending on sports specializations among high-ranked Mongolian male athletes.

Materials and Methods

Research design and subjects

The prospective and longitudinal study design was applied. Our study involved 218 athletes aged between 18 - 34 in six sports. 100 martial arts' athletes are from the National Team of the Department of Physical Education and Sports. 118 team sports' athletes are from the Mongolian National Basketball Association, the Mongolian Volleyball Association and the Mongolian Football Association. Our study was conducted in 2015 - 2021. On April 29 of 2015, the topic and methodology of the research work was discussed and approved by the council of scientist of Mongolian National University of Medical Sciences (MNUMS). Material collection was organized in 2 summer Olympics in 2016 and 2021. We believed that our research results would be better if the research was conducted when the athletes were preparing for the Olympics when they get the highest level of preparation.

Inclusion criteria

Athletes need to be a member of the national team or premier league, have a sport degree or a rank, be relatively healthy, and agreed to participate in the study.

Exclusion criteria

Athletes who are not members of the national team or premier league, don't have a sports degree or a rank, or are unable to participate in the study (due to any injury).

Questionnaire

The questionnaire included questions aimed at identifying factors that affect each athlete's physical development and preparation. Athletes' age, gender, type of sport, duration of training, rank, place of birth and ecological, living environment, smoking was recorded. We split the living environment into two groups: one is housing with a public heating system, another one is ger district with uses stoves for heating. An oft-cited problem of ger districts in Ulaanbaatar and a number of other larger Mongolian cities is the air pollution (especially in winter) caused by the use of simple iron stoves for cooking and heating.

Anthropometer measurement

Each athlete's standing height was measured using an anthropometer (Model 101 "GPM" manufacturered in Switzerland) and weight was measured by a digital scale. The circumferences of chest, waist, hips, arm, forearm, thigh, lower leg were measured using a measuring tape and outside caliper. Skinfold thicknesses at the subscapulum, over the triceps, over the biceps, abdominal, and suprailiac areas were measured with a Harpenden skinfold caliper.

Bioelectrical impedance analysis (BIA)

Bioelectrical impedance analysis is a measurement of the whole-body impedance on the right side of the body using the bioelectrical impedance analyzer (ABC-01 'Medass', Russia), which uses a conventional tetrapolar method at a frequency of 50 kHz. Body composition variables, such as fat-free mass, fat mass, skeletal muscle mass and active cell mass were determined using appropriate equations provided by the manufacturer [16].

Harvard step test

Harvard Step Test (HST) is a test for measuring the physical fitness (cardiovascular endurance) of a human by using a mathematical formula for determining an Index Number, called the Physical Efficiency Index (PEI). The athlete steps up and down on the box at a rate of 30 steps per minute (every two seconds) for 5 minutes or until his/her exhaustion. Exhaustion is defined as when the athlete cannot maintain the stepping rate for 15 seconds. The athlete immediately sits down on completion of the test, and the total number of heartbeats is counted between 1 to 1.5 minutes after finishing.

Physical fitness testing

We determined the level of physical development of adults by a test method that assesses five physical qualities (speed, strength, flexibility, endurance and balance).

Spirometry test

Athletes' lung function was assessed using a spirometer ("Medikro Spirometer", Finland). The spirometer program produces the following results which are normal, obstructive, restrictive and mixed.

Statistical analysis

Frequencies, percentages, and independent t-tests were used to examine the difference among groups. A p-value of < 0.05 was used as the cut-off point for determining the statistical significance. Statistical analysis was done using the one-way ANOVA test, followed by the theTukey test as a multiple comparison. SPSS 23.0 and Microsoft Excel 2013.

Ethical statement

The study was approved by the Research Ethics Committee of the Mongolian National University of Medical Sciences on April 29, 2015 (No. 14-15/21 (02)). All athletes are provided with written informed consent before participating in the study.

Results

Our study involved 218 male athletes aged 18 - 34 in six sports. In Mongolia, athletes are awarded 1st and 2nd degrees, as well as master and Master of Sport International Class degrees. In our study, 185 (85 %) of the athletes are masters of sports and above and 121 (70 %) were non-smoking (Table 1).

Physical development and body composition measurement

Mongolian athletes involved in various sports have objectively existing morphological and functional features, in addition to the values of skin folds (Table 2).

Athletes of game types, in terms of body length, are ahead of athletes of other sports specializations ($p < 0.001$), in terms of component composition they are characterized by a decrease ($p < 0.001$) in specific metabolism and an increase in fat mass, body fat mass index and extracellular fluid content. Athletes involved in football and boxing, according to all morphological and functional indicators, are inferior ($p < 0.05$) to athletes from other sports groups. Wrestlers outperform ($p < 0.05$) peers involved in other sports in all parameters of physical development and body composition, except for body length.

Table 1. General characteristics of athletes.

Characteristics	Number	Percentage
Sports group		
Basketball	34	15.6%
Volleyball	31	14.2%
Football	53	24.3%
Judo	27	12.4%
Wrestling	42	19.3%
Box	31	14.2%
Rank		
Degree	33	15.1%
Master	133	61.0%
International Master	52	23.9%
Living enviroment		
Housing	140	64.2%
Ger distict	78	35.8%
Smoking		
Yes	47	29.7%
No	121	70.3%

Table 2. Body composition measurement by sports group.

Features	Basketball	Volleyball	Football	Judo	Wrestling	Box	F	*p-value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
Height (cm) [a]	182.2 ± 7.6	177.3 ± 6.8	171.7 ± 6.5	173 ± 7.3	167 ± 6.3	170.9 ± 7.3	6.310	0.048
Weight (kg)	79.3 ± 12.5	72.7 ± 8.6	67.7 ± 12	81.6 ± 17.8	74.7 ± 13.1	65.1 ± 7.5	2.404	0.060
Chest circumference (cm) [b]	94.3 ± 7.2	88.9 ± 6.4	88.9 ± 7.2	98.8 ± 8.8	96.7 ± 5.9	89.8 ± 5.1	3.196	0.008
Waist circumference (cm) [c]	81.5 ± 9.2	77 ± 6	76.5 ± 7.6	83.1 ± 10	81.6 ± 7.2	74.2 ± 4.2	5.484	0.014
Hip circumference (cm) [d]	96.5 ± 7	94 ± 4.9	92.5 ± 6.6	97.9 ± 7.7	95.3 ± 7	91.3 ± 4.6	7.429	0.047
Right wrist circumference (cm) [e]	28.9 ± 4.2	28.7 ± 2.6	27.6 ± 3.1	33.3 ± 3.8	31.8 ± 3.3	27.5 ± 2	3.482	0.009
Left wrist circumference (cm) [f]	28.7 ± 4.1	27.9 ± 2.5	27.3 ± 3.3	33.2 ± 3.9	31.4 ± 3.2	27.1 ± 3.1	4.949	0.028
Tight circumference (cm) [g]	56.2 ± 7.2	55.3 ± 4.3	55 ± 5.3	58.6 ± 6.4	56.6 ± 4.2	52.7 ± 4	7.421	0.089
Average of skinfold (cm) [h]	1.08 ± 0.36	1.05 ± 0.35	0.89 ± 0.3	1.15 ± 0.57	0.98 ± 0.41	1.03 ± 0.31	8.414	0.007
Fat mass (kg)	15.6 ± 6.7	13.3 ± 5.2	13.6 ± 7.2	16.6 ± 14.9	13.7 ± 6.4	9.8 ± 3.2	9.413	0.083
Fat-free mass (kg) [i]	63.5 ± 6.9	59.3 ± 4.9	54.2 ± 6.3	64.5 ± 8.4	61.4 ± 8	55.5 ± 6	4.473	0.016
Active cell mass (kg) [j]	38.5 ± 4.4	36.0 ± 3.2	32.6 ± 5	41.4 ± 6.1	38 ± 5.3	34 ± 4.2	5.483	0.035
Skeletal muscle mass (kg) [k]	34.5 ± 3.5	32.4 ± 2.6	29.6 ± 3.3	35.1 ± 5.7	33.2 ± 4.3	30.5 ± 3.5	6.420	0.000
Body fluids (L) [l]	46.5 ± 5	43.4 ± 3.6	39.6 ± 4.6	47.5 ± 6.5	44.9 ± 5.9	40.6 ± 4.4	8.402	0.002
Extracellular fluid (L) [m]	18.7 ± 2.6	17.1 ± 1.7	16.8 ± 2.5	18.9 ± 2.7	18 ± 3.3	16.6 ± 2.1	6.742	0.031
Basal metabolism (kcal) [n]	1833 ± 140	1 755 ± 102	1658 ± 123	1923 ± 193	1814 ± 166	1691 ± 133	3.401	0.006
Surface metabolism (kcal) [o]	910.8 ± 39.1	925.2 ± 44.6	935.9 ± 75.9	981.7 ± 48	1003.8 ± 44	960.1 ± 40	6.201	0.001

*One-way ANOVA test. Tukey test: [a]Basketball vs. Wrestling, p-value 0.014; [b]Volleyball vs. Judo, p-value 0.039; [c]Basketball vs. Foodball, p-value 0.000; [d]Judo vs. Wrestling, p-value 0.021; [e]Basketball vs. Football, p-value 0.001; [f]Football vs. Judo, p-value 0.006; [g]Basketball vs. Volleyball, p-value 0.005; [h]Judo vs. Wrestling, p-value 0.034; [i]Football vs. Volleyball, p-value 0.008; [k]Judo vs. Wrestling, p-value 0.006; [l]Basketball vs. Volleyball, p-value 0.000; [m]Football vs. Judo, p-value 0.020; [n]Judo vs. Wrestling, p-value 0.009; [o]Judo vs. Box, p-value 0.001.

As the rank increases, the body composition of the athletes becomes better. When comparing the training years with their rank, athletes with a master's degree or above have an average of 8 ± 4 years of training. It shows that after many years of training, the body composition of athletes changes for the better (Table 3).

Harvard step test result

Athletes' performance indicators, or adaptation of post-workout cardiovascular function, were tested by the Harvard test. Out of 218 athletes surveyed by the Harvard test , a total of 167 (76.6 %) athletes completed, while 51 (23.4 %) failed the test due to certain reasons such as stopping the test, or health deterioration. According to the test results, 66.5 % (111) of 167 athletes, were rated as excellent, 25.7 % (43) were rated as good, and 7.8 % (13) were rated as average.

Within sport groups athletes in the martial arts group (judo, wrestling, box) have higher average test scores ($p = 0.004$, $p < 0.05$) than those in the sport games group (basketball, volleyball, football). The cardiovascular function of athletes involved in martial arts quickly returns to normal after training (Figure 1).

Physical performance

When it comes to determining the level of physical development and fitness of athletes by the test method to assess the 5 physical qualities, in the sports group, the best result ($p < 0.001$) was shown as judo male athletes but no significant differences were found in speed. Mongolia has won 11 out of 30 medals in the Olympics in judo, which shows that Mongolian athletes are better at judo than other sports. (Table 4) [17].

Physical performance is the same as body composition. As the rank increases performance becomes better. It means that after many years of training, the body composition of athletes is changing, and performance is getting better (Table 5).

Table 3. Body composition measurement by ranks.

Features	Degree	Master	International Master	F	*p-value
	Mean ± SD	Mean ± SD	Mean ± SD		
Height (cm) [a]	172.5 ± 8.2	174.5 ± 8.3	170.7 ± 8.4	7.410	0.041
Weight (kg) [b]	69.3 ± 10.4	71.9 ± 12	77.7 ± 17	3.201	0.032
Chest circumference (cm) [c]	90.3 ± 5.7	91.1 ± 7.2	97.8 ± 8.2	8.196	0.006
Waist circumference (cm) [d]	76.6 ± 6.2	78.1 ± 7.7	82 ± 9.4	4.401	0.008
Hip circumference (cm)	93.6 ± 5.4	93.9 ± 6.3	96 ± 8.3	5.215	0.072
Right wrist circumference (cm) [e]	28.1 ± 2.9	28.8 ± 3.6	32 ± 3.9	6.264	0.003
Left wrist circumference (cm) [f]	28.1 ± 3.3	28.4 ± 3.7	31.6 ± 4.2	7.314	0.001
Tight circumference (cm) [g]	56.2 ± 7.2	55 ± 5.3	58.6 ± 6.4	5.329	0.046
Average of skinfold (cm)	1.11 ± 0.27	0.98 ± 0.37	1.02 ± 0.5	5.421	0.091
Fat mass (kg)	12.9 ± 5.2	13.4 ± 6.4	15 ± 11.9	6.427	0.068
Fat-free mass (kg) [k]	57.1 ± 3.4	58.4 ± 7.2	62.6 ± 8.9	7.310	0.001
Active cell mass (kg) [l]	34.7 ± 5	35.5 ± 4.9	39.6 ± 6.3	6.241	0.003
Skeletal muscle mass (kg) [m]	31 ± 4.1	32 ± 3.8	33.9 ± 5.2	6.194	0.000
Body fluids (L) [n]	41.8 ± 5.3	42.7 ± 5.2	46 ± 6.7	5.141	0.000
Extracellular fluid (L) [o]	17.1 ± 2.7	17.4 ± 2.4	18.5 ± 3.2	6.619	0.046
Basal metabolism (kcal) [p]	1712 ± 157	1741 ± 140	1867 ± 200	7.141	0.008
Surface metabolism (kcal) [q]	943 ± 57.7	941 ± 62.9	989 ± 46.9	6.414	0.003

*One-way ANOVA test. Tukey test: [a]Degree vs. Master, p-value 0.000; [b]Master vs. International master, p-value 0.002; [c]Degree vs. Master, p-value 0.000; [d]Master vs. International master, p-value 0.002; [e]Degree vs. Master, p-value 0.000; [f]Master vs. International master, p-value 0.002; [g]Degree vs. Master, p-value 0.000; [k]Master vs. International master, p-value 0.002; [l]Degree vs. Master, p-value 0.000; [m]Master vs. International master, p-value 0.002; [n]Degree vs. International master, p-value 0.002; [o]Degree vs. Master, p-value 0.002; [p]Degree vs. Master, p-value 0.002; [q]Master vs. International master, p-value 0.002.

Table 4. Physical performance by sports group.

Features	Basketball	Volleyball	Football	Judo	Wrestling	Box	F	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		*p-value
Right handgrip strength (kg) [a]	43 ± 7	39 ± 5	35 ± 9	48 ± 10	45 ± 8	37 ± 9	8.141	0.002
Left handgrip strength (kg) [b]	41 ± 7	38 ± 5	34 ± 9	45 ± 9	42 ± 8	36 ± 9	4.428	0.014
Speed (times/10sec)	47 ± 6	47 ± 8	45 ± 8	44 ± 7	49 ± 7	45 ± 7	5.617	0.089
Push ups (times/30sec) [c]	30 ± 6	30 ± 5	31 ± 8	43 ± 6	39 ± 6	35 ± 7	7.141	0.031
Crunch (times/30sec) [d]	26 ± 4	23 ± 5	24 ± 5	28 ± 4	28 ± 5	29 ± 7	4.411	0.007
Flexibility (cm) [e]	13 ± 6	13 ± 6	12 ± 7	19 ± 6	17 ± 6	14 ± 7	5.431	0.002
Balance (cm) [f]	38 ± 38	28 ± 28	37 ± 35	9 ± 13	17 ± 19	10 ± 12	6.174	0.009
Endurance (sec) [g]	18.06 ± 6.2	21.77 ± 8	18.81 ± 8	24.67 ± 8.5	16.6 ± 5	14.84 ± 4.3	3.418	0.004
Broad jump (cm) [h]	249 ± 22	231 ± 25	230 ± 16	237 ± 17	255 ± 27	243 ± 30	7.411	0.015
Agility shuttle run (sec) [i]	7.12 ± 0.4	7.45 ± 0.6	7.46 ± 0.5	7.21 ± 0.5	7.16 ± 0.51	7.65 ± 0.57	4.615	0.005

*One-way ANOVA test. Tukey test: [a]Basketball vs. Box, p-value 0.042; [b]Football vs. Judo, p-value 0.021; [c]Basketball vs. Foodball, p-value 0.004; [d]Judo vs. Wrestling, p-value 0.062; [e]Volleyball vs. Football, p-value 0.031; [f]Basketball vs. Judo, p-value 0.000; [g]Volleyball vs. Judo, p-value 0.003; [h]Football vs. Wrestling, p-value 0.014; [i]Football vs. Box, p-value 0.001.

Table 5. Physical performance by ranks.

Features	Degree	Master	International Master	F	
	Mean ± SD	Mean ± SD	Mean ± SD		*p-value
Right handgrip strength (kg)[a]	37 ± 9	39 ± 8	47 ± 9	8.141	0.002
Left handgrip strength (kg)[b]	35 ± 10	38 ± 8	45 ± 8	4.428	0.014
Speed (times/10sec)[c]	44 ± 7	45 ± 7	50 ± 5	5.617	0.046
Push ups (times/30sec)	30 ± 7	33 ± 7	42 ± 7	7.141	0.056
Crunch (times/30sec)[d]	22 ± 4	25 ± 5	30 ± 5	4.411	0.015
Flexibility (cm)[e]	12 ± 8	14 ± 6	17 ± 6	5.431	0.008
Balance (cm)[f]	23 ± 22	30 ± 33	13 ± 20	6.174	0.003
Endurance (sec)	18.8 ± 8.1	18.6 ± 6.9	19.3 ± 8.3	3.418	0.094
Broad jump (cm)[g]	238 ± 27	237 ± 24	253 ± 23	7.411	0.021
Agility shuttle run (sec)	7.53 ± 0.6	7.33 ± 0.5	7.26 ± 0.52	4.615	0.089

*One-way ANOVA test. Tukey test: [a]Master vs. International master, p-value 0.001; [b]Degree vs. Master, p-value 0.000; [c]Degree vs. Master, p-value 0.024; [d]Degree vs. International master, p-value 0.005; [e]Degree vs. Master, p-value 0.009; [f]Master vs. International master, p-value 0.008; [g]Master vs. International master, p-value 0.004.

Table 6. Spirometry test by sports group.

Features	Basketball	Volleyball	Football	Judo	Wrestling	Box	F	*p-value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
FVC (L) [a]	4.67 ± 0.6	4.27 ± 0.42	4.26 ± 0.53	4.38 ± 0.6	4.08 ± 0.55	4 ± 0.66	6.419	0.001
FEV1 (L) [b, c]	3.47 ± 0.64	3.51 ± 0.38	3.36 ± 0.42	3.31 ± 0.44	3.09 ± 0.53	3.11 ± 0.51	5.142	0.047
FEV6 (L)	4.58 ± 0.58	4.22 ± 0.42	4.21 ± 0.53	4.3 ± 0.61	4.04 ± 0.55	3.97 ± 0.65	8.414	0.051
FEV1/FVC (%)	75.47 ± 10.59	81.76 ± 8.23	79.13 ± 8.09	76.06 ± 8.96	77.97 ± 8.33	78.74 ± 11.8	7.341	0.062
PEF (L/sec)	7.42 ± 2.39	7.17 ± 0.75	6.97 ± 1.52	7.29 ± 1.38	6.12 ± 1.18	6.39 ± 1.78	4.145	0.074

*One-way ANOVA test. Tukey test: [a]Basketball vs. Wrestling, p-value 0.000; [b]Volleyball vs. Football, p-value 0.000; [c]Basketball vs. Box, p-value 0.008.

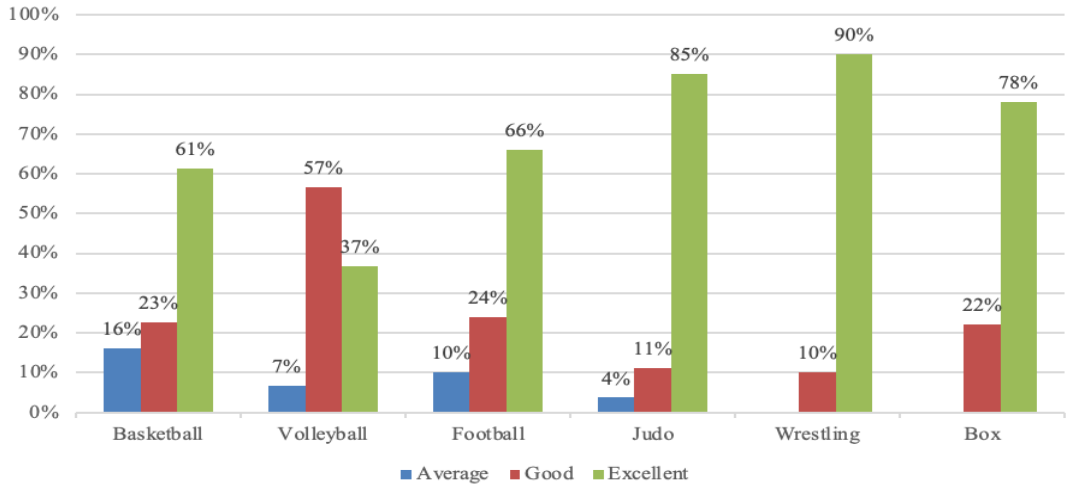

Figure 1. Harvard step test result by sports group.

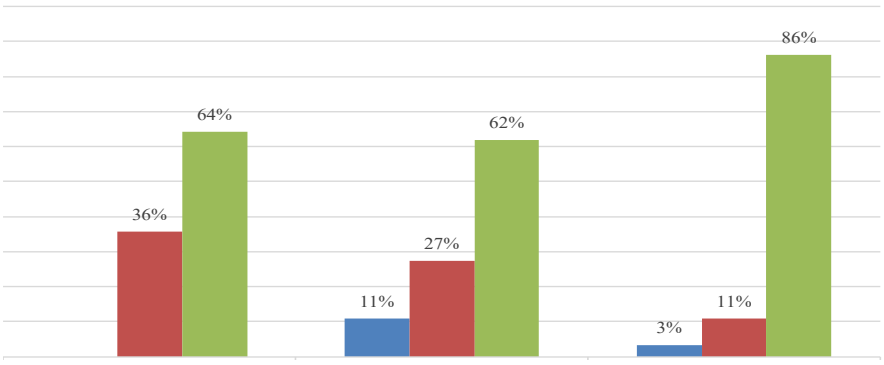

Figure 2. Harvard step test result by ranks.

Spirometry test

Athletes' lung function was tested by spirometry. Within sport groups athletes in the sport games group such as basketball have higher lung FVC (Forced vital capacity) and FEV (forced expiratory volume in 1 sec) than martial arts group (Table 6). It means sport games group one game duration is longer than martial arts so lung function is adapted. No statistically significant difference was found in smokers and non-smokers and living environment.

Discussion

As comparing training years with sport degree, athletes who have a sport degree have spent an average of 6 ± 3 years for training. In detail, athletes spend 8 ± 4 years for a master of sports, and 11 ± 3 years for an international master's degree. From the above, the fact that those athletes participating in the study have ranks and titles shows that they have been trained for many years in physical fitness. Our researchers studied some indicators of physical development of athletes and found that it differs depending on the type of sport and the state of training, and the main physical indicators of athletes are higher than non-athletes.

We compared our 18, 19, 20 years old participats/athletes to the study "Physical development of young athletes in relation to sports" [10]. The study included student and athletes in a variety of sports, such as sports games, wrestling and skiing, and long-distance running. Compared to our study 21 years later, the anthropometric parameters are greater in terms of standard deviations or wider in scope, which indicates that the physical structure of athletes in different sports varies depending on the characteristics of the sport ($p < 0.001$). 18 and 19 years old male athletes tend to increase in height (166.9 ± 0.9 cm) to (173.8 ± 6.5 cm), weight (61.9 ± 1.6 kg) to (67.6 ± 65 kg), and chest circumference (86.6 ± 2.1 cm) to (87.1 ± 5.9 cm) compared to 21 years ago, but 20-year-olds remain the same. However, the thickness of adipose tissue is increased in male athletes of all ages, and the quality of strength and flexibility is decreased, which are indicators of the level of physical fitness [11].

Mixed martial art fighters are compared to a study and our research result is not far from "Some performance and morpho-physiological indicators of Mongolian athletes" [10, 18, 19].

Compared to the study of freestyle wrestlers, the rate of height (174.8 ± 4.2 cm) to (169.8 ± 7.3 cm) is decreased where their rate of weight (65.5 ± 6.3 kg) to (73.6 ± 4.6 kg) is increased. No significant differences were observed in chest circumference [10, 18].

Judo wrestlers are taller, heavier, and have a increased chest circumference (94 ± 3.1cm) to (98.8 ± 8.8 cm) than athletes from 21 years ago compared to the study. Compared male volleyball players of the Mongolian national team have increased in height and weight [10].

Measurements of anthropometric variables can create a profile of athletes within specific sports, because different sports have different anthropometric characteristics, and could help coaches to select players for the professional level according to the playing position [20]. That result of the study is consistent with our study.

Prevalence of smoking among university athletes was relatively high, although nicotine addiction was very low and lung functions were still good. In our study there no difference between smokers and non-smokers and living environment such

as air pollution affecting the lung and athlete's lung functions were still good [21].

Compared to the study of martial art athletes, our martial arts athlete spirometer result is lower than Turkish martial arts athletes. But within sports groups there was no statistically significant difference found in their study which compared respiratory functions similar to the results of our study [22].

This study had several limitations. In Mongolia, judo, freestyle wrestling, and boxing are the most successful sports. It's the same for years of training, but martial arts is more successful than a team sport. Because it depends on the efforts of each person, team athletes require the efforts of all members of the team. Due to this, in our research sample, the sample of athletes with an international master's degree tended to be made up of martial artists. But now team sports are developing, for example, our athletes are participating in the 3x3 basketball Olympics. We hope that this research will be expanded in the future and that we will study the athletes in each cycle of the Olympic Games and contribute to the development of Mongolian athletes.

Conclusion

Mongolian high-ranked male athletes have different body compositions in different sports types and can create a profile of athletes within specific sports. Many years of training can change the athlete's performance for the better. The cardiovascular function of athletes involved in martial arts quickly returns to normal after training. In team sport groups, lung function is more adapted to a long period of training.

Conflict of Interest

The authors state no conflict of interest.

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