

## **Research on the Sensitive Period of Physical Fitness of Chinese Students between 7-18 Years Old Han and Six Minorities in 2014**

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**ABSTRACT.** *Objective: Study the sensitive age of the physical fitness of Chinese Han and minority students, and the development characteristics of the sensitive period. Provide data support for optimizing the physical education curriculum of Chinese children and adolescents, provide scientific basis for improving the physical fitness of young people, and provide theoretical basis for the selection of young athletes. Methods: Using the calculation method of Deng Huayuan and Deng Shuzhen, this method is: the average annual growth rate plus half the standard deviation of the annual growth rate. Use this method to calculate the critical value of the sensitive period of the physical fitness of male and female students of various nationalities, and the age of the sensitive period. Then the ethnic differences in various indicators are studied to understand the development characteristics of the physical fitness of male and female students between the Han and six ethnic minorities in the 7-18 age group in China. Results: The sensitive period of male strength quality of the three ethnic groups of China, Han, Mongolian and Korean are all 12-15 years old. The sensitive period of Korean girls' strength began at the earliest (8 years old). The sensitive ages of speed quality of male and female students of various nationalities are scattered, and they all start from 8 or 9 years old. The sensitive age for speed quality of Uyghur girls is 9-10 years old, with the shortest duration. Hui, Uygur, and Tibetan boys have the longest sensitive period of explosive quality. The sensitive period of the overall endurance quality of all ethnic students starts from 8-9 years old. The sensitive ages of male muscular endurance of various ethnic groups are concentrated in 15 and 16 years old. The sensitive ages of muscular endurance for girls of various nationalities are mainly 9, 11 and 13 years old. The sensitive period of pliability of Han, Mongolian, Hui and Zhuang boys all began at the age of 13. The sensitive period of flexibility for Mongolian and Hui girls starts at the age of 11. Conclusion: The sensitive periods of various physical fitness have ethnic and gender differences, and show the characteristics of both continuous age groups and scattered age points.*

**KEYWORDS:** *Physical fitness, Sensitive periods, Students, Minority*

## 1. Introduction

China is a multi-ethnic country dominated by the Han nationality. The distribution of ethnic minorities in China is characterized by large mixed living and small clusters, living in a staggered manner. Among the 55 ethnic minorities, the Zhuang ethnic group has the largest number. Ethnic minorities with a population of more than 5 million include Manchu, Hui, Miao, Tibetan, Yi, Uygur, Mongolian, etc.[3]. Due to the relatively large populations of the six ethnic minorities, Mongolia, Hui, Uygur, Zhuang, Korean, and Tibetan, they are concentrated in ethnic minority autonomous regions. Therefore, in addition to Han students, this paper also selects students from these 6 ethnic minorities to conduct a comparative study on the sensitive period of physical fitness among students of various ethnic groups.

The body's body abilities such as speed, strength, endurance, agility, balance, flexibility and coordination in muscle activity are collectively called physical fitness. Physical fitness is one of the important indicators to measure the physical condition of a human body, and it is the basis for the formation and development of sports skills [4]. During the growth and development of children and adolescents, the growth rates of various physical fitness are different at different ages. The age when the relative growth rate of physical fitness is relatively fast is called the sensitive period of physical fitness growth [5]. Each physical fitness has a "sensitive development period", that is, the age when the physical fitness develops fastest and most sensitive to external stimuli. At this age, the targeted development of a certain physical fitness of children and adolescents is easy to achieve significant results [6-7].

This paper studies the sensitive period of physical fitness of boys and girls between the 7-18-year-old Han nationality and six ethnic minorities in my country in 2014, and compares the age at which young people of various nationalities develop faster in the natural growth process. Understand the influence of different regions, climates, living conditions, eating habits and environments on the physical development age of boys and girls of different nationalities [8]. Clarify the sensitive period of various physical fitness of children and adolescents, as well as their ethnic, age, and gender differences, and conduct comparative analysis on them. This research provides a scientific basis for optimizing the goals and content of children and adolescents' physical education curriculum, improving the physical fitness of adolescents, and selecting young athletes.

## 2. Data Sources and Research Methods

Date source: According to the data published in the "2014 Chinese Students' Physique and Health Survey Report"[9], exercise indicators such as grip strength, 50-meter's run, standing long jump, endurance run, pull-ups/sit-ups, sit-and-reach are selected. And select 242,829 students from the Han, Mongolian, Hui, Uygur, Zhuang, Korean, and Tibetan groups in the age range of 7-18 years as the research objects. Among them, there are 214,443 Han students, 5107 Mongolian students,

5308 Hui students, 5740 Uygur students, 5267 Zhuang students, 4546 Korean students, and 2,418 Tibetan students.

Research method: All sports indicators are tested in accordance with the requirements in the “2014 National Student Physical Health Survey Work Manual” [10]. The main test items are: grip strength, standing long jump, 50-meter’s run, pull-ups for boys, sit-ups for girls, 50-meter  $\times$  8 round-trip runs for students aged 7-12, men and women aged 13-18 Students are 1,000-meter running and 800-meter running, sit-and-reach.

To define the sensitive period of physical fitness: This study assumes that the developmental stage of adolescents' physical fitness is 7-18 years old. According to the method of Deng Huayuan[1] and Deng Shuzhen[2]. Use the average annual growth rate of a physical fitness plus the standard deviation of 0.5 times the annual growth rate to calculate the critical value. So as to determine the sensitive period of physical fitness development, and carry out statistical analysis on it.

#### Calculation Method for Sensitive Period of Physical Fitness:

1) Calculate the annual growth value of each physical fitness: the annual growth value of a certain sports indicator in a certain year is equal to the performance of this sports indicator in the current year, minus the performance of the previous year; (Note: due to the lack of 6-year-old students in this study Relevant data, so the annual growth value of the indicators in the 7-year-old age group cannot be calculated by this calculation, and it is defined as 0 in this study.)

2) Calculate the total growth value of a certain physical fitness of the students in the 7-18 age group: the total growth value is equal to the 18-year-old performance of this sports index minus the 7-year-old performance of this sports index.

3) Calculate the annual growth rate of a certain physical fitness: the annual growth rate is equal to the annual growth value divided by the total growth value of this physical fitness, and then multiplied by 100%;

4) Calculate the average and standard deviation of the annual growth rate of each physical fitness;

5) Calculate the critical value of a certain physical fitness sensitive period: the critical value is equal to the average annual growth rate, plus 0.5 times the standard deviation of the annual growth rate;

6) Determine the sensitive period of each physical fitness: When the value of a certain annual growth rate of physical fitness is greater than or equal to the critical value of this physical fitness sensitive period, the corresponding age group is the sensitive period of this physical fitness.

Statistical methods: This study uses SPSS23.0 software to process and compare the survey data of students' physical fitness, and calculate the total growth value of each physical fitness, the average and standard deviation of the annual growth rate, and the defined value of the sensitive period.

### 3. Research Results

#### 3.1 The Determination of the Sensitive Age of Students' Strength Quality and Its Development Characteristics

The grip strength index represents strength quality. It can be seen from Table 1 that the sensitive period of the power quality of the three ethnic groups of Han, Mongolian and Korean boys are all 12-15 years old. Zhuang boys have the shortest sensitive period of strength, which is 13-14 years old. The sensitive period of Uyghur boys' strength quality spans the largest, 13-16 and 18 years old. The total increase in the grip strength index of Mongolian boys is the largest, with a total increase of 35.30kg. The total increase value of the Korean boys' grip strength index was the smallest, with a total increase of 29.34kg. The sensitive period of the strength and quality of the girls of the Han, Mongolian and Zhuang nationalities all starts at the age of 10. Uyghur girls have the shortest sensitive period of strength, being 13 or 17 years old. Among the seven ethnic groups, the sensitive period of Korean girls' strength quality began the earliest (8 years old), and their grip strength index had the smallest total increase value, which was 15.13 kg.

*Table 1 Strength Quality (Grip Strength) Total Growth Value, Critical Value and Sensitive Age*

National	Boys			Girls		
	Total growth	Critical value	Sensitive age	Total growth	Critical value	Sensitive age
Han	32.55	0.107	12-15	16.81	0.110	10-13
Mongolian	35.30	0.107	12-15	17.52	0.119	10-12
Hui	33.02	0.110	12-14	18.19	0.118	11-12,14
Uyghur	32.51	0.113	13-16,18	18.32	0.159	13,17
Zhuang	30.17	0.115	13-14	16.48	0.112	10-13
Korean	29.34	0.105	12-15	15.13	0.120	8-9,11
Tibetan	31.47	0.110	11,13-15	17.58	0.130	11,14,16

#### 3.2 Determination of the Sensitive Age of Students' Speed Quality and Its Development Characteristics

The student's 50-meter run index represents speed quality. It can be seen from Table 2 that the sensitive ages for speed quality of male and female students of various ethnic groups are scattered, and they all start from 8 or 9 years old. The sensitive period of speed quality of Han boys is the longest and is two consecutive age groups (8-9, 12-14 years old); the sensitive period of speed quality of Mongolian and Hui boys, Zhuang and Tibetan girls ends the latest (15 for boys) Years old, girls are 16 or 17 years old). Uyghur girls have the shortest sensitive age

for speed quality, 9-10 years old. Uyghur students have the largest total increase in the 50-meter run index, which is -4.22sec for boys and -2.43sec for girls.

*Table 2 Speed Quality (50-meter's Run) Total Growth Value, Critical Value and Sensitive Age*

National	Boys			Girls		
	Total growth	Critical value	Sensitive age	Total growth	Critical value	Sensitive age
Han	-3.42	0.111	8-9,12-14	-1.79	0.144	8-11
Mongolian	-3.62	0.107	8,13,15	-0.96	0.245	8-9,11
Hui	-3.14	0.111	8,12-15	-1.34	0.162	8-10
Uyghur	-4.22	0.118	9,10-11,13	-2.43	0.156	9-10
Zhuang	-3.68	0.115	8,10,13	-2.27	0.129	8-11,16
Korean	-3.00	0.114	8-9,13	-1.01	0.244	8-11,14
Tibetan	-4.19	0.116	8-9,11,15	-2.25	0.148	8,9,14,17

### **3.3 Determination of Sensitive Age of Students' Explosive Power Quality and Its Development Characteristics**

The students' standing long jump index represents their explosive quality. Table 3 shows that Hui, Uyghur and Tibetan boys have the longest sensitive periods of explosive power quality, which are (9, 12-15) years old, (10-11, 13-14, 16) and (8, 11, 13-15) year old. The explosive power quality sensitive period of boys from the Zhuang, Korean and Tibetan nationalities started the earliest, and they were all 8 years old, but they ended at different ages. The sensitive age of girls of all ethnic groups starts from 8 years old. From the perspective of total growth value, the standing long jump index scores of students of all ethnic groups increase year by year with age. Mongolian boys have the largest total growth value of standing long jump indicators, 111.67cm; Uyghur girls have the largest total growth value of standing long jump indicators, 60.90cm.

*Table 3 the Total Growth Value, Critical Value and Sensitive Age of Students' Explosive Power Quality (Standing Long Jump)*

National	Boys			Girls		
	Total growth	Critical value	Sensitive age	Total growth	Critical value	Sensitive age
Han	103.57	0.106	12-15	51.84	0.115	8-11
Mongolian	111.67	0.104	9,13,16	49.26	0.134	8-9,11
Hui	109.63	0.112	9,12-15	55.68	0.128	8-9,15

Uyghur	110.37	0.105	10-11,13-14,16	60.90	0.111	8-11,13
Zhuang	106.89	0.109	8,10,13,16	55.44	0.125	8-9,16
Korean	99.29	0.107	8,12-13	47.41	0.129	8-9,11
Tibetan	106.82	0.103	8,11,13-15	49.00	0.139	8-11,14,17

### 3.4 Determination of the Sensitive Age of Students' Overall Endurance Quality and Its Development Characteristics

Table 4 Total Growth Value, Cut-Off Value and Sensitive Age of Students' Overall Endurance Quality

National	7-12 year old boys 50m*8 round trip		13-18 year old boys 1000 meters run		All the boys	7-12 years old girls 50m* 8 round trip		13-18 year old girls 1000 meters run		All the girls
	Total growth	Critical value	Total growth	Critical value		Sensitive age	Total growth	Critical value	Total growth	
Han	-21.59	0.20	-36.78	0.26	8,10-11,14-15	-18.88	0.22	-5.26	0.44	8-11,14,15
Mongolian	-20.32	0.22	-36.61	0.28	8-9,11,15	-16.68	0.26	8.74	0.29	8,11
Hui	-17.50	0.23	-38.26	0.35	9-11,14-15	-16.95	0.27	-22.73	0.40	9-10,14-15
Uyghur	-24.83	0.24	-80.83	0.22	9,11,14-15	-26.49	0.23	-24.61	0.30	8,11,14,16
Zhuang	-16.54	0.26	-79.55	0.25	8,10-11,14,16	-10.06	0.27	-35.99	0.30	8,11,14,16
Korean	-11.16	0.44	-23.46	0.31	8-9,14	-16.24	0.30	0.02	111.90	8-10,14,16-17
Tibetan	-25.09	0.31	-39.58	0.48	11,14,16	-23.02	0.25	-13.59	0.93	8,11,14,16

The smaller the student's 50m\*8 round-trip, 800m and 1000m run, the better the overall endurance quality. Table 4 is available, the sensitive period of the whole body endurance quality of students of all ethnic groups starts from 8-9 years old. The sensitive period of the whole body endurance quality of Han and Zhuang boys is the longest, being 8, 10-11, 14-15 years old and 8, 10-11, 14, 16 years old. The sensitive period of the overall endurance of Tibetan boys starts at the latest (11 years old). The sensitive period of the whole body endurance of Mongolian girls is the shortest, 8 and 11 years old; the sensitive period of the whole body endurance of

Korean girls ends at the latest (17 years old). From the perspective of total growth value, the results of the 50-meter\*8 round-trip run of students of various nationalities get better and better with age.

### ***3.5 Determination of the Sensitive Age of Students' Muscular Endurance Quality and Its Development Characteristics***

Oblique pull-ups for boys aged 7-12, pull-ups for boys aged 13-18, and sit-ups for girls aged 7-18 represent muscular endurance quality. It can be seen from Table 5 that the sensitive period of male muscular endurance quality is mainly 15 and 16 years old. The sensitive period for the muscular endurance quality of Han boys starts at the latest at the age of 12. Mongolian and Tibetan boys have the longest muscular endurance sensitive period, which is 10-11, 15-16, 18 and 8, 12, 14, 16, and 18, respectively. The total increase value of the oblique pull-ups index for Tibetan boys was the largest at 32.04 times, and the total increase value of the pull-ups index for Uyghur boys was the largest at 6.41 times per minute. The sensitive ages of female muscular endurance quality are mainly 9, 11, and 13 years old. The sensitive period of the muscular endurance of Tibetan girls ends at the latest at the age of 16; except for the Han girls' muscular endurance, which is a continuous age group (8-11 years old), the sensitive period of muscular endurance of other ethnic girls is several Age points and age groups exist at the same time. Among the 7 ethnic students, Korean girls have the largest increase in sit-up performance, 25.81 times per minute.

*Table 5 Total Growth Value, Critical Value and Sensitive Age of Students' Muscle Endurance Quality*

National	7-12 year old boys diagonal pull-ups		13-18 year old boys pull-ups		All the boys Sensitive age	Sit-ups for girls ages 7 to 18		
	Total growth	Critical value	Total growth	Critical value		Total growth	Critical value	Sensitive age
Han	5.43	0.22	2.60	0.22	12,14-15	11.36	0.13	8-11
Mongolian	0.65	1.54	3.89	0.23	10-11,15-16,18	9.29	0.18	8-9,11,15
Hui	5.52	0.30	3.14	0.28	8,12,15	9.82	0.18	9-11,15
Uyghur	13.61	0.32	6.41	0.22	11-12,15-16	12.11	0.14	11,13
Zhuan	3.45	0.59	2.49	0.32	8,10,16-17	8.53	0.26	8,10,13
Korean	-3.96	0.98	3.09	0.23	8,14,16,18	25.81	0.12	8,10,13-14
Tibetan	32.04	0.28	4.83	0.34	8,12,14,16,18	16.86	0.21	11,13-14,16

### 3.6 Determination of the Sensitive Age of Students' Flexibility and Their Development Characteristics

The sit-and-reach of the student sitting body represents flexibility. As shown in Table 6, the sensitive period of flexibility of Han, Mongolian, Hui and Zhuang boys all began at 13 years old, but the sensitive period of flexibility of Zhuang boys ended at the latest (18 years old). Mongolian and Hui girls' flexibilities start the earliest in the sensitive period, both at 11 years old. The sensitive period of Korean girls' flexibility is the largest, ranging from 12-13, 15-16, and 18. Tibetan students have the smallest total increase in sit-and-reach, which is -0.21cm for boys and 1.36cm for girls. The Hui and Uyghur students had the largest total increase in sit-and-reach, which was 9.86 cm and 9.73 cm for boys and 6.39 and 6.24 cm for girls.

Table 6 Total Growth Value, Critical Value and Sensitive Age of Students' Flexibility (Sit-and-Reach)

Nationality	Boys			Girls		
	Total growth	Critical value	Sensitive age	Total growth	Critical value	Sensitive age
Han	4.76	0.171	13-16	3.37	0.158	13-16
Mongolian	6.69	0.193	13,16	3.78	0.206	11,13,15-16
Hui	9.86	0.185	13-15	6.39	0.202	11,13-15
Uyghur	9.73	0.133	14-15,17	6.24	0.149	13-17
Zhuang	2.42	0.236	13-15,17-18	3.48	0.195	12,14,18
Korean	4.42	0.218	12,15,17	5.70	0.165	12-13,15-16,18
Tibetan	-0.21	5.382	10,13-14,16	1.36	0.735	14,16

## 4. Discussion

Among the Chinese Han nationality and the 6 ethnic minorities, the development of various physical qualities of students aged 7-18 shows a wave-like and staged characteristics [10]. The sensitive period of various physical fitness of children and adolescents usually has 3-5 sensitive ages. The composition of various physical fitness sensitive periods includes both scattered age points and continuous age groups [2,11], as well as stages where both exist. For example, the sensitive period of muscular endurance of Mongolian boys is 10-11, 15-16, and 18 years old, the sensitive period of muscular endurance of Hui boys is 8, 12, 15 years old, and the sensitive period of muscular endurance of Uyghur boys is 11- 12 and 15-16 years old.



From the perspective of the total growth value of various sports indicators, the sports indicators of the 7 ethnic students generally increase with age in the 7-18 years old age group. The total increase in grip strength of Mongolian boys is the largest. At this stage, Mongolian boys have the best power quality. The total increase value of the 800-meter run index for Mongolian girls is positive, indicating that the overall endurance of Mongolian girls is generally decreasing at the age of 13-18. The above situation may be due to the Mongolian unique eating habits and traditional national sports which can better develop the strength of boys [12], but ignore the development of cardiorespiratory endurance of girls. The 7-12-year-old Tibetan boys have the largest total increase in oblique pull-ups. Uyghur boys aged 13-18 have the largest total increase in pull-ups. These two nationalities have the best development of muscular endurance quality, which may be because these two nationalities pay more attention to physical exercises to develop muscular endurance. Tibetan students have the smallest total increase in sitting body forward bending index, and their development of flexibility is the worst. It may be because the geographical location, climate, living conditions and ethnic habits of Tibetan students are not conducive to the development of their flexibility. Therefore, Tibetan students should pay attention to the development of flexible physical exercises.

Most of the sensitive period of the strength quality of the Han and 6 ethnic minority boys are in the 12-15 age group. The sensitive period of female strength quality is mostly in the 10-12 years old age group. The sensitive age of girls' strength quality is 2-3 years earlier than that of boys, and the index of grip strength of students of all nationalities increases with age. The sensitive period of the strength of boys and girls of various nationalities is mainly distributed in the 8-9 and 11-year-old age group. The sensitive period of the strength of boys and girls is later than that of girls. There are many sensitive ages for explosive power qualities of various ethnic groups and spans a wide range. Boys are mainly distributed between the ages of 8 and 13-14, while girls are older than boys, mostly at the age of 8-9 and 11. The sensitive period of endurance quality of boys and girls of various nationalities spans a large range, mostly composed of 4-5 sensitive ages, mainly distributed in 8, 11 and 14-16 years old. Sensitive age of male muscular endurance quality first appeared at 8 years old, mainly distributed in 12, 15-16 years old, and its sensitive period spanned large and scattered. The sensitive period of female muscular endurance is mainly in the age group of 9, 11 and 13 years old [13]. The sensitive period of flexibility of boys and girls of various nationalities starts later, and the sensitive period of flexibility of boys and girls is mainly in the ages of 13-17 and 13-15. The results of this study are consistent with the results of Wang Weijie [14]. After entering puberty, girls from the Han nationality and the six major ethnic minorities have the same development of flexibility as boys, but the development of other physical fitness is worse than that of boys. The beginning age of the sensitive period of the physical fitness of girls of all nationalities is generally smaller than that of boys, showing obvious gender differences.

During the growth and development of children and adolescents, the sensitive period of physical fitness should be used, according to the development sequence and physiological characteristics of the physical fitness of each age, and a certain

degree of exercise intervention should be used to reasonably improve the physical fitness at the age when the physical fitness develops fastest. The physical fitness of children and adolescents can be improved from the current state to a better state [15-17]. School physical education should gradually establish a physical education model characterized by the sensitive period of physical fitness, further optimize the physical education and extracurricular activities of primary and secondary school students, and effectively improve the physical health of young students. At the same time, the sensitive period of physical fitness and the national differences and national advantages shown in various sports can also be used in the selection of athletes, which has practical significance for the early selection and training of young athletes.

In summary, this research updates the investigation and research on the sensitive period of physical fitness of Chinese Han and six major ethnic minorities, and provides a certain theoretical basis for the determination and comparison of the sensitive period of physical fitness of ethnic minority students in the future. However, due to the cross-sectional data used in this study, and the lack of relevant data for students before the age of 7, this study has certain limitations, and it is impossible to clarify the law of physical fitness development of students in the age group of 1-7. The above questions need to be further supplemented by follow-up research.

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