Physical Development Measures of Mongolian Adolescents and Affecting Factors

Sanjaabadam Sed✉ *, Lkhagvasuren Tserendorj, Bayarmaa Bazarsuren

*sanjaabadam@mier.mn
Human Development Research Sector, Mongolian National Institute for Educational Research, Ulaanbaatar, Mongolia

Abstract. The physical development of Mongolian adolescents (11-14 years old, male and female) are studied by two components namely, general physical development (height, weight, thigh, head and chest circumferences) and physical fitness (muscle strength, muscle endurance, flexibility). The research was carried out 2 times with an interval of 5 years (2014-2017 & 2019-2021), and this article describes the changes in the physical development of the adolescents involved in this research and some factors that influenced these changes. Analysis of normal distribution, calculation and comparison of average values (Anova, T-test, standard method of calculation of scores, chi-square criterion), factors of influence (correlation, non-parametric tests), and factor analysis were used for processing the data results. According to the research results, the general physical development of children has been increased, for instance children's height increases by 4.74 cm at the age of 11-12 and by 2.41 cm at the age of 13-14, which indicates that they are in an intensive stage of development. Regarding of physical fitness, the performance of 11-14 year-old boys and girls, also increased in Research 2.

Keywords: Age · Gender · Height · Weight · Endurance · Flexibility · Agility · Strength Change · Reason · Measurement

The main indicators of physical growth are body height, weight, and body circumferences, while the indicators of physical fitness depend on the development of large and small muscles, which are manifested by training qualities such as speed, agility, endurance, flexibility, and balance [1].

According to human development researchers, pre-school age is a period of large muscle development related to the rapid development of protein brain neurons, while early school age is a period of small muscle, speed, agility, and body growth, and middle school is a period of height and weight growth due to the transitional age. At the senior school age, children's muscle strength increases, and from this period, education becomes more important in the child's development.

Optimum support for human development from childhood through education and developmental activities is essential for the formation of a healthy lifestyle and improving the quality of life. The fundament of human development is physical development. For this reason, we measured and compared changes in the physical development of children over 5 years.

When measuring the physical growth and development of children, the actual measurements were taken in the age groups of 11-14 years [4]. It includes

2

For processing the data results, the following methods were used: analysis of normal distribution, method of calculation and comparison of average values (Anova, T-test, standard method of calculation of scores, chi-square criterion), method of calculation of factors of influence (correlation), method of factor analysis, tables and graphs [1]

Ability correlation was determined using SPSS and SPSS-Amos programs, confirmatory and test factor analysis, multivariate regression analysis, Pearson and Spearman correlation coefficients. Analysis was performed by replacing missing values with an approximate mean, if necessary [2].

When calculating the impact factor, correlation, regression and non-parametric analysis were used to identify differences in data and influencing factors.

The reliability and validity of the test were determined.

Research data was collected in printed and digital forms, covering 16 schools in 5 provinces and 7 districts of Ulaanbaatar city. The research was carried out by a two-stage, simple random sampling method. The sampling design was determined according to the same principles as in previous research. The report on Research 1 concluded that the margin of error and design effect for key parameters were within the range estimated for the schools researched, and therefore no change in sample size or design was necessary [1].

Stage 1: Choosing schools

Schools were selected from 7 districts of Ulaanbaatar (Bagankhangai district does not meet the sample requirements, and Baganuur district can be included as remote region). When selecting schools, a systematic method was used, assuming that there would be 2 schools, at least 1 province from each region, 2 soum schools within the province, and 2 schools in the center of the province.

Step 2: Selection of respondents

The primary sample unit or the research participant was selected by simple random sampling and the remaining number of respondents was selected from the respondents who were eligible (except for health or other reasons) of that age group using a RNG (random number generator) application [5].

Sampling size

The sample size is calculated using the following formula from the respondets who can participate in the research with equal probability.

$$n = \frac{z^2 p(1-p)}{e^2} deff$$

n - the number of respondents or sample size

z - statistical value to determine the desired level of significance

p - the percentage of the key indicator to be measured in the research

deff – an indicator that increases the sample size by a certain percentage, taking into account the design effect, or the number of cases that are not included in the research for any reason

e - acceptable margin of error in the confidence interval

4952 children participated in the Research 2 as for the total sample size of the research.

Table 1. Number of children participating in the research, Research 2 (by age group)

Age group	The number of students		Total
	Province	Capital city	
11-14 years	966	384	1350
Total	3225	1439	4952

3

A total of more than 1000 children participated in the research, and we compared it by measuring and comparing it according to one sample according to the same methodology. Age and gender were assumed to be equal in the sample.

General physical development

Growth and development are two interrelated aspects of the same process taking place in the body. Growth is a change in the amount of growth in the body as a whole and in the size of individual organs. Development is a qualitative change in which the structure and organization of organs become functionally sophisticated. The growth and development of the body at each age stage is different depending on the internal metabolism of the body.

General physical development was assessed by weight, height, waist and chest circumferences.

Height: It is the most stable and complex of other parameters of physical development, and is characterized by steady and rapid growth at each age stage. The change in the child's height is a very important basic indicator to evaluate the child's health and growth in detail. A child's growth from birth increases approximately 3.5 times throughout life.
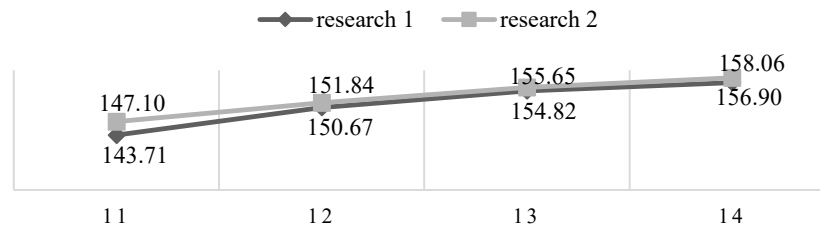

Fig. 1. Height mean of girls aged 11-14 years as compared by Research 1 and Research 2 (cm)

Compared to the results of the previous research, the average height of boys aged 11-14 years has increased by 2.8-3.8 cm.

Weight: Body weight is changeable and unstable compared to height. It can be easily changed due to the influence of many internal and external factors, so it is the main indicator for assessing the health along with other indicators of physical growth and development.
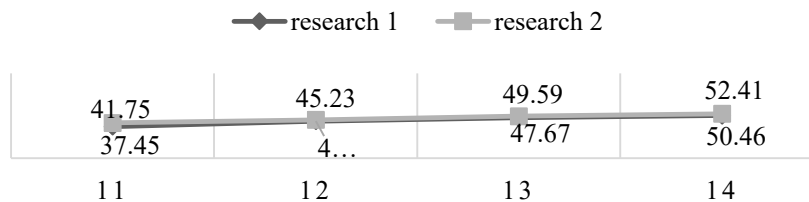
Fig. 2. Means for weight of girls aged 11-14 years as compared by Research 1 and Research 2 (kg)

Compared to the average figure 5 years ago, the body weight of girls increased by 3.03 - 4.3 kg per year from the age of 10. For boys, it increased the most at the age of 11, by 4.32 kg, and at the age of 12 and above, it increased by 4.1-3.35 kg.

BMI - body mass index - is one of the most important parameters to consider calculating body weight.

Table 2. Body mass index of female students

Among girls aged 11-14 years, 0.4% of children have obesity class of I and II, and 51.2% have normal weight.

Chest circumference: The size of the chest circumference is determined by the capacity of the chest, the development of the thorax and the subcutaneous fat. The size of the chest circumference is the main indicator of the healthy growth of the child.
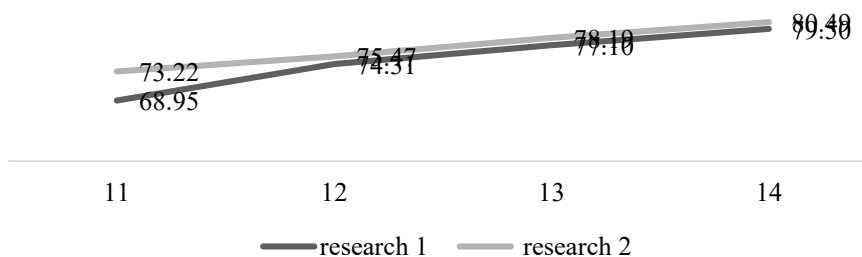

Fig. 3. Means for chest circumference of girls aged 11-14 years as compared by Research 1 and Research 2 (cm)

The chest circumference of girls increased by 4.27 by the age of 11. This indicator is similar to the increase in body weight with age. In boys, it increased by 2.57 - 3.76 cm at the age of 11-14.
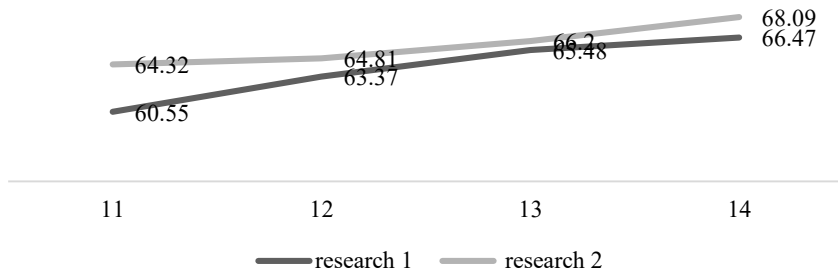

Fig. 4. Means for waist circumference of girls aged 11-14 years as compared by Research 1 and Research 2 (cm)

The waist circumference of girls increased the most at the age of 11, by 3.77 cm, the chest circumference and body weight increased by the same amount at this age. As for boys, it increased by 1.77-4.34 cm at the age of 11-14.
Physical fitness: It can be considered as a generalized indicator of the ability and practice of a person to master a specific goal. We looked at physical fitness in terms of left and right hand grip strength, speed, flexibility, agility, strength, and endurance.
Speed: Speed is the physical ability to repeat a specific movement in the shortest possible time. Speed is detected in 3 ways, and we measured it as a single movement speed.

Table 3. Statistics of speed, by age and gender, Research 2

11-14-year-old girls ran 10.0 seconds and boys 9.08 seconds, while 11-year-old girls ran 13.8 seconds and boys 15.9 seconds.
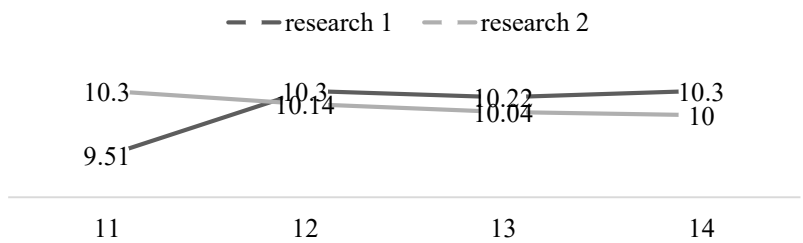

Fig. 5. Means for speed of 11-14 years old girls comparing Research 1 and Research 2 (sec)

Children aged 11-14 years old were measured by the time it took them to cover 50 m distance. In 11-year-olds, the speed slowed down by 0.8 seconds, and in 12-16-year-olds, it took the same amount of time. For boys, 11-year-olds slowed by 1.04 seconds, and 12-17-year-olds performed at the same pace as 5 years ago.

Flexibility: It refers to the ability to perform activities with maximum amplitude due to the amount of stretch of the muscles and tendons. Maximum range of motion is a measure of flexibility. In order to maintain flexibility for a long time, it is necessary to regularly perform various stretching exercises.
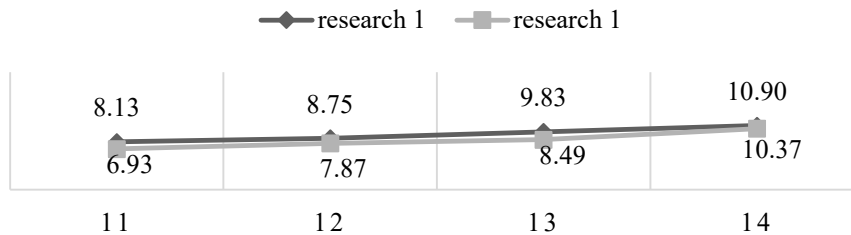
Fig. 6. Means for flexiblity of 11-14 years old girls comparing Research 1 and Research 2 (cm)

For girls, between 11 and 14 years of age, flexibility decreased by 1.2 cm to 0.96 cm per age. When comparing the average index of flexibility with the index of the previous research, it shows that it has decreased from 11 years to -13 years, and it has become stiff at the age of 14 years.
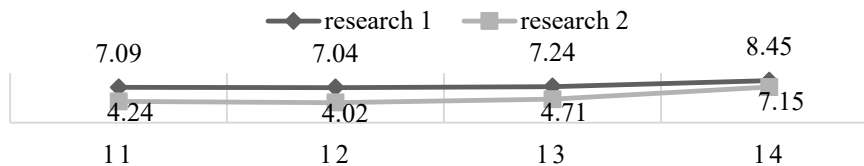

Fig. 7. Means for flexiblity of 11-14 years old boys comparing Research 1 and Research 2 (cm)

For boys, flexibility decreased by 1.77 cm to 3.24 cm per year comparing to the previous research (Research 1). This indicates that they are becoming inflexible and that flexibility needs to be supported through training activities.

Strength: refers to the ability to overcome external environmental resistance or negative action with the participation of muscle power. Strength is the basis for the development of all qualities of the human body. The quality of physical strength was determined by methods of determining the strength of the arms and legs.
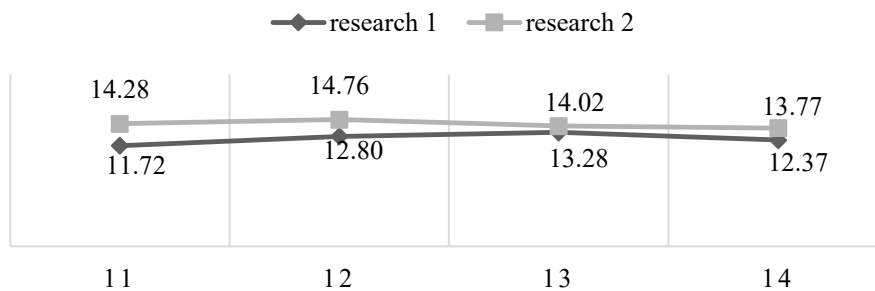

Figure 8. Means for push-ups of 11-14 years old girls comparing Research 1 and Research 2 (sec)

Grip strength of the right and left hands: The development of the palm of the hand is related to the development of the small muscles of the child, which is related to the ability to write.

As for girls, the average right and left hand grip strength was 2.01-3.12 kg less in each age group of 11-14 years, while it was the same as the results of the previous study in the age groups of 14-15 years. For left hand grip strength, average grip strength is the same for children aged 11-14.

The average grip strength of the left hand was 1.6-2.06 kg less at 11-12 years old, and 1.12-3.03 kg more at 13 years old. For boys, the grip strength of the right and left hands increased from the average of the research before the age of 13.

Leg Strength: Leg strength or dynamic lower-limb strength was measured with the farthest jump of 3 jumps.

Table 4. Leg Strength statistics, by age and gender
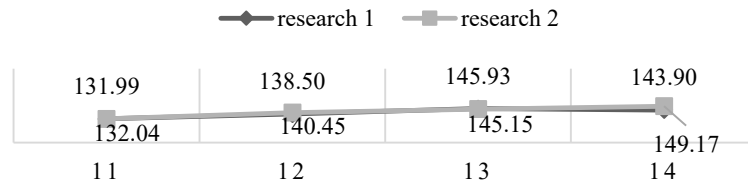
The leg strength of boys has been increasing by 9.62-13.86 cm with the age.

Fig. 9. Means for leg strength of 11-14 years old girls comparing Research 1 and Research 2 (cm)

Girls' leg strength was almost identical to Study 1, while boys' increased 5.27 cm at age 14.

Endurance: refers to the ability to work for a long time without reducing the intensity of work. We examined general endurance, or the ability to sustain moderate-intensity exercise for long periods of time under metabolically oxygenated conditions, in which most muscles are engaged.
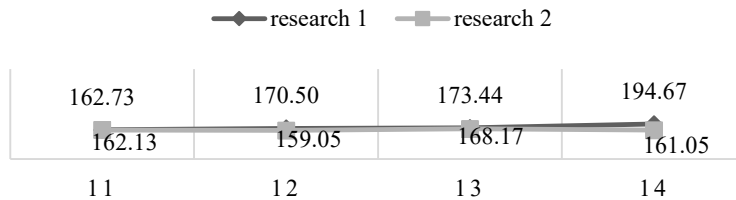
Fig. 10. Means for endurance of 11-14 years old girls comparing Research 1 and Research 2 (sec)

Depending on the age characteristics of the children, the ability to endure 300m, 500m, 800m, and 1000m distance was 20.88 seconds for 12-year-old boys and 29.08 seconds in 14-year-old boys.

According to the results of the research, there is a need to support the ability of girls to cover a certain distance with endurance at all ages, and there is a need to support flexibility at age 11, strength at age ages 12 and 14, and agility at age 12.

3.2. Factor analysis of physical development

The capital city and the province: In terms of fitness, local location had a significant impact on speed, flexibility, strength, and grip strength of the right and left hands.

Speed: As for children living in the center of Sumy, the speed is higher than children living in the center of the province and the capital (sum M=9.4, region M=9.7, capital M=9.8), and in terms of flexibility, children living in the capital have poor performance (M = 4.5), while children living in the center of the province have good flexibility (M = 7.5).

Strength: as for children living in soum centers M=19.2, while M=16.6 and M=17.2 for children living in the capital and provincial centers, which indicates good hand strength in children living in soums compared to children living in the capital and provinces.

Place of residence: For children living at home, M=153.9 is higher (p<.001) than children living in other boarding houses, relatives and grandparents, while the height of children living in families they know is 11.5 cm lower than children living at home. shows the importance of children living in the family.

Home to school: Children who come to school by taxi M=53.3 or by private car M= 47.6 weigh 3.2 kg to 7.8 kg more than children who come to school by public transport by school bus M=42.8 (p<.001).

Bedtime: Children who go to bed at 8 pm (M= 41.1) weigh 7.8 kg less than children who go to bed at 11 pm (M=48.9). (p<.001) Similarly, the chest circumference of children who go to bed at 8 pm (M= 72.6) is 5.4 cm smaller than that of children who fall asleep late (p<.001). In terms of right and left hand grip strength, children who went to bed after 11 pm (M= 19.4) had 4.3 kg less grip than children who went to bed after 8 pm.

Family income: The body height (M=151.1- M=157.6) increases by 9.5-6.5 cm with the increase of family monthly income (over 1,500,000). As family income increases, children's chest circumference increases by 4.3-2.1 cm (p<.001).

General physical development

Physical fitness

Authors' Contributions. All authors contributed in this article and readan agreed to the published version of the manuscript.

1.   Begz,N., Sanjaabadam,S., Enkhbayar,B., Bayarmaa,B., Lkhagvasuren,Ts., Bayasgalan,E. (2023). Physical, socio-emotional and cognitive development characteristics of Mongolian children. Monograph. Ulaanbaatar.
     egz,N., Sanjaabadam,S., Enkhbayar,B., Lkhagvasuren,Ts., Bayarmaa,B., Bayarsaikhan,B. (2018). Theory and methodology of child and youth development. Monograph. Ulaanbaatar.
     ахнарович, А.М., Юрьева, М.Н., (1990). Психолингвистический анализ семантики и грамматики.

5.   B. Sarah , W. Krista, & F. Jacob (2011). Development of Emotional Competencies in Children with Complex Communication Needs: Implications for Practice and Research (pp 22-34) from www.ebookbrowsee.net