Morphofunctional Development of Tyvan and Russian Schoolchildren

V. A. Krasil’nikova, L. K. Buduk-ool, and R. I. Aizman

Tyvan State University, Kyzyl, Republic of Tyva, Russia
Novosibirsk State Pedagogical University, Novosibirsk, 630126 Russia

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Abstract—The specific features of the physical development and functional capacity of the cardiorespiratory system of young schoolchildren living in the Republic of Tyva (formerly, Tuva) as dependent on the sex, ethnicity, and social conditions were studied. Acceleration processes in the physical development of Tyvan children aged 8–11 years during the past 35 years were identified. It was shown that morphological adaptation to climatic conditions was more obvious in schoolchildren of both ethnic groups living in the countryside as compared to those in urban areas: they had a smaller total body size, stronger physique, and better developed chest. Analysis of the functional capacity of the cardiorespiratory system showed that Tyvan children had higher reserves of the cardiorespiratory system as estimated by the vital index, pulmonary capacity, stroke volume, and cardiac output than Russian children of the same age. Sex-dependent differences in the morphofunctional development of children of both ethnic groups become evident beginning from the age of nine years.

INTRODUCTION

Human ontogeny is determined by the combined action of three kinds of programs: genetic, individual, and ecological. The genetic programs of humans comprise a number of aspects, including the species-, genus-, and order-specific characters of Homo sapiens, as well as race- and sex-specific and individual characters [1]. Some diagnostic racial characters have been formed under the effect of the environment in which a race lives. As each landscape zone is inhabited, as a rule, by people of different ethnic groups or even races, this circumstance facilitates the study of the effect of the environment on human populations because it makes it possible to identify parallelism in the responses of different ethnic communities to environmental effects and, at the same time, determine whether these responses are genetically programmed [2]. One of the trends in studying the effect of the environment on humans is also analysis of the morphological variation in rural and urban populations living under different social and economic conditions [3]. In this respect, the Republic of Tyva is a natural testing ground in which morphofunctional and psychophysiological adaptations of different ethnic groups can be studied. At present, such studies have been done with adolescents [4–7], whereas the earlier period of ontogeny remains virtually unstudied.

Therefore, the objective of this study was to compare morphofunctional features of young schoolchildren of the Tyvan and Russian ethnic groups.

METHODS

In 2001–2005, we studied the main morphofunctional characteristics of Tyvan and Russian children attending school (years 2–4) in the Republic of Tyva. A total of 1916 children aged 8–11 years in the city of Kyzyl and rural areas were studied. All children were divided into groups according to sex, age, and ethnicity. The age was determined in conformity with the generally accepted standards, and the ethnicity, by the ethnicity of both parents. The evaluation of the morphofunctional status was based on the following parameters.

(1) Evaluation of the physical development by the generally accepted methods of Stavitskaya and Aron [8]. We determined the total body size parameters (the height, weight, and chest circumference (CC)) and calculated the Quetelet weight–height index for evaluating the physique and the Erisman index for evaluating chest development.

(2) Evaluation of the functional status of the cardiorespiratory system by the heart rate (HR), blood pressure (BP), and pulmonary capacity (PC). Reference values of PC (RPC) were determined and compared with actual data (PC in percent of RPC); the other parameters that we estimated were the vital index (VI, PC/kg body weight), pulse pressure (PP), stroke volume (SV), and cardiac output (CO) calculated using Starr’s formula modified by Pugina and Bomash [9].

All the results were processed by the methods of mathematical statistics using the nonparametric Wilcoxon–Mann–Whitney test for independent samples (the Statistica 6 software).
RESULTS AND DISCUSSION

Analysis of morphological characteristics demonstrated anthropometric differences between Tyvan and Russian schoolchildren. For example, we found that Tyvan children had a shorter body, lower weight, and smaller CC (Table 1). The human body height is known to be under stronger genetic control [10, 11]; therefore, in all probability, the smaller linear dimensions of Tyvan boys and girls as compared to their Russian counterparts reflect specific features of the Asian race.

Individual estimation of the body weight by the Quetelet index showed that children with a normal body weight prevailed among Russian schoolchildren living in urban areas and children with high and low body weights among urban Tyvan children. The number of low-body-weight children decreased with age among Tyvan and Russian boys living both in urban and in rural areas; on the contrary, their number increased among Russian girls in urban areas (Fig. 1). In the literature, the body weight, in contrast to the body height, is generally considered to be a more labile indicator, which varies quickly under different external conditions [1, 12].

In this connection, an increase in the number of Tyvan schoolchildren with low body weights living in rural areas may be accounted for by worse socioeconomic conditions. This may also be the reason why children in the countryside are not as tall as children of the same age in urban areas (Table 1).

It is known that a wider chest relative to shorter limbs causes “emphysematous” dilatation of the lungs and improves alveolar diffusing capacity in aboriginals of the Far North and high mountains [13]. Despite the smaller CC of Tyvan schoolchildren, good development of the chest among them is a more frequent phenomenon than among their Russian counterparts. There were more narrow-chested children in cities and towns, whereas a well-developed chest was more common for village children of both ethnic groups. With age, the number of narrow-chested children decreased among Tyvan children and Russian boys and increased among Russian girls (Fig. 2).

Since severe climatic factors are somewhat mitigated by the comfortable living conditions of towns and cities, morphological adaptations are more obvious among people in rural areas; “northern children” (ethnic Russians from rural populations) are stockier and more thickset [14]. At the same time, the lack of statistically significant differences in the yearly CC increase (in Russian children and Tyvan girls) in comparison with the increase in the body weight and height can be regarded as weakening of the physique under the conditions of the severe ultracontinental climate of central Asia.

The study of the yearly increase in the total body size showed that growth processes were slower in Tyvan children. This points to peculiar trends of physical development of Tyvan children, which is confirmed by published data [15].

Comparative analysis of the time course of the physical development of Tyvan schoolchildren (Fig. 3) during the past 35 years allows a conclusion to be drawn regarding an ongoing acceleration process, although a negative trend in the body weight parameters is observed among 11-year-old girls. This is probably a consequence of the “emotional impact of mass media, which publicize an ideal and fashionable figure” [12]. Probably, this explains why the number of girls with a disharmoniously developed body increases with age. Consequently, the acceleration relates to a greater extent to the body height of Tyvan children.

Thus, despite the high average values of the total body size of Tyvan schoolchildren living in urban areas...