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Changes in cardiovascular risk factors among adolescents from 1995 to 2004 in the Republic of Karelia, Russia

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Background: In Russia, cardiovascular mortality is among the highest in the world. Behaviours related to the development of cardiovascular disease are usually adopted in childhood and adolescence. Very little information exists on prevalence and trends of risk factors among Russian youth. This study aims to investigate changes in the prevalence of cardiovascular risk factors among adolescents in the Republic of Karelia, Russia, from 1995 to 2004.

Methods: Cross-sectional surveys on chronic disease risk factors were carried out among 15-year-old adolescents in Pitkäranta region, in the Republic of Karelia. The surveys were conducted in all 10 secondary schools in the Pitkäranta region. All ninth-grade students in 1995 ($N = 385$, response rate 95%) and in 2004 ($N = 395$, response rate 85%) were included in the survey samples.

Results: Systolic blood pressure decreased statistically significantly among boys (from 119 to 116 mmHg). Diastolic blood pressure decreased statistically significantly among both girls (from 64 to 59 mmHg) and boys (from 62 to 59 mmHg). Total cholesterol increased statistically significantly only among girls (from 3.9 to 4.1 mmol/l). Body mass index did not exhibit any significant changes in both genders. Daily smoking rate doubled statistically significantly among girls from 7% to 15%. **Conclusion:** The study results show changes in the prevalence of cardiovascular disease risk factors among adolescents in the Republic of Karelia occurring over the last decade. Active measures need to be taken to prevent the increase in smoking prevalence, especially among girls, and to avert the unfavourable development of other risk factors in the future.

Keywords: adolescents, cardiovascular disease, health behaviour, population survey, risk factors

Mortality from cardiovascular disease has declined in the developed countries even though, heart attack and stroke remain leading causes of death.[1] Most of the cardiovascular disease events nowadays are taking place in low- and middle income countries, posing a new challenge for public health. Since the prevalence of risk factors is quite high in these countries.[2]

Atherosclerosis has its origin in childhood. Levels of risk factors found in early life and in adolescence correlate with those observed later in adulthood.[3–9] Infants in ethnic populations with a high mortality from coronary heart disease have thicker inner vascular layers in their coronary arteries.[10] Hypertension, hypercholesterolemia, and overweight are usually tolerated at a younger age and barely perceived as harmful. However, over time these conditions can lead to excessive morbidity and mortality from cardiovascular causes.[11] Exposure to cardiovascular risk factors early in life have been demonstrated to induce permanent changes in the arteries that contribute to the development of atherosclerosis.[12–14] Assessment of the risk factor profile in adolescents has been shown to predict adult common carotid artery intima-media thickness independently of the presence of risk factors occurring in adulthood.[15]

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The development of major cardiovascular risk factors at an early age is closely related to health behaviour. Dietary habits, smoking, and physical inactivity all play major roles. Lifestyles are adopted early in life, embedded in the social and cultural environment, and represent a serious obstacle in CVD interventions since they are difficult to change.[16]

In the Russian population, cardiovascular disease is the leading cause of mortality, and the rates appear to be among the highest in the world. They account for more than half of the east-west gap in life expectancy in Europe.[17] In 2004, all-cause mortality per 100 000 population in Russia was 1598, with more than half of these deaths attributable to diseases of the heart and circulatory system.[18]

The Republic of Karelia is located in the North-West of Russia. The Republic is neighboured in the West by Finland, in the North by the Murmansk region, in the East by the Archangelsk region, in the South by the Leningrad and Vologda regions of Russian Federation.[18]

The patterns of mortality from cardiovascular disease vary across the Russian Federation. Some regions have much higher mortality rates than others. The Republic of Karelia belongs to those regions with high cardiovascular disease mortality rate: in 2003 it was 1004 per 100 000 population compared to 895 in whole Federation. The average life expectancy in the Republic of Karelia is 54 years for men and 69 years for women.[19]

Very little is known on prevalence and trends of cardiovascular disease risk factors among adolescents in the Russian Federation.[20,21] Conducted studies investigated behavioural risk factors of cardiovascular disease, but the data have been based on self-reports.[22–26]

There have been no recent studies on the prevalence of biological risk factors in connection with related behaviour and social context among Russian adolescents. As cardiovascular risk factors develop already at an early age, the understanding

of the development of risk factors among youth is essential for the prevention planning and policy adjustment. Such information can reliably be gathered only through population risk factor surveys. The aim of the present study was to determine the prevalence of biological (blood pressure, cholesterol, body mass index) and behavioural (smoking) risk factors and describe their changes among 15-year-old adolescents in Pitkäranta, Republic of Karelia from 1995 to 2004.

Materials and methods

In 1995 and 2004, surveys evaluating cardiovascular risk factors were carried out among school children in the Republic of Karelia, Russia. The Pitkäranta district was chosen as the study area, because according to the statistical information it is relatively typical area in the Republic of Karelia with respect to the demographics, economical structure and urbanisation rate. In Pitkäranta region, in addition to one town, there are seven villages, which each have their own school. The 1995 study was carried out in connection with the cardiovascular health survey conducted among children in eastern Finland by the National Public Health Institute in 1984, 1987, 1988, and 1995.[27,28] In 2004, the study was not repeated in Finland.

The survey methods were based on the World Health Organisation protocol 'Atherosclerosis Precursors in Children' (WHO 1978). The methods were identical in both survey years. The study population in 1995 and 2004 was ninth-grade students from all 10 comprehensive schools in the Pitkäranta district in the Republic of Karelia. In 1995, the initial sample was 385 students with 95% response rate. In 2004, the study sample comprised 395 students with 85% response rate. The mean age for boys was 15.3 years in 1995 and 15.6 years in 2004 and for girls was 15.2 years in 1995 and 15.7 years in 2004. The survey included a self-administered questionnaire translated and adjusted for local circumstances, physical measurements, and laboratory analyses of blood samples. In both years, specially trained researchers distributed the questionnaires and carried out the measurements in the schools. A standardised questionnaire was initially developed and piloted in North Karelia in Finland for North Karelia Youth Study. It consisted of mainly precoded answers, included sections on physical activity, smoking, nutrition, alcohol consumption, and self-reported symptoms.[27] This questionnaire was translated into the Russian language with minor adjustments for the local cultural circumstances. Informed consent was received from the respondents and their parents after they were informed of the anonymity and confidentiality of the procedures.

Blood pressure was measured after 5 min rest, in the sitting position, from the right arm of the subject by a mercury sphygmomanometer (Riester, Diplomat presameter, Germany) with 12 cm × 35 cm cuff. The appearance of Korotkoff sounds was taken as systolic blood pressure (SBP) and the Korotkoff fifth phase (the disappearance of sounds) was recorded as the diastolic blood pressure (DBP). Blood pressure was measured two times at least one minute apart and the average value of the measurements was used in the present analyses.

To measure serum total cholesterol and high-density lipoprotein (HDL), a venous blood specimen of non-fasting subjects was taken to a 10 ml tube in a sitting position. Serum was separated after at least 20 min clotting time and then transferred to the National Public Health Institute in Helsinki. Serum lipids were determined using an enzymatic method (CHOD-PAP, Boehringer Mannheim, Monotest). Before analysis, HDL-cholesterol was precipitated from the sample by the PTA-precipitation method. All laboratory analyses were made from fresh serum samples in the Department of Biochemistry at the National Public Health Institute of Finland in Helsinki. The Laboratory is accredited and standardised against national and international reference laboratories.

Smoking was assessed using a standard set of questions in the self-administered questionnaire. Participants were divided into four categories according to the frequency of tobacco consumption. Those who have not been smoking at the time of surveys were classified as non-smokers. Occasional smokers were divided into two sub-categories: those smoking once a week and those smoking once a month. Participants who reported smoking every day were classified as daily smokers.

Weight and height were measured for the calculation of body mass index. Weight was measured using a beam balance scale in light clothing to an accuracy of 0.1 kg. Height was measured without shoes with a stadiometer to an accuracy of 0.1 cm.

Statistics

Means and frequencies were computed and analysed by gender and survey year. Differences in continuous variables between survey years were tested by *t*-test. Chi-square test was used for assessment of difference in prevalence rates between survey years. For all continuous variables 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles were computed. For BMI, also 85th percentile was calculated. All statistical analyses were performed using the statistical software SPSS for Windows (release 13.0).

Results

Blood pressure

The mean systolic blood pressure (SPB) had decreased among both boys and girls from 1995 to 2004, but the difference was statistically significant only among boys: 119 mmHg in 1995 and 116 mmHg in 2004, $p = 0.011$. A general decrease in cut-off points of all of the assessed percentiles had occurred in both genders in 2004 compared to 1995. Mean diastolic blood pressure (DBP) decreased from 1995 statistically significantly among both genders. Also for DBP, the cut-off points of percentiles generally decreased among girls and boys (Table 1).

Serum lipids

A statistically significant increase in total cholesterol levels was observed only among girls. In 1995, mean total cholesterol had been 3.9 mmo/l and it was 4.1 mmo/l in 2004. Among boys the mean total cholesterol level of 3.6 mmol/l did not change. The mean of high-density cholesterol statistically significantly increased between the survey years in both genders. The mean levels of high-density cholesterol for girls had been 1.2 mmol/l in 1995 and it was 1.4 mmol/l in 2004. In boys, the respective HDL-cholesterol levels were 1.0 mmol/l in 1995 and 1.2 mmol/l in 2004 (Table 2).

Smoking

The proportion of daily smokers increased statistically significantly among girls; it doubled between the years 1995 and 2004. The numbers of non-smokers decreased among girls and boys between 1995 and 2004. The number of occasional (monthly) smokers increased among boys and slightly decreased among girls (Table 3).

Height, weight, and body mass index (BMI)

Girls were slightly taller in 1995 than in 2004. A statistically significant increase in the mean height was observed only among boys; in 1995 the average height was 168 cm and in 2004 the average height was 171 cm.

Table 1 Percentile values and mean (±SD) of systolic and diastolic blood pressure (mmHg) in 1995 and 2004

	Systolic BP (mmHg)						Diastolic BP (mmHg)					
	Girls			Boys			Girls			Boys		
Percentiles	1995	2004	*t*-test	1995	2004	*t*-test	1995	2004	*t*-test	1995	2004	*t*-test
5	97	98		100	98		50	48		46	45	
10	101	101		103	102		54	49		51	49	
25	107	106		110	107		58	53		56	53	
50	113	113		119	115		64	59		61	59	
75	123	119		127	123		70	64		69	64	
90	128	126		134	129		76	69		75	70	
95	134	130		143	136		79	75		78	73	
Mean ± SD	115 ± 11	113 ± 9	$p = 0.072$	119 ± 12	116 ± 11	$p = 0.011$	64 ± 8	59 ± 8	$p < 0.001$	62 ± 10	59 ± 8	$p = 0.001$
N	182	168		165	168		182	168		165	168	

Table 2 Percentile values and mean (±SD) of serum total and HDL-cholesterol (mmol/l) in 1995 and 2004

	Cholesterol mmol/l						HDL-Cholesterol mmol/l					
	Girls			Boys			Girls			Boys		
Percentiles	1995	2004	*t*-test	1995	2004	*t*-test	1995	2004	*t*-test	1995	2004	*t*-test
5	2.8	3.0		2.7	2.7		0.8	1.0		0.7	0.8	
10	3.0	3.2		2.9	2.9		0.9	1.0		0.8	0.9	
25	3.4	3.7		3.2	3.1		1.2	1.1		0.9	1.0	
50	3.8	4.1		3.6	3.5		1.2	1.4		1.0	1.2	
75	4.3	4.5		3.9	4.0		1.3	1.6		1.2	1.3	
90	4.9	4.9		4.5	4.2		1.5	1.7		1.3	1.5	
95	5.0	5.1		4.7	4.8		1.5	1.8		1.4	1.6	
Mean ± SD	3.9 ± 0.7	4.1 ± 0.7	*p = 0.006*	3.6 ± 0.7	3.6 ± 0.6	*p = 0.860*	1.2 ± 0.2	1.4 ± 0.3	*p < 0.001*	1.0 ± 0.2	1.2 ± 0.3	*p < 0.001*
N	179	157		164	162		179	157		164	162	

Table 3 Smoking prevalence (%) by gender and year

	Girls		Boys	
	1995	2004	1995	2004
Non-smoker	85	78	64	57
Occasional, 1–2 times/ month or less	6	2	3	7
Occasional 1–2 times/week	2	5	3	5
Daily smoker	7	15	29	31
Total	100	100	100	100
Chi-square	$\chi^2 = 12.3$	$p < 0.015$	$\chi^2 = 7.6$	$p = 0.104$

The mean weight among girls increased from 51.1 kg in 1995 to 52.7 kg in 2004. Among boys mean weight was 55.1 kg in 1995 and 58.0 kg in 2004. The difference in mean weight between the survey years was statistically significant only among boys.

There were no statistically significant changes in the mean BMI between 1995 and 2004. The mean BMI among girls was 19.7 kg/m^2 in 1995 and 20.1 kg/m^2 in 2004. The mean BMI among boys did not change between the survey years. The mean BMI in boys was 19.6 kg/m^2 in 1995 and 19.7kg/m^2 in 2004 (Table 4).

Discussion

A comprehensive investigation of biological and behavioural risk factors of cardiovascular disease was carried out among adolescents in Pitkäranta in 1995 and 2004. Some changes were revealed in cardiovascular disease risk factor profile. Mean systolic and diastolic blood pressure levels decreased among both genders. Total cholesterol level increased slightly only among the girls. High-density cholesterol level increased statistically significantly in both girls and boys. Smoking prevalence doubled among girls but no changes observed among boys. The mean weight as well as body mass index increased very slightly among girls, while the mean height increased statistically significantly only among boys.

The strengths of these surveys were coverage by survey of all adolescents from a single age group (15-year-old) from the area of Pitkäranta and high participation rates. Sample size in these studies was quite small, but big enough to analyse differences reaching public health value. Self-administered questionnaires bring anonymity to respondents and privacy

Table 4 Percentile values and mean (± SD) of height (cm), weight (kg) and BMI (kg/m^2) in 1995 and 2004

	Height (cm)			Weight (kg)			BMI (kg/m^2)		
Percentiles	1995	2004	*t*-test	1995	2004	*t*-test	1995	2004	*t*-test
Girls									
5	152	152		40.0	41.7		16.1	16.3	
10	154	154		41.9	43.3		16.8	17.1	
25	158	158		45.6	47.5		17.8	18.3	
50	161	162		50.3	51.6		19.2	19.7	
75	165	166		55.3	56.8		21.1	21.6	
85	167	168		60.2	60.0		22.4	22.9	
90	168	169		61.9	62.0		23.1	23.6	
95	174	180		76.7	81.3		24.0	25.1	
Mean ± SD	161 ± 5.7	162 ± 6.2	$p = 0.295$	51.1 ± 7.7	52.7 ± 8.1	$p = 0.061$	19.7 ± 2.6	20.1 ± 2.6	$p = 0.113$
N	182	168		182	168		182	168	
Boys									
5	154	156		43.0	44.0		16.6	16.6	
10	157	161		44.5	47.0		17.0	17.2	
25	162	167		48.3	52.7		18.1	18.2	
50	168	171		54.2	58.0		19.5	19.5	
75	173	176		60.5	62.0		20.7	21.1	
85	175	178		65.6	66.0		21.5	21.6	
90	178	180		66.9	67.0		22.0	22.6	
95	183	187		83.0	78.2		23.7	23.3	
Mean ± SD	168 ± 7.5	171 ± 7.2	$p < 0.001$	55.1 ± 9.0	58.0 ± 8.1	$p = 0.010$	19.6 ± 2.2	19.7 ± 2.1	$p = 0.667$
N	165	169		165	169		165	169	

for sensitive questions such as tobacco consumption. Earlier studies among adults in Pitkäranta have shown that self-administered questionnaire are reliable methods to assess smoking among men, but women tend to underreport their smoking.[29] Taken into account possible underreporting the smoking prevalence among girls might be even higher than reported here.

As Pitkäranta is very typical area in the Republic of Karelia, the observed risk factors levels most likely represent the situation in the whole Republic. Unfortunately these data cannot be used to draw conclusions on general trends of cardiovascular disease risk factor for all Russian adolescents due to the geographical, social, and ethnical diversities in the Russian population. Nevertheless, even the exact prevalence and levels of risk factors among youth in Russian Karelia cannot be fully projected to the whole Russian Federation; the changes in risk factors levels most likely reflect the general development in the country. Thus the information gathered is of use in planning health policies targeted to Russian youth.

Very little information exists on cardiovascular disease risk factors from other parts of Russia. Before the socio-economic transformations in Russia, levels of blood pressure and body mass index among adolescents living in different parts of Russia were similar to those of their counterparts in the United States.[30,31] The economic transformations after the break of the Soviet Union have impacted in various degrees on different geographical regions in Russia and have led to various changes in disease risk profiles among young. In Siberia, the prevalence of high blood pressure and total cholesterol has decreased and HDL-cholesterol has increased, while the prevalence of daily and weekly smoking rates, after brief decline, has again started to increase.[32] In the Far North of Russia, an increase in the prevalence of all risk factors was reported among adolescents.[33]

Our results on blood pressure changes show very similar trends to the cardiovascular disease risk factors surveys conducted among adults in Pitkäranta in 1992 and 1997, demonstrating a statistically significant decrease in systolic blood pressure in both women and men.[34] Also in other countries such as the United States, the United Kingdom and Northern Ireland, blood pressure has been reported to be decreasing among children and adolescents.[35–37] Decrease in blood pressure among youth in Pitkäranta cannot be related to improved hypertension control in the region, but is closely related to changes in lifestyle such as diet and physical activity. Further research is needed to understand the reasons behind these changes.

Serum total cholesterol level increased significantly among girls between 1995 and 2004; thus being in contradiction with the results reported in Pitkäranta for adults, where total cholesterol decreased significantly in women between 1992 and 1997. However, the study period was somewhat different.[34] In Novosibirsk, between 1989 and 1999 a decrease in serum cholesterol level was observed in children aged 14–17.[32] Russian economy was in transition during the 1990s. This closely affected also the diet of the population as the availability

of certain food products was limited. Economy has improved quite a lot since then. Purchasing power and availability of products have increased influencing also the diet, which might be reflected in increased level of cholesterol among youth.

Data on smoking prevalence among European youth, obtained from the Health Behaviour in School-aged Children (HBSC), a WHO collaborative cross-national study conducted in 2001/02, suggested that in a number of countries and regions, the proportion of girls who smoke continues to rise. Smoking rates among 15-years-old girls tend to be higher than among boys of the same age. In many Northern and Western European countries, smoking rates for girls will soon exceed those for boys. This pattern was particularly marked in Scotland and Wales.[23]. Despite the considerable increase of smoking rates among girls, smoking prevalence among boys in Pitkäranta is still higher that the average levels in Eastern Europe. Corresponding results have been obtained from the studies conducted in other Russian regions as Moscow and town Volzhsky.[25,26] An increase in smoking rates among girls in Pitkäranta may reflect the general growth in tobacco consumption by young people similar to that observed in Northern and Western Europe. If the growth of smoking continues as predicted in the WHO report,[38] the increase of tobacco consumption is expected to continue in both genders.

The mean BMI did not change statistically significantly in either girls or boys. In western countries, increased trends of obesity among youth have been reported recently.[39] In Pikäranta, adult women are quite obese but trends in obesity did not change between 1992 and 1997.[34] The slight increase observed in BMI among girls may be evident for the development of increasing body weight in the future as was seen among adult women.

Boys in Pitkäranta became significantly taller. The corresponding positive secular trend on growth in the 20th century has been associated with food intake, improved intrauterine growth, urbanisation characteristics, and mitigation of social-class contrasts.[40]

Conclusion

The development of cardiovascular risk factors among adolescents in the Republic of Karelia has been generally favourable, except for the increase in smoking rates. Further research is needed to reveal the factors behind those changes such as recovery from recent economic and social transformations in the country. Russia is not yet facing an epidemic of obesity in its children and adolescents. However, considering the situation of increased mortality due to cardiovascular disease in the Russian Federation, attention should be paid towards known risk factors and their possible negative development trends in the future.

Unless effective preventive measures are implemented today's adolescents with their relatively low risk factor prevalence may became tomorrow's adults with a high prevalence of risk factors and ultimately patients suffering the symptoms of cardiovascular disease.

Public health services in Russia are mainly designed for prevention and control of communicable diseases. However cardiovascular conditions are increasingly contributing to burden of disease. More attention should be paid to the prevention of non-communicable diseases as well as promoting healthy lifestyles such as introduction of lessons on health education in the schools. Development of preventive programs tailored to different age groups and legislation and policies affecting children and youth is essential. Implementation of regulations such as tobacco act and advertisement restrictions needs careful follow-up. Understanding and preventing the risks of cardiovascular disease should be started early in life and then be followed by regular monitoring.

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Key points

- The study reports changes in the prevalence of cardiovascular risk factors among adolescents in the Republic of Karelia, Russia, from 1995 to 2004. Very little earlier information exists on prevalence and trends of risk factors among Russian youth.
- Behaviours related to the development of cardiovascular disease are usually adopted in childhood and adolescence. It is important to monitor the chronic disease related risk factors and health behaviour already in childhood and especially among adolescents to serve health education and prevention planning.

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