Research Article

Influence of Hard Drinking Water with High Content of Calcium, Magnesium and Sodium on Morphofunctional Development of Prepuberty Age Children

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Abstract

The article describes the effect of long-term consumption of drinking water with high content of vital cations of calcium, magnesium and sodium on physical development of adolescents 11 - 12-years old. In the examined children, compared with the control group, there was found a decrease in the level of physical development, relative strength, volume of external respiration and functional reserves of the cardiovascular system.

Keywords: Drinking Water; Vital Cations; Physical Development of Adolescents; Cardiorespiratory System

Introduction

The multicomponent nature of the environment in which a child grows and develops has influence on ontogenesis as a complex process [1-5]. These facts show that the state of the child's body can serve as an indicator of unfavorable conditions for the implementation of ontogenesis.

Aim of the Study

Based on the above, one of the main goals of the study was to assess the impact of the water factor on the physical development of children and the functional state of the cardio-vascular and respiratory systems.

Methods

The selection of districts in the Novosibirsk region for research was carried out on the basis of available data from the Novosibirsk Research Institute of Hygiene and was a part of a comprehensive study of the impact of man-made and natural environmental factors on the health of the population. Thus, the children of Verh-Irmen village (n = 80) were recognized as a control group (the content of calcium in drinking water was 65,9 ± 4,3, magnesium - 37,5 ± 2,4, sodium-61,2 ± 6,1 mg/L) and the quality of drinking water corresponded to the Sanitary Norms; and the children from Vengerovo (n = 61) consumed the water with increased content level of vital cations (calcium- 80,8 ± 5,2, magnesium- 55,1 ± 5,6, and sodium-224,6 ± 22,5 mg/L) - the experimental group. Children (boys and girls) of 11 - 12 -years-old having the 1-st-2-d health groups, without acute diseases at the time of the survey were selected for the examination of the physical development and physiological state of cardiorespiratory system.

The main anthropometric indicators: body length (BL), body weight (BW), chest circumference (CC) were measured using conventional methods and the Ketle Index (IK) was calculated (BW, kg/BL, m^2). Functional indicators of cardiorespiratory system: heart rate (HR), systolic (SBP) and diastolic (DBP) blood pressure, the cardiovascular system index during the functional test Rufe (RI) (30 squats in 45 sec with subsequent pulse rate estimation us-

Influence of Hard Drinking Water with High Content of Calcium, Magnesium and Sodium on Morphofunctional Development of Prepuberty Age Children

77

ing the formula: RI = [4x(HR$_1$+HR$_2$+HR$_3$)-200]:10), where: HR$_1$ at rest; HR$_2$ after 30 squats, and HR$_3$ in 30 sec after HR$_2$ estimation); chronotropic heart reserve (HRC= HR$_2$. - HR$_1$, beats/min), lung vital capacity (LVC), life index (LI= LVC/BW), the efficiency of blood circulation (EBC= SBPx100/HR$_1$), as well such physical parameters: the strength of the muscles of the hand and back (HS), hand index (HI= HS/BW), back power (BP), back power index (BPI= BP/BW) were determined by the comprehensive health assessment program [6].

Statistical analysis of the study results was performed using the nonparametric Wilcoxon-Mann-Whitney U-test for independent samples when comparing different groups, as well as standard programs of the Statistics 10 package; the differences were considered significant at p < 0.05.

Results and Discussion

According to the main indicators of physical development, the children studied corresponded to the normative parameters, which indicated the representativeness of the groups selected for the survey (Table 1).

When assessing the morphofunctional parameters of schoolchildren from Verh-Irmen and Vengerovo schools, gender and regional differences were established. The 12-year-old boys from both regions had higher indicators of physical development (BL, BW, IK) and lung vital capacity (LVC) than 11-year-old ones. At the same time, it should be noted that there were no significant differences in the cardiovascular system parameters (HR, SBP, DBP, Rufe index, CR, EBC) between 11-and 12 - years-old boys.

But 11-year-old pupils in the Vengerovo village revealed a low relative indicators of strength capabilities and external respiration system (LVC, LI), while 12-year-olds demonstrated reduction of functional reserves of cardiovascular system (a higher value of the Rufe-index) compared to peers of Verh-Irmen control groups (Table 2).

The analysis of morphofunctional indicators of girls of the Verh-Irmen school showed that all absolute and relative parameters of physical development in 12-year-old girls had higher values than in

Parameters	Village Verh-Irmen (n = 80)	Village Vengerovo (n = 61)
Body length, cm	149,7 ± 2,0	147,6 ± 1,5
Body weight, kg	44,8 ± 2,4	43,9 ± 3,1
Ketle Index, kg/m^2	19,8 ± 0,9	19,9 ± 1,1

Table 1: Indicators of physical development of pupils aged 11 - 12 years who participated in the survey (M ± δ).

Age	11 years		12 years	
Area of residence Parameter	Verh-Irmen	Vengerovo	Verh-Irmen	Vengerovo
BL, cm	143,9 ± 2,1	145,8 ± 2,2	149,4 ± 1,5*	149,4 ± 1,2*
BW, kg	36,2 ± 2,4	41,1 ± 2,8	47,8 ± 3,2*	42,9 ± 1,9#
CC, cm	66,9 ± 1,5	70,7 ± 2,0	73,7 ± 2,0*	72,5 ± 1,6
Kettle Index, kg/m^2	17,4 ± 0,7	19,1 ± 1,0#	21,1 ± 1,2*	19,2 ± 0,7#
HS, kg	21,4 ± 1,3	19,1 ± 1,8	24,3 ± 1,6	23,4 ± 1,1*
HI, kg/kg	61,2 ± 4,0	45,6 ± 3,1#	50,6 ± 2,0*	53,3 ± 2,2*
LVC, mL	1850 ± 133	1489 ± 88#	2111 ± 83*	1500 ± 98#
LI, mL/kg	51,4 ± 2,4	37,8 ± 2,4#	46,2 ± 2,2*	35,9 ± 2,4#
BP, kg	45,2 ± 3,7	41,5 ± 4,0	49,2 ± 2,3	45,4 ± 2,4
BPI, kg/kg	1,27 ± 0,11	1,01 ± 0,07#	1,07 ± 0,05*	1,07 ± 0,06
SBP, mm.Hg	113,5 ± 2,5	112,8 ± 2,7	115,8 ± 3,1	112,5 ± 2,4
DBP, mm.Hg	71,0 ± 2,3	66,3 ± 2,0	72,4 ± 1,5	69,5 ± 1,6
HRC, beats/min	97,5 ± 5,7	92,5 ± 3,8	102,4 ± 4,3	94,3 ± 5,2
Rufe index, conventional units	11,5 ± 1,1	12,4 ± 1,1	12,1 ± 0,5	14,8 ± 1,0*#
EBC, conventional units	134,7 ± 6,5	139,5 ± 4,7	132,1 ± 3,3	138,5 ± 5,2

Table 2: Morphofunctional parameters of boys aged 11-12 years of Verh-Irmen and Vengerovo schools (M ± m). Note: Differences are statistically significant at p < 0.05: *: Between 11 and 12-year-old boys in the same district; #: Between subjects of the same age in different districts.

Influence of Hard Drinking Water with High Content of Calcium, Magnesium and Sodium on Morphofunctional Development of Prepuberty Age Children

78

11-year-old ones, that was consistent with traditional ideas about the stages of ontogenesis. However, there were no significant differences in the indicators of the cardiovascular system at relative rest and at standard physical activity - test Rufe (Table 3).

Morphofunctional indicators of girls aged 11 - 12 years of Vengerovo school differed from schoolgirls of Verh-Irmen village. In 11-year-old girls from Vengerovo it was revealed the lower values of indicators of the respiratory system (LVC, LI) and the car-

Age	11 years		12 years	
Area of residence	**Verh-Irmen**	**Vengerovo**	**Verh-Irmen**	**Vengerovo**
Parameter				
BL, cm	146,3 ± 2,1	148,1 ± 3,0	152,8 ± 1,3*	154,1 ± 2,6*
BW, kg	40,1 ± 2,3	40,7 ± 4,2	44,5 ± 2,2*	45,8 ± 3,7
CC, cm	70,4 ± 1,8	69,6 ± 3,2	72,9 ± 1,7	72,9 ± 2,8
Kettle Index, kg/m^2	18,5 ± 0,7	18,2 ± 1,3	19,1 ± 0,9	19,2 ± 1,3
HS, kg	18,8 ± 0,9	18,9 ± 1,5	24,5 ± 1,4*	19,6 ± 1,1#
HI, kg/kg	46,6 ± 2,0	46,6 ± 1,9	53,5 ± 3,4*	41,4 ± 3,1*#
LVC, mL	1794 ± 77	1438 ± 115#	2100 ± 57*	1565 ± 131#
LI, mL/kg	45,6 ± 1,5	37,5 ± 2,7#	48,2 ± 2,1	34,5 ± 2,0#
BP, kg	32,8 ± 2,3	29,4 ± 3,1	43,2 ± 4,1*	31,1 ± 2,6#
BPI, kg/kg	0,83 ± 0,05	0,75 ± 0,07	0,97 ± 0,08*	0,69 ± 0,05#
SBP, mm.Hg	111,9 ± 2,7	112,8 ± 5,0	112,1 ± 3,6	112,0 ± 2,4
DBP, mm.Hg	72,4 ± 1,6	74,4 ± 2,8	72,5 ± 3,0	70,5 ± 2,4
HRC, beats/min	96,9 ± 4,9	109,7 ± 7,1#	98,4 ± 6,0	95,0 ± 5,9*
Rufe index, conventional units	11,3 ± 1,0	17,5 ± 1,4#	11,3 ± 1,0	15,5 ± 1,3#
EBC, conventional units	132,0 ± 4,4	118,5 ± 8,5#	131,4 ± 6,6	135,1 ± 6,3*

Table 3: *Morphofunctional parameters of girls aged 11-12 years of Verh Irmen and Vengerovo schools (M ± m).*

Note: Differences are statistically significant at p<0.05: *: Between 11 and 12-year-old girls in the same district; #: Between subjects of the same age in different districts.

diovascular system (HRC, Rufe index), compared with the peers of control village Verh-Irmen. In 12-year-old girls of the experimental district, the lower parameters of the HI, BPI and LI were found, which was due to low values of absolute indicators. They also showed a decrease in EBC, that indicated a deterioration in the functional state of the cardiovascular system and its smaller functional reserves (Rufier test). compared with the subjects in the control area - Verh-Irmen village.

Thus, the described results indicated a lower level of morphofunctional development of 11 - 12 years old children of both sexes in the Vengerovo school compared to the control area.

Conclusion

Since the socio-economic and climate geographic conditions of living in both areas of the same region were almost identical, the data obtained indicated an adverse effect of long-term consumption of hard drinking water with excessive content of vital cations on the morphofunctional development of children of puberty age.

Conflicts of Interest

There are no conflicts of interest.

Influence of Hard Drinking Water with High Content of Calcium, Magnesium and Sodium on Morphofunctional Development of Prepuberty Age Children

79

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