JTS

The Journal of Transdisciplinary Studies, 4(2): 145-157, 2020
https://doi.org/10.22685/JTS.2020.4.2.145

# A Case Study on Physical Characteristics of High School Male Elite Athletes according to Sport Type: Focusing on the Target Elite Athletes of Seoul Sports Science Research Institute*

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ARTICLE INFO

*Article history:*
Received 23 Nov 2020
Revised 16 Dec 2020
Accepted 18 Dec 2020

*Keywords:*
Physical Characteristics,
High School Male,
Elite Athletes,
Sport Type,
Sports Science Research Institute

ABSTRACT

Since 2015, Korea has been operating regional sports science centers in 10 cities across the country, and is pursuing a plan to systematically link athletes' physical fitness through physical fitness measurements according to the athlete's life cycle. For 243 elite athletes whose physical strength was measured by the Seoul Sports Science Center, the development direction of each sport type of the elite athletes in Seoul is analyzed through classification and grade. As a result of the study, in terms of basic physical strength, the difference in physical strength by sport type was significant in all items of muscle strength, muscular endurance, muscle power, cardiopulmonary endurance, agility, balance, and coordination except flexibility. As a result of analyzing the difference in the level of the physical strength factor according to the application of the fitness grade criteria for each sport type, the A type showed significantly higher differences in grip strength and back strength than the B and D types. It was significantly higher in sit-up than type A. Type B showed significantly higher physical endurance, muscle power, cardiopulmonary endurance, agility, coordination, and equilibrium compared to the A and D types, and D type showed higher physical strength level than the A type in cardiopulmonary endurance, agility, and balance. Based on the results of this study, it is considered necessary to compare the performance and physical strength of male high school students in Seoul and the characteristics of athletes by sport type to review the training method and improvement of the performance.

* This work was supported by the Ministry of Culture, Sports and Tourism of the Republic of Korea and Korea Institute of Sport Science in Korea Sports Promotion Foundation.

## 1. Introduction

Our sport establishes a solid foothold in an international sport field as a sport power such as a mega sport event of the World cup and the Busan Asian Game in 2002, the Incheon Asian Game in 2014, the PyeongChang Winter Olympic Game in 2018, etc...held by the Seoul Olympic. We won 13 gold medals - the most expedition from the most countries ever to be participated at the London Olympic in 2012 and show countenance to achieve a fine record within the top 10 at Olympics.

As the value criterion for victory in sports has emerged greatly, physical fitness becomes the most important criterion for discriminating athletes, and is acting as a major factor in determining athletic performance (Cureton, 1956). Therefore, prior to the training plan, elite athletes should first find out the physical characteristics of athletes and the physical strength factors that take into account the characteristics of each sport (Hoff, 2005).

For example, in athletics, physique and stamina are very important skills for athletic performance. Short-distance sports produce explosive power for a short time, so short-term strength, endurance, quickness, speed, and agility are required (Bark & Sung, 2004). On the other hand, in Taekwondo, the balance of mid-term muscle strength, muscle endurance, and muscle power is very important (Kim & Jeon, 2006) and in sports that require ball control, such as soccer, handball, and basketball, it is said that the interaction of the lower limb muscles including the knee and ankle joints, which maintains balance and rotation, and maintains body center and maintains quickness and agility, plays a very important role in performance (Park et al., 2020). In this way, winning or losing is determined by the athletes' ability to perform the exercise and the physical characteristics and physical strength of each athlete are important factors (Shin & Shoi, 2011). Although there are some differences depending on the type and characteristics of the sport, considering that most of the international male and female adult elite athletes are in the mid-20s or older, it is necessary to systematically monitor the development of high school athletes in the long-term view of athlete training (Martine et al., 2001).

The Korea Institute of Sport Science aims to expand the scientific support for the national team to local athletes, expand the base of elite sports, and establish a pool of national candidates, and to systematically and scientifically measure and evaluate excellent athletes for early discovery since fiscal year. The Regional Sports Science Center has been running (Korea Institute of Sport Science, 2018a). Here, the basic and professional physical strength measurement and evaluation projects are mainly being carried out, and the elite athlete management system from elementary school students to adults is being introduced at local sports science centers in 10 provinces.

The purpose of this study is to reinforce the unique characteristics of sports by analyzing the physical characteristics of high school student athletes of the Seoul Sports Science Center by event type, and to seek a balanced development of sports in the region.

In previous studies so far, studies of physical strength characteristics for specific sports have been conducted, but studies comparing the characteristics of regional athletes and multi-sports physical strength to find excellent athletes are insufficient. In addition, it is possible to analyze the sport characteristics and physical strength development factors of elite male high school student athletes in Seoul by applying and analyzing the classification by sport according to the physiological characteristics developed by the Korea Institute of Sport Science in 2018. The purpose of this study is that this

study's data contributes as basic data in constructing an efficient training program and analysis of the characteristics of the sport to discover excellent athletes in the future.

## 2. Materials and Methods

### 2.1 Study Design and Participants

The subjects of this study used data on the physique and basic physical strength of elite athletes who measured physical fitness using the Seoul Sports Science Center. From September 2015 to October 2016, elementary, middle and high school students and general athletes using the Seoul Sports Science Center collected data from 52 sports, a total of 1096 people. In this study among them, 261 male athletes attending high school with remarkable growth based on physical strength were sampled, and 22 errors in measurement and missing details were deleted, and finally 13 sports and 243 data were collected and utilized.

**Table 1.** Criteria for Classification of Similar Sports Physiologically in Sports

| Classification | Classification Standard & Event |
|---|---|
| A-Type | Determining competency Professional stamina factors: Short-term Muscular Power, Short-term Endurance |
| | Short-term muscle power and anaerobic endurance training<br>Anaerobic 40-100%, Aerobic 0-60% events<br>Ultra-short (less than 10 seconds), short-time exercise (10-180 seconds) events |
| | kendo, golf, diving, wrestling, bodybuilding, bowling, cycle short distance, short track 1000m, short track 1,500m, short track 500m, snowboard, indoor rock climbing, Korean wrestling, alpine skiing, weight lifting, judo, athletics100m, athletics200m, athletics400m, athletics800m, athletics-leap, athletics-throw, gymnastics, fencing |
| B-Type | Determining competency Professional stamina factors: Middle-term Muscular Endurance |
| | Mid-term muscle endurance training event<br>Anaerobic 10-400%, Aerobic 60-90% events<br>Short time (3 to 20 minutes), mid-time exercise (20 to 60 minutes) events |
| | boxing, cycle long distance, short track3000m, water polo, all events of swimming, speed skating, synchronize, aerobics, Chinese martial arts, athletics1,000m, athletics1,0500m, athletics10,000m, athletics3,000m, athletics5,000m, inline skate, rowing, canoe, kayak, kickboxing, taekwondo, fin swimming |
| C-Type | Determining competency Professional stamina factors: a long term cardiopulmonary endurance |
| | Long-term muscular endurance and cardiopulmonary endurance training events<br>Anaerobic 0-10%, Aerobic 90-100% events<br>Long time (1-4 hours) exercise events |
| | modern pentathlon, nordic skiing, marathon, biathlon, cycle MTB, Road cycling, cycle long distance, ice hockey, yacht, cross country skiing, triathlon |
| D-Type | Determining competency Professional stamina factors: agility, coordination, flexibility, equilibrant |
| | Agility, Coordination, flexibility, Equilibrium Training events<br>ATP-PC 60-90%, corresponding action 0-20% events |
| | archery, basketball, billiards, rugby, volleyball, badminton, Shooting, cycleBMX, Sepaktaraw, softball, squash, baseball, lawn tennis, soccer, curling, cricket, table tennis, tennis, figure skate, field hockey, handball |

For the classification of the event type, the classification of a similar event group based on sports physiology of Korea Institute of Sport Science was used. This classification method classified the energy system use into four categories according to the characteristics of energy system use, energy supply type, and physical activity as follows Table 1. It was classified into type A-short

famine power, short-term endurance-centered sports group, B-type medium-term endurance-centered sports group, C-type long-term muscle endurance-centered sports group, and D-type agility and coordination-oriented sports group (Korea Institute of Sport Science, 2018b).

Table 2 shows the sampling of the test subjects used for classification of the item type in this study. A-type such as athletics and wrestling were 69, B-type such as Taekwondo and boxing were 55, and D-type such as soccer and handball was 117, and C-type had no applied players due to missing data.

**Table 2.** Experiment Subject

| Classification | N | Event | N (%) |
|---|---|---|---|
| A-Type (Short-term Muscle Power, Muscular Endurance) | 69 | fencing | 2(0.83) |
| | | athletics-leap | 4(1.66) |
| | | athletics-throw | 5(2.07) |
| | | athletics-short distance | 8(3.33) |
| | | wrestling | 9(3.74) |
| | | alpine | 2(0.83) |
| | | kendo | 7(2.90) |
| | | Korean Wrestling | 32(13.28) |
| B-Type (Mid-term Muscle Endurance Type) | 55 | boxing | 5(2.07) |
| | | taekwondo | 50(20.75) |
| D-Type (Agility, Coordination, flexibility, Equilibrium) | 117 | handball | 13(5.39) |
| | | soccer | 92(38.17 |
| | | tennis | 12(4.98) |
| Total | 241 | 15 | 241(100) |

### *2.2 Physical Fitness Rating Rable by Sport Type*

The grade was classified based on the criteria table for each item type of male high school students applying the Cajori 5-step relative evaluation criteria developed in 2018 by the Korea Institute of Sport Science (Korea Institute of Sport Science, 2018a). The criteria for classifying basic physical strength by item type are shown in Table 3.

**Table 3.** Classification Criteria for Physical Fitness Level by Sport Type

| Classification | Item | | Event type | Level 5 Classification | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Level 1 | level 2 | Level 3 | Level 4 | Level 5 |
| Basic Physical Strength | Muscle Strength | Grip (kg) | A | 53.7or more | 46.4 or more~ 53.7under | 39.2or more~ 46.4under | 32or more~ 39.2under | 32under |
| | | | B | 49.9or more | 43.2or more~ 49.9under | 36.5or more~ 43.2under | 29.8or more~ 36.5under | 29.8under |
| | | | C | 48.7or more | 43.2or more~ 48.7under | 37.7or more~ 43.2under | 32.2or more~ 37.7under | 32.2under |
| | | | D | 51.6or more | 45.1or more~ 51.6under | 38.6or more~ 45.1under | 32.1or more~ 38.6under | 32.1under |

| Classification | Item | | Event type | Level 5 Classification | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Level 1 | level 2 | Level 3 | Level 4 | Level 5 |
| | | Back Strength (kg) | A | 157.3or more | 134.9or more~ 157.3under | 112.4or more~ 134.9under | 90or more~ 112.4under | 90under |
| | | | B | 148.7or more | 122.1or more~ 148.7under | 100.4or more~ 122.1under | 78.8or more~ 100.4under | 78.8under |
| | | | C | 144.6or more | 125.5or more~ 144.6under | 106.5or more~ 125.5under | 87.4or more~ 106.5under | 87.4under |
| | | | D | 144.9or more | 125.3or more~ 144.9under | 105.7or more~ 125.3under | 86or more~ 105.7under | 86under |
| | Muscle Endurance | Sit-Up (time/ 60second) | A | 66or more | 56or more~ 66under | 46or more~ 56under | 36or more~ 46under | 36under |
| | | | B | 66or more | 57or more~ 66under | 49or more~ 57under | 40or more~ 49under | 40under |
| | | | C | 65or more | 57or more~ 65under | 49or more~ 57under | 40or more~ 49under | 40under |
| | | | D | 62or more | 53or more~ 62under | 45or more~ 53under | 36or more~ 45under | 36under |
| | Muscle power | Sargent Jump (cm) | A | 64.5or more | 54.7or more~ 64.5under | 45or more~ 54.7under | 35.3or more~ 45under | 35.3under |
| | | | B | 58.8or more | 50.5or more~ 58.8under | 42.3or more~ 50.5under | 34or more~ 42.3under | 34under |
| | | | C | 60.6or more | 52.6or more~ 60.6under | 44.6or more~ 52.6under | 36.6or more~ 44.6under | 36.6under |
| | | | D | 60.9or more | 53.1or more~ 60.9under | 45.3or more~ 53.1under | 37.5or more~ 45.3under | 37.5under |
| | | Standing Board Jump (cm) | A | 269.2or more | 245.7or more~ 269.2under | 222.2or more~ 245.7under | 198.8or more~ 222.2under | 198.8under |
| | | | B | 254.6or more | 236or more~ 254.6under | 217.4or more~ 236under | 198.8or more~ 217.4under | 198.8under |
| | | | C | 253.5or more | 236.3or more~ 253.5under | 219or more~ 236.3under | 201.7or more~ 219under | 201.7under |
| | | | D | 253.6or more | 234.5or more~ 253.6under | 215.4or more~ 234.5under | 196.3or more~ 215.4under | 196.3under |
| | Cardiopul monary Endurance | Lung Capacity FVC (cc) | A | 5552.3or more | 4879.5or more~ 5552.3under | 4206.7or more~ 4879.5under | 3534or more~ 4206.7under | 3534under |
| | | | B | 5863.5or more | 5110.1or more~ 5863.5under | 4356.7or more~ 5110.1under | 3603.3or more~ 4356.7under | 3603.3under |
| | | | C | 5661.3or more | 5040.6or more~ 5661.3under | 4419.9or more~ 5040.6under | 3799.2or more~ 4419.9under | 3799.2under |
| | | | D | 5621.2or more | 4986.or more~ 5621.2under | 4351.7or more~ 4986.5under | 3717or more~ 4351.7under | 3717junder |
| | Agility | Side Step (time/ 20times) | A | 52or more | 47or more~ 52under | 42or more~ 47under | 37or more~ 42under | 37under |
| | | | B | 51or more | 47or more~ 51under | 42or more~ 47미under | 37or more~ 42under | 37under |
| | | | C | 51or more | 46or more~ 51under | 42or more~ 46under | 37or more~ 42under | 37under |
| | | | D | 53or more | 48or more~ 53under | 43or more~ 48under | 38or more~ 43under | 3under |

| Classification | Item | | Event type | Level 5 Classification | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Level 1 | level 2 | Level 3 | Level 4 | Level 5 |
| | Equilibrium | One-legged Standing with Eyes Closed (second) | A | 91or more | 54.8or more~ 91under | 18.7or more~ 54.8under | 0.1or more~ 18.7under | 0.1under |
| | | | B | 81.9or more | 48.9or more~ 81.9under | 15.8or more~ 48.9under | 0.1or more~ 15.8under | 0.1under |
| | | | C | 88or more | 51.3or more~ 88under | 14.6or more~ 51.3under | 0.1or more~ 14.6under | 0.1under |
| | | | D | 106.7or more | 64or more~ 106.7under | 21.3or more~ 64under | 0.1or more~ vunder | 0.1under |
| | | Eye-hand Total Coordination Time (second) | A | 36.6under | 36.6or more~ 43.9under | 43.9or more~ 51.2under | 51.2or more~ 58.5under | 58.5under |
| | | | B | 34.2under | 34.2or more~ 44.1under | 44.1or more~ 54.1under | 54.1or more~ 64under | 64under |
| | | | C | 29.6under | 29.6or more~ 43under | 43or more~ 56.4under | 56.4or more~ 69.8under | 69.8under |
| | | | D | 37.1under | 37.1or more~ 44.3under | 44.3or more~ 51.5under | 51.5or more~ 58.7under | 58.7under |
| | Flexibility | Trunk Flexion (cm) | A | 26.7under | 18.4or more~ 26.7under | 10or more~ 18.4under | 1.6or more~ 10under | 1.6under |
| | | | B | 28.3under | 20.2or more~ 28.3under | 12.1or more~ 20.2under | 4or more~ 12.1under | 4under |
| | | | C | 25.8under | 18.7or more~ 25.8under | 11.6or more~ 18.7under | 4.4or more~ 11.6under | 4.4under |
| | | | D | 24.9under | 16.8or more~ 24.9under | 8.8or more~ 16.8under | 0.7or more~ 8.8under | 0.7under |

### *2.3 Statistical Analysis*

The data of this study were calculated using the SPSS 23.0 statistical program to calculate the mean and standard deviation for each measurement item, and an one-way ANOVA was performed to analyze the significance difference between the types of events, and the Scheffe test was used as a post-test. Statistical significance was set at $P<0.05$.

## 3. Results

### *3.1 Analysis of Differences between Physique and Physical Strength Characteristics by Event Type*

In terms of physique factors, it was found that there were differences by sport type in weight, BMI, and thigh (top) excluding height Table 4.

In terms of weight and BMI, short-term muscle power and muscle endurance Type-A was the highest, and medium-term endurance Type-B had the largest circumference.

In terms of basic physical strength, Table 5 showed significant differences in physical strength for each sport type in all items of muscle strength, muscular endurance, muscle power, cardiopulmonary endurance, agility, balance, and coordination excluding flexibility.

Short-term strength Type-A showed the highest above average in grip strength and back muscle strength, and mid-term muscle endurance Type-B was higher than average in the sit-up of muscle endurance and sergeant jump of muscle power.

Agility, coordination, flexibility, and equilibrium-type D-Type sports were the highest above average in the side-staff of agility and the one-legged standing with closed eyes of balance, and there was a distinct difference in the development of physical factors such as the characteristics of the sports events.

### *3.2 Analysis of the Difference in the Level of the Fitness Factor according to the Application of the Fitness Level Criteria by Sport Type*

This is the result of applying the physical fitness level of each sport type of male registered high school athletes in Seoul Table 6. Each sport type showed a significant difference in physical strength grade in all physical strength items except for Trunk Flexion.

Type-A showed significantly higher differences in grip strength and abdominal strength than those of B and D-Types, whereas D and B-Types were significantly higher than Type-A in the sit-up of muscular endurance.

Type-B showed significantly higher physical endurance, muscle power, cardiopulmonary endurance, agility, coordination, and equilibrium compared to the A and D-types, and D-Type showed a higher physical strength level than the A-Type in cardiopulmonary endurance, agility, and balance.

There was a significant difference in the order of grip strength and abdominal strength in the order of A>B>D, muscle endurance D>B>A, cardiopulmonary endurance lung capacity B>A>D. Was significantly higher in Type-D, and the total coordination time between the balanced and closed eyes and coordination was significantly different in the order of B>D>A.

**Table 4.** Comparison of Physique Characteristics by Event Type

| Classification | Factor | Measurement Item | Event Type | M±SD (Average, Standard Deviation) | F | P |
|---|---|---|---|---|---|---|
| Build | Length | Height | A-Type | 175.14±6.83 | 1.058 | 0.349 |
| | | | B-Type | 173.61±6.28 | | |
| | | | D-Type | 174.88±5.92 | | |
| | | | | 174.67±6.28 | | |
| | Weight | Weight | A-Type | 83.58±20.63 | 33.609 | 0.001*** |
| | | | B-Type | 66.81±10.76 | | |
| | | | D-Type | 67.37±10.18 | | |
| | | | | 71.83±15.84 | | |
| | | BMI | A-Type | 27.04±5.14 | 45.404 | 0.001*** |
| | | | B-Type | 22.11±2.98 | | |
| | | | D-Type | 21.98±2.91 | | |
| | | | | 23.45±4.33 | | |
| | Circumference | Thigh(R) | A-Type | 61.64±7.46 | 168.4368 | 0.001*** |
| | | | B-Type | 75.63±3.50 | | |
| | | | D-Type | 56.49±4.48 | | |
| | | | | 62.35±9.26 | | |

*p<.05, **p<.01, ***p<.001

**Table 5.** Comparison of Characteristics of Basic Physical Strength by Event Type

| Classification | Factor | Measurement Item | Event Type | M±SD (Average, Standard Deviation) | F | P |
|---|---|---|---|---|---|---|
| Basic Stamina | Muscle Strength | Grip (kg) | A-Ttpe | 48.44±7.99 | 24.621 | 0.001*** |
| | | | B-Type | 41.78±13.85 | | |
| | | | D-Type | 41.66±5.62 | | |
| | | | | 43.62±9.29 | | |
| | | Back Strength (kg) | A-Type | 132.65±25.39 | 45.176 | 0.001*** |
| | | | B-Type | 95.90±15.73 | | |
| | | | D-Type | 103.40±17.24 | | |
| | | | | 109.77±24.06 | | |
| | Muscle Endurance | Sit-Up (Time/60Second) | A-Type | 46.75±12.13 | 7.685 | 0.001*** |
| | | | B-Type | 52.00±6.23 | | |
| | | | D-Type | 52.69±7.43 | | |
| | | | | 50.84±9.15 | | |
| | Muscle Power | Sergeant Jump (cm) | A-Type | 42.90±9.04 | 77.466 | 0.001*** |
| | | | B-Type | 54.92±4.69 | | |
| | | | D-Type | 42.49±5.31 | | |
| | | | | 45.47±8.27 | | |
| | | Jump in place (cm) | A-Type | 228.86±26.34 | 3.255 | 0.040* |
| | | | B-Type | 216.28±36.70 | | |
| | | | D-Type | 223.05±17.58 | | |
| | | | | 223.75±24.629 | | |
| | Cardiopulmonary Endurance | Lung Capacity FVC (cc) | A-Type | 4835.22±585.39 | 12.216 | 0.001*** |
| | | | B-Type | 4382.68±595.52 | | |
| | | | D-Type | 4464.24±524.45 | | |
| | | | | 4550.78±585.77 | | |
| | Agility | Side Step (Time/20Times) | A-Type | 42.51±5.60 | 33.409 | 0.001*** |
| | | | B-Type | 39.09±6.68 | | |
| | | | D-Type | 45.59±3.40 | | |
| | | | | 43.22±5.60 | | |
| | Equilibrium | One-legged Standing with Eyes Closed (second) | A-Type | 27.33±26.93 | 12.993 | 0.001*** |
| | | | B-Type | 29.28±25.79 | | |
| | | | D-Type | 48.47±34.57 | | |
| | | | | 37.99±32.08 | | |
| | Coordination | Eye-hand Total Coordination Time (second) | A-Type | 52.26±7.14 | 12.027 | 0.001*** |
| | | | B-Type | 52.27±5.86 | | |
| | | | D-Type | 48.52±5.15 | | |
| | | | | 50.45±6.21 | | |
| | Flexibility | Trunk Flexion (cm) | A-Type | 11.84±9.91 | 0.852 | 0.428* |
| | | | B-Type | 13.53±9.81 | | |
| | | | D-Type | 11.62±8.57 | | |
| | | | | 12.17±9.26 | | |

*p<.05, **p<.01, ***p<.001

**Table 6.** Analysis of the Difference in the Level of the Fitness Factor according to the Application of the Fitness Level Criteria by Sport Type

| Classification | Factor | Measurement Item | Event Type | Grade by Type M±SD (Average, Standard Deviation) | F | P | Post-Hoc (Scheffe) |
|---|---|---|---|---|---|---|---|
| Basic Stamina | Muscle Strength | Grip (kg) | A-Type | 2.28±0.968 | 17.163 | 0.001*** | A>B, 0.001*** A>D, 0.001*** |
| | | | B-Type | 3.14±1.119 | | | |
| | | | D-Type | 3.04±0.881 | | | |
| | | | | 2.85±1.027 | | | |
| | | Back Strength (kg) | A-Type | 2.60±1.024 | 24.946 | 0.001*** | A>B, 0.010* A>D, 0.001*** B>D, 0.007* |
| | | | B-Type | 3.13±0.974 | | | |
| | | | D-Type | 3.61±0.877 | | | |
| | | | | 3.21±1.032 | | | |
| | Muscle Endurance | Sit-Up (time/60second) | A-Type | 3.31±1.131 | 14.132 | 0.001*** | D>A, 0.001*** B>A, 0.047* |
| | | | B-Type | 2.86±1.034 | | | |
| | | | D-Type | 2.49±0.931 | | | |
| | | | | 2.80±1.062 | | | |
| | Muscle Power | Sergeant Jump (cm) | A-Type | 3.68±0.931 | 28.582 | 0.001*** | B>A, 0.001*** B>D, 0.001*** |
| | | | B-Type | 2.89±1.021 | | | |
| | | | D-Type | 3.88±0.602 | | | |
| | | | | 3.60±0.901 | | | |
| | | Jump in place (cm) | A-Type | 3.26±1.080 | 4.800 | 0.009** | D>B, 0.009*** |
| | | | B-Type | 3.55±0.872 | | | |
| | | | D-Type | 3.08±0.907 | | | |
| | | | | 3.24±0.967 | | | |
| | Cardiopulmonary Endurance | Lung Capacity FVC (cc) | A-Type | 2.57±0.882 | 109.596 | 0.001*** | B>A, 0.001*** B>D, 0.001*** A>B, 0.001*** |
| | | | B-Tyle | 1.40±0.710 | | | |
| | | | D-Type | 3.36±0.823 | | | |
| | | | | 2.69±1.126 | | | |
| | Agility | Side Step (time/20times) | A-Type | 3.45±1.222 | 6.448 | 0.002** | D>A, 0.003*** |
| | | | B-Type | 2.97±0.941 | | | |
| | | | D-Type | 2.95±0.729 | | | |
| | | | | 3.10±0.962 | | | |
| | Equilibrium | One-legged Standing with Eyes Closed (second) | A-Type | 3.38±0.824 | 27.182 | 0.001*** | B>A, 0.001*** B>D, 0.001*** D>A, 0.001*** |
| | | | B-Type | 2.18±0.945 | | | |
| | | | D-Type | 2.86±0.914 | | | |
| | | | | 2.86±0.988 | | | |
| | Coordination | Eye-hand Total Coordination Time (second) | A-Type | 3.62±0.989 | 47.076 | 0.001*** | B>A, 0.001*** B>D, 0.001*** D>A, 0.001*** |
| | | | B-Type | 1.94±0.984 | | | |
| | | | D-Type | 3.05±0.749 | | | |
| | | | | 3.05±1.001 | | | |
| | Flexibility | Trunk Flexion (cm) | A-Type | 3.33±0.834 | 2.443 | 0.089 | |
| | | | B-Type | 3.00±0.739 | | | |
| | | | D-Type | 3.09±0.996 | | | |
| | | | | 3.14±0.903 | | | |

*p<.05, **p<.01, ***p<.001

## 4. Discussion

In order to discover and foster talented athletic talents scientifically, Korea has been conducting ‘the Student Athlete Training Project’ since 2009 and’ the Student Athletes Integrated Support Center Project’ since 2011 to improve the performance of middle and high school athletes. Currently, since 2015, local sports science centers in 10 cities across the country are being operated to systematically link athletes’ physical strength through finding excellent athletes and measuring physical fitness according to the athlete’s life cycle (Korea Institute of Sport Science, 2018a; Choi, 2015). In particular, the elite athletes belonging to Seoul won the first place overall with medals of 128 gold, 126 silver, and 144 bronze at the 100th National Sports Festival in 2019, and among them, the male high school students won a silver medal in soccer and 4 in athletics. He won gold medals in dogs and 3 silver medals in Taekwondo. In addition, the elite athletes belonging to the city of Seoul represent the elite athletes of Korea by maintaining the top ranks in national sports competitions for many years, and it can be seen as a center for discovering excellent athletes for middle and high school student athletes. Therefore, by analyzing the physical characteristics of high school student athletes of the Seoul Sports Science Center by event type, it is considered to be an important basic data for reinforcing the unique characteristics of the sport and seeking the balanced development of the sport in the region.

In the study of sports events and body types, it is reported that not only a body type suitable for the event exists, but also a difference in body type exists between athletes with excellent performance and those who do not (Hawes & Sovak, 1994). Considering the physical characteristics of high school and higher athletes who enter the maturity stage of some degree of growth, it is thought that it is necessary to be careful (Hong et al., 2010).

As a result of this study, sport Type-A showed significantly higher physical strength level than other sport types in grip strength (2.28±0.968) and abdominal strength (2.60±1.024), which are muscle strength. They were endurance (3.31±1.131), agility (3.45±1.222), coordination (3.62±0.989), and balance (3.38±0.824). In Hong et al.(2010) study, it was reported that the grip strength and abdominal strength showed a significant influence on the physical strength factors between the age group and the sub-sports of athletes. In addition, in the study of Park et al. (2009), the study on the performance analysis according to physical fitness of wrestlers showed grip strength, flexibility, and aerobic ability. In other words, this is thought to be the result of the characteristics of the sports that mainly require short-term strength and endurance in the A-Type sport types such as athletics, kendo, restring, and wrestling.

Type-B showed higher physical strength level than other sports types in almost all items such as muscular endurance, muscular power, cardiopulmonary endurance, agility, coordination, and balance. The lower physical strength compared to other sport types was the grip strength (3.14±1.119). In addition to the sport characteristics that require mid-term muscular endurance, it is thought that the characteristics of the Taekwondo sport in the B-Type, where many Taekwondo athletes were present, had a large influence.

Taekwondo competition is a competition in which the opponent approaches and competes within a limited time of 3 minutes and 3 rotations, and requires very instantaneous skills and strength,

endurance, agility, and quickness (Park et al., 2002). According to Choi, K. S. (2015)'s research, muscular endurance is the ability to continuously perform muscle exercises and to maintain smooth muscle contraction without feeling tired, and is an important physical strength factor in the characteristics of Taekwondo Gyeorugi athletes. He also reported that developing muscle endurance to continuously generate power determines the win or loss of the match (Koh et al., 2007). In this way, in addition to the strength and endurance, which are the characteristics of Type-B sports such as Taekwondo, it is related to cardiorespiratory endurance, agility, etc., which is related to the balance of high school student Taekwondo athletes in Seoul, high-difficulty kicking and high jumping power, and rotational power. This is thought to be because agility is the physical strength that appears in excellent performance along with the characteristics of the sport.

Finally, D-Types such as soccer, handball, and tennis show higher physical fitness levels than the A-Type in cardiorespiratory endurance, agility, and balance. The lower physical strength than other sports types was back strength (3.61±0.877) and sergeant jump of muscle power (3.88±0.602). Sport Type-D is a sport that requires a lot of physical strength because it has to move continuously for a long time. As a result of the study of the model of potential physical factors and technical factors, the influence on muscular endurance, agility, coordination, equilibrium, and muscle power was confirmed (Choi, 2006), Considering these points, D-Type suitable for male high school students in Seoul used in this study. It was confirmed that it had a physical strength factor.

As a result of comparing and analyzing the physical strength of elite athletes of high school students by sport type measured at the Seoul Sports Science Center, the Korea Institute for all sporting events and sport types, as it is the city of Seoul where athletes who have excellent athletic performance in Korea such as national sports competitions are participating. It was confirmed that it maintains physical strength of 3 or higher in the standard table presented by of Sport Science. In particular, in Type-B, where Taekwondo and boxing players were mostly, not only muscle endurance and muscle power, which are the characteristics of the sporting event. Cardiopulmonary endurance, agility, parallelism, and coordination also showed excellent physical strength. There were no physical factors that significantly fell below the average for each sport type, but Type-A showed lower endurance, agility, coordination, and balance compared to other sport types, and compared the performance and physical strength and characteristics of athletes to review training methods and performance improvement.

Through this study, it was possible to analyze the physical strength of athletes according to the sport characteristics. Most of the high school male athletes in Seoul had a high level of fitness as they were athletes with excellent athletic performance, and in particular, in Taekwondo and boxing players of Type-B, they were very balanced and highly evaluated by their physical strength factors. In this study, the results of physical fitness according to the event type can identify strengths and weaknesses that are suitable for the characteristics of the event, and it is thought that it will be possible to confirm very beneficial results in solving the shortcomings. In addition, the discovery of physical strength factors during this period is deeply related not only to performance but also to injuries ahead of adult games, and is thought to be helpful as an evaluation tool for finding excellent players and data for physical strength improvement.

The training course for improving athletic performance should have a systematic system for discover-

ing, selecting, training and fostering athletes based on the determining factors and physical strength of each sport (Kim, 2013). In addition, an accurate analysis of the potential ability to discover excellent athletes should be systematic and future-oriented as a starting point for training to improve athletic performance. This study analyzed the physical strength of male high school students in Seoul by sport type based on the data of Seoul athletes among the data from the regional sports science center. However, the characteristics of individual athletes such as athletes' career, performance, and amount of practice are not investigated in the data, and there is a lack of a system that can confirm the increase in physical fitness by year. In particular, this data is made up of data from 2015-2016 when the regional sports science center was established, so it can be seen as a limitation of this study that there is a further insufficient data composition. In the future, it is important to collect the personal characteristics of players for continuous data collection, and it is expected to be helpful in feedback, improvement, and evaluation of performance.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## References

Back, H. Y., & Sung, B. J. (2004). The effects of periodized training on the improvement of isokinetic muscle power and performance in sprinters. *Exercise Science, 13*(4), 513-524.

Choi, K. S. (2015). Effect of Different Set Composition during Resistance Training on Isokinetic Muscular Functions and Cross-Sectional Area of Quadriceps Muscle in Taekwondo Athletes. *Korean society for Wellness, 10*(2), 221-229.

Choi, T. H. (2006). The Relation between Physique, Physical Fitness, Basic Skill and Ranking of Tennis Players. *Korea Sport Research, 17*(1), 477-488.

Cureton, T. K. (1956). Relationship of Physical Fitness to Athleti Performance and Sports. *The Journal of American Medical Associzion, 162*(12), 1139-1149.

Hawes, M. R., & Sovak, D. (1994). Morphological prototypes, assessment and change in elite athletes. *Journal of Sports Sciences, 12*(3), 235-242.

Hoff, J. (2005). Training and testing physical capacities for elites soccer players. *Journal of Sports science, 23*(6), 573-582.

Hong, C. B., Ahn, N. Y., & Kim, K. J. (2010). Differences between the events in age groups when physical fitness is evaluated for selecting excellent athletes. *Journal of Coaching Development, 12*(1), 213-224.

Kim, K. J. (2013). Comparisons of Body Composition, Physical Fitness, Blood ACE and 12-week Combined Exercise Intervention-Mediate Changes according to ACE Gene Polymorphism in Obese Juveniles. *Journal of Coaching Development, 15*(2), 68-76.

Kim, W. K., & Jeon, M. J. (2006). A study on the isokinetic muscle strength and muscle endurance

of male high school Taekwondo athletes. *Korean journal of physical education, 45*(6), 381-388.

Koh, Y. J., Lee, M. G., & Kong, S. A. (2007). Comparison of body composition, physical fitness, and isokinetic leg strength according to competition level in collegiate and high school taekwon-do players. *Exercise Science, 16*(4), 411-420.

Korea Institute of Sport Science. (2015). *Development of physical fitness evaluation criteria for middle and high school students and research on connection plans*.

Korea Institute of Sport Science. (2018a). *Development of indicators for improving performance of regional sports science centers*.

Korea Institute of Sport Science. (2018b). *2017 Regional Sports Science Center Research Project Report; Development of physical fitness training programs for each sport*.

Martin, D. T., McLean, B., Trewin, C., Lee, H., Victor, J., & Hahn, A. G. (2001). Physiological characteristics of nationally competitive famale road cyclists and demands of competition. *Sports Medicine, 31*(7), 469-477.

Park, I. R., Jun, T. W., Park, K. S., Kwan, R. B., & Choi, J. H. (2002). A Study on the change of Heart Rate, Blood Lactate, Blood Pressure and MO2 in Taekwondo Athletes during Taekwondo Competition. *Korean Journal of Sport Studies, 14*(5), 625-634.

Park, J. S., Yoon, D. K., Kim, G. J., & Kwon G. R. (2020). Comparison of Physical Fitness and Lower Extremity Isokinetic Muscular Functions Characteristics of High School Soccer Players and Taekwondo Players. *Journal of Coaching Development, 22*(1), 131-139.

Park, S. H., Kim, K. H., & Huh, Y. (2009). College Ssireum Player's Strength Profile and Performance Perdictions. *The Journal of Korean Alliance of Martial Arts, 11*(1), 213-225.

Shin, S. M., & Shoi, O. J. (2011). Comparison of Physical Fitness, Isokinetic Muscular Strength and Anaerobic Power in the Position of High School Soccer Player. *The Korean Journal of Sport, 9*(3), 227-234.