Published in final edited form as:

Int J Cardiol. 2013 October 30; 169(2): . doi:10.1016/j.ijcard.2013.08.090.

Childhood Lifestyle and Clinical Determinants of Adult Ideal:

Cardiovascular Health The Cardiovascular Risk in Young Finns Study, the Childhood Determinants of Adult Health Study, the Princeton Follow-up Study

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Conflicts of interest

This study has no conflicts of interest.

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Abstract

Background—The American Heart Association recently defined ideal cardiovascular health by simultaneous presence of seven health behaviors and factors. The concept is associated with cardiovascular disease incidence, and cardiovascular disease and all-cause mortality. To effectively promote ideal cardiovascular health already early in life, childhood factors predicting future ideal cardiovascular health should be investigated. Our aim was thus to comprehensively explore childhood determinants of adult ideal cardiovascular health in population based cohorts from three continents.

Methods—The sample comprised a total of 4409 participants aged 3–19 years at baseline from the Cardiovascular Risk in Young Finns Study (YFS; N=1883) from Finland, Childhood Determinants of Adult Health Study (CDAH; N=1803) from Australia and Princeton Follow-up Study (PFS; N=723) from the United States. Participants were re-examined 19–31 years later when aged 30–48 years.

Results—In multivariable analyses, independent childhood predictors of adult ideal cardiovascular health were family socioeconomic status ($P<0.01$; direct association) and BMI ($P<0.001$; inverse association) in all cohorts. In addition, blood pressure ($P=0.007$), LDL-cholesterol ($P<0.001$) and parental smoking ($P=0.006$) in the YFS, and own smoking ($P=0.001$) in CDAH were inversely associated with future ideal cardiovascular health.

Conclusions—Among several lifestyle and clinical indicators studied, higher family socioeconomic status and non-smoking (parental/own) in childhood independently predict ideal cardiovascular health in adulthood. As atherosclerotic cardiovascular diseases are rooted in childhood, our findings suggest that special attention could be paid to children who are from low socioeconomic status families, and who smoke or whose parents smoke, to prevent cardiovascular disease morbidity and mortality.

Keywords

children; cardiovascular diseases; epidemiology; risk factors; prevention

INTRODUCTION

In setting strategic impact goals for 2020, the American Heart Association (AHA) charted a new direction by focusing not only on preventing cardiovascular events but also on promoting cardiovascular health. The goal was to help everyone to move toward ideal cardiovascular health by focusing on seven ideal health metrics that can be used in monitoring cardiovascular health over time.¹ Ideal cardiovascular health was defined as the simultaneous presence of four ideal health behaviors (never smoked or quit >12 months ago, body mass index [BMI] <25 kg/m², physical activity at goal levels, and diet consistent with current guideline recommendations) and three ideal health factors (untreated total cholesterol <5.17 mmol/l [$<200\text{mg/dL}$], untreated blood pressure <120mmHg/<80mmHg and untreated fasting plasma glucose <5.6 mmol/l [$<100\text{mg/dL}$]).

Recent studies have described that the prevalence of ideal cardiovascular health is very low.^{2–4} Meeting a greater number of ideal cardiovascular health metrics in adulthood is associated with a lower risk of cardiovascular disease (CVD) incidence and mortality of all causes and diseases of the circulatory system.^{3, 5–7} Recently, the ideal cardiovascular health concept was also inversely associated with incident cancer.⁸ We have previously shown in the Cardiovascular Risk in Young Finns study that the number of ideal cardiovascular health metrics present in childhood is associated with a lower risk of hypertension, high LDL-cholesterol, metabolic syndrome and high-risk intima-media thickness in adulthood.⁹ These evidence support the application of the AHA ideal cardiovascular health concept for cardiovascular risk assessment. To effectively promote ideal cardiovascular health already early in life, childhood factors predicting future cardiovascular health should be investigated.

Using data from Finnish, Australian and American cohorts followed-up for 19–31 years since childhood, we examined a comprehensive set of CVD risk factors in childhood as predictors of ideal cardiovascular health in adulthood. Since the initiation of atherosclerotic CVD begins in childhood, these data may have implications in the early prevention of CVDs.

METHODS

The study comprised 4409 participants from three international cohort studies conducted in Finland (YFS), Australia (CDAH), and USA (PFS). Each study was approved by local ethics committees and all participants provided written informed consent. All laboratory measurements were performed using fasting blood samples. For the statistical analyses, we included those participants with data on CVD risk factors in childhood and ideal cardiovascular health metrics in adulthood.

The Cardiovascular Risk in Young Finns study (YFS)

The YFS sample and methods have been described in detail elsewhere.¹⁰ In this study, the sample comprised 1883 participants aged 3–18 years at baseline (1980) who provided ideal cardiovascular health metrics data when aged 30–45 years (2007).

Childhood risk factors—All serum lipid level determinations were performed with standard methods.¹¹ Blood pressure was measured using a standard mercury sphygmomanometer. Information on dietary habits, physical activity, participant's own smoking in childhood, parental smoking and parental socioeconomic status were obtained with questionnaires.¹¹ Children who reported that they have never smoked or have quit smoking were classified as non-smokers and children who reported current smoking as smokers. The length of parent's education (in years), parental occupation, and family annual income were considered as indicators of socioeconomic status in childhood. Parental occupation was coded from 1 to 5 (1=farmers, 2=lower manual, 3=upper manual, 4=lower non-manual 5=upper non-manual). In the present analyses, we converted the family income in 1980 into its present-day value in euros and formed three income groups: low (<16000 EUR), medium (>16000 EUR to 35000 EUR), or high (>35000 EUR). Parental smoking was considered positive if either parent had smoked daily for at least 12 months.

Childhood Determinants of Adult Health Study (CDAH)

The CDAH sample and methods have been described in detail elsewhere.¹² In this study, the sample comprised 1803 participants aged 7–15 years at baseline who provided ideal cardiovascular health metrics data at follow-up when aged 26–36 years (2004–2006).

Childhood risk factors—In childhood, blood samples were collected only on those aged 9, 12, and 15 years owing to time and economic constraints. Serum lipid levels were analyzed using standardized methods.¹² Blood pressure measurements were collected using a standard mercury sphygmomanometer. Data on diet, physical activity, participant's own smoking, parental smoking and family socioeconomic status were acquired through questionnaires.^{13, 14} Children who reported that they were not smoking regularly were classified as non-smokers and children who reported regular smoking as smokers. Parental smoking was considered positive if at least one parent was smoking.¹⁵ Participants retrospectively (at follow-up) reported the highest level of education completed by their parents (low=school only, medium=trade/vocational certificate, high=university) when participants were aged 12 years.¹¹ Participants also retrospectively reported the main occupation of their parents (not in labour force, blue collar, white collar, managers or professionals) until participants turned 12 years.

The Princeton Follow-up Study (PFS)

The PFS sample and methods have been described in detail elsewhere.¹⁶ In this study, the sample comprised 723 participants aged 6–19 at baseline who provided ideal cardiovascular health metrics data when aged 30–48.

Childhood risk factors—All serum lipid level determinations were performed with standard methods.¹⁶ Blood pressure was measured with a standard sphygmomanometer. Data on smoking in childhood and family socioeconomic status were acquired through questionnaires; physical activity, diet and parental smoking status were not assessed in this cohort in childhood. Children who reported that they have never smoked or have quit smoking were classified as non-smokers and children who reported current smoking as smokers. Educational and occupational classes (range 1 to 7) of the head of the household were considered as indicators of family socioeconomic status.¹⁷ For education, completion

of less than the seventh grade was coded “1” and completing a graduate or professional degree was coded “7”. For occupation, the code “1” represented unskilled labor while code “7” represented a higher executive, major professional, or proprietor of a large concern.

Assessing the Ideal Cardiovascular Health Metrics

AHA guidelines were used to construct an ideal cardiovascular health index of seven ideal metrics. Ideal health factors were as follows: systolic blood pressure (SBP) <120 mmHg and DBP <80 mmHg; total cholesterol 5.17 mmol/l (200 mg/dL); fasting glucose $<5.6 \text{ mmol/l}$ ($<100 \text{ mg/dL}$). Ideal health behaviors included: BMI $<25 \text{ kg/m}^2$; 150 min/week moderate or 75 min/week vigorous physical activity or combination; and not smoking: either never having smoked or quit smoking >12 months ago. Heterogeneity of data collection among the cohorts required some modifications of the AHA definitions (Table 1). The ideal cardiovascular health index corresponds to the number of ideal health behaviors and factors present at the 2007 follow-up in Young Finns, 2004–2006 follow-up in CDAH or 1998–2003 follow-up in PFS. In analyses we used the ideal cardiovascular health index as a continuous variable (index 0 to 7).

Statistical analyses

Associations between individual baseline metrics and ideal cardiovascular health index were examined using age- and sex-adjusted linear regression. The significant determinants were then entered into an age- and sex-adjusted multivariable linear regression model constructed to determine the independent childhood predictors of ideal cardiovascular health index. This model was additionally adjusted for race in PFS cohort. Blood pressure and blood lipids was only available for a subset of CDAH participants (those aged 9, 12, and 15 years at baseline) and blood pressure data for a subset of PFS ($N=497$). Two models were fitted for these cohorts: the first model maximized the N by only including those childhood variables where data were available for most participants and the second model considered all variables; hence the sample size was reduced. For analysis where the cohorts were pooled, mixed multivariable regression model with cohort as a random effect was used. The statistical tests were performed with SAS version 9.2 (SAS institute, Inc, Cary, NC). Statistical significance was inferred at a 2-tailed P-value <0.05 .

RESULTS

Baseline characteristics and the proportion of participants who met individual ideal cardiovascular health metrics in adulthood in each cohort are shown in Table 2. The length of follow-up between measurement time points was 27 years for YFS, from 19 to 21 years for CDAH, and from 22 to 31 years for PFS. Participants in YFS met on average (mean $\pm$ SD) 3.5 ± 1.5 , in CDAH 3.9 ± 1.3 , and in PFS 3.8 ± 1.3 of all 7 ideal metrics in adulthood.

Associations between childhood risk factors and ideal cardiovascular health index

In YFS, family income, parental education, and childhood vegetable and fruit consumption were directly, and parental smoking and childhood BMI, systolic and diastolic blood pressure, LDL-cholesterol and triglycerides inversely associated with ideal cardiovascular health index (Table 3). In CDAH, parental education and childhood HDL-cholesterol were directly, and parental smoking, participant’s own smoking and childhood BMI, systolic blood pressure, and LDL-cholesterol inversely associated with ideal cardiovascular health index. In PFS, parental education, parental occupation and childhood HDL-cholesterol were directly, and childhood BMI, systolic blood pressure, LDL-cholesterol and triglycerides inversely associated with ideal cardiovascular health index.

In age- and sex-adjusted multivariable analysis, independent predictors of ideal cardiovascular health (Table 4) in YFS included family income (direct association), parental smoking and childhood BMI, systolic blood pressure, and LDL-cholesterol (inverse association). The results were similar using other indicators of family socioeconomic status (parent's education or parental occupation, data not shown). In CDAH, independent predictors of ideal cardiovascular health (Table 4) included parental education (direct association), participant's own smoking in childhood, and childhood BMI (inverse association). The results were similar using parental occupation as a marker of family socioeconomic status. Parental smoking was affected by all variables in the model: adding BMI reduced the regression coefficient for parental smoking by 14%, adding participant's own smoking reduced the coefficient for parental smoking by 14%, and adding parental education reduced the coefficient for parental smoking by 20%. The model for the CDAH subset that had data on lipids and blood pressure (N=366) showed parental education (direct association), and childhood measures of BMI and LDL-cholesterol (inverse association) to be independent predictors of ideal cardiovascular health (data not shown). In PFS, independent predictors of ideal cardiovascular health included parental education (direct association), and childhood BMI (inverse association). The results were similar using parental occupation as a marker of family socioeconomic status. The results were not altered (coefficient change less than 4% in parental education or childhood BMI) in the PFS subset that had data also on blood pressure. Additionally, the cohorts were pooled and the association of variables available for all subjects with adult ideal cardiovascular health was studied (n=4243). The results in these analyses taking into account cohort variable were similar to those reported in Table 4 showing family socioeconomic status ($\beta \pm \text{SE}$ 0.18 $\pm$ 0.03, $p < 0.0001$) and childhood BMI ($\beta \pm \text{SE}$ 0.11 $\pm$ 0.005, $p < 0.0001$) as independent predictors of adult ideal cardiovascular health.

In an attempt to further delineate the independence of effects for family socioeconomic status in childhood, we performed additional analyses that adjusted for participants' own socioeconomic status in adulthood. In YFS, when participant's own annual income was added to the multivariable model, family income remained as an independent predictor of ideal cardiovascular health index ($\beta \pm \text{SE}$ 0.18 $\pm$ 0.05, $p = 0.0005$). In CDAH, the effect of parental education in childhood was attenuated ($p = 0.21$) when participants' own education was added to the model. When occupation was used as a marker of participants' own socioeconomic status in CDAH, parental education remained as an independent predictor of ideal cardiovascular health index ($\beta \pm \text{SE}$ 0.10 $\pm$ 0.04, $p = 0.02$). In PFS, parental education remained as an independent predictor of ideal cardiovascular health index ($\beta \pm \text{SE}$ 0.08 $\pm$ 0.04, $p = 0.04$) when participants' own education was added to the model.

Family socioeconomic status, parental smoking and ideal cardiovascular health

Because family socioeconomic status and parental smoking were observed to predict ideal cardiovascular health, we further explored these associations. Family socioeconomic status was directly associated with ideal smoking status, and BMI in all cohorts and additionally with physical activity and blood pressure in YFS, total cholesterol in CDAH, and blood pressure and glucose in PFS (data not shown). Parental smoking was inversely associated with ideal smoking status, BMI, and glucose in YFS, and with ideal smoking status in CDAH (data not shown).

Among cohorts with data on both family socioeconomic status and smoking, we created a parental risk score that assigned a value of 1 for low family income (YFS) or school-only parental education (CDAH) and a value of 1 for parental smoking. Medium or high family income (YFS) and vocational or university education (CDAH), and parental non-smoking were assigned values of 0 (possible score range 0–2). Figures 1a and 1b show age- and sex-

adjusted mean values (SEM) of ideal cardiovascular index in the parental risk score groups in YFS and CDAH. In both cohorts, the parental risk score was inversely associated with ideal cardiovascular health index in adulthood ($P<0.001$). In YFS, participants who had none of the parental risk factors met on average 3.8 (0.07) ideal metrics in adulthood while those with 2 risk factors met 3.2 (0.08) adult ideal metrics. In CDAH, participants who had none of the parental risk factors met on average 4.0 (0.05) ideal metrics in adulthood while those with 2 risk factors met 3.6 (0.07) adult ideal metrics. The association between parental risk score and the number of ideal metrics in adulthood was graded (In YFS, parental risk score group 0 vs. 1: $P<0.0001$, group 1 vs. 2: $p<0.02$, and in CDAH parental risk score group 0 vs. 1: $P=0.02$, group 1 vs. 2: $p=0.02$).

DISCUSSION

Using data from three independent cohort studies from three continents we studied a comprehensive set of childhood predictors of adult ideal cardiovascular health. Among several clinical and lifestyle indicators studied, we observed that higher family socioeconomic status in all cohorts and non-smoking (parental in YFS, own in CDAH) in childhood were independently associated with ideal cardiovascular health two to three decades later in adulthood.

Already in childhood, passive smoking has been shown to associate with unfavorable lipid profiles¹⁸, increase in platelet aggregation¹⁹, and carotid and aortic intima-media thickness.²⁰ We have previously reported in the YFS and CDAH cohorts that parental smoking status in childhood is associated with reduced endothelium-dependent vasodilatation measured over 20 years later.¹⁵ However, there are no previous studies concerning the association between parental smoking in childhood and clustered cardiovascular health factors and behaviors in adulthood. In this study among the YFS cohort, we showed that children whose parents did not smoke met a greater number of ideal cardiovascular health metrics in adulthood.

In previous studies, childhood socioeconomic disadvantage has been shown to associate with individual cardiovascular risk factor levels in adulthood.²¹ In addition, childhood socioeconomic circumstance and intergenerational education mobility is associated with health-related behaviours in adulthood.^{22, 23} In line with these studies, we report novel data using as an endpoint a cluster of AHA-defined ideal cardiovascular health factors and behaviours associated with CVD morbidity and mortality. Cardiometabolic risk factors tend to occur together more frequently than expected by chance alone^{24, 25, 26} and clustering of risk factors is thought to be a better measure of cardiovascular risk, instead of studying individual risk factors²⁴ Importantly, we observed that children with higher family socioeconomic status exhibited a greater number of ideal cardiovascular health metrics in adulthood independent of several other childhood risk factors. In addition, in YFS and PFS this association was independent of participants own socioeconomic status in adulthood. In CDAH, the results were similar when occupational status was used as a marker of participants own socioeconomic status. However, the effect of parental education in childhood was attenuated when participant's own education was used as a marker of socioeconomic status, consistently with previous reports from the CDAH study.^{22, 23} These data also support the recent AHA Scientific Statement²⁷, which encourages to implement community-wide interventions that are socially and culturally appropriate to reduce disparities and inequities in the cardiovascular health of socioeconomically disadvantaged subgroups.

Recent studies have shown that meeting a greater number of the ideal cardiovascular health metrics in adulthood is associated with a lower risk for CVD incidence and mortality.^{3, 5-7}

In the present study, children whose parents were smokers and who had a low family socioeconomic status, had 0.4–0.6 adult ideal metrics less than those participants without these risk factors. In the ARIC study, Folsom et al. reported that white adults with 3 ideal health metrics in adulthood had 33% higher CVD incidence rate (12.4/1,000 person-years vs. 9.3/1,000 person years) than those with 4 ideal health metrics.³ In addition, Yang et al. reported that adults with 3 ideal health metrics had 37% higher risk for CVD death and 42% higher risk for all-cause death compared to those with 4 ideal metrics.⁷ Based on these data, the difference of 0.6 ideal cardiovascular health metrics observed in this study suggests that participants who had a low socioeconomic status and were exposed to parental smoking in childhood may have 15–25% higher CVD incidence than participants who did not have these exposures.

The mechanisms by which passive smoking increases the risk of CVDs are multiple and interact with each other. Exposure to cigarette smoke increases inflammation, platelet aggregation, endothelial dysfunction, oxidation of LDL-cholesterol, oxidative stress, and atherosclerosis.²⁸ Because of their partially developed or compromised cardiovascular, endocrine, and immune systems, the physiologically immature children may be more susceptible to damage from the toxic effects of passive smoking, particularly given the fact that the effects of passive smoking may occur at very low levels of exposure.^{28, 29} This may be one reason why the effect of parental smoking found in our study seems to remain long-term, and independent of potential confounders (socioeconomic status) or other mediators such as traditional CV risk factors. Likewise, differences in risk factor levels related to socioeconomic status have been observed in the life-course already in children and adolescents.¹⁷ In addition, we have found parental occupation related differences in children's lifestyle choices, particularly in diet and smoking.³⁰ Thus, children with higher parental socioeconomic status may have adopted a healthier lifestyle than those with lower socioeconomic background.

Study limitations

Limitations of the present study include the capture of environmental tobacco smoke exposure using questionnaires of parental smoking without cross-validation against a biomarker of passive smoke exposure. However, it has been shown that questionnaire data on parental smoking habits correlates well with serum cotinine levels.³¹ A potential source of bias is that those continuing in the study differ from those lost to follow-up. However, we previously reported that baseline characteristics were similar among participants and non-participants in the YFS³² such that the cohort seems to be representative of the original study population. For CDAH, however, we have noted differential loss to follow-up in area-level socioeconomic status, overweight and regular smoking.²³ In sensitivity analyses that applied inverse proportional weights to those that attended follow-up to account for differential loss to follow-up among the exposures, we found the results to be essentially similar (no coefficient changed by more than 5%). The major strengths of this study include the longitudinal study design and the extensive follow-up of the participants who were very well phenotyped both in childhood and adulthood among three large cohorts.

Conclusions

Higher family socioeconomic status in all cohorts and non-smoking (parental in YFS, own in CDAH) in childhood predicted ideal cardiovascular health, as defined by the AHA, 19–31 years later in adulthood. These data thus emphasize that special attention could be paid to children who smoke or are exposed to parental smoking or are from low socioeconomic status families. From both the children's and their parents' perspective, these families provide one of the primary targets for interventions to promote ideal cardiovascular health and subsequently prevent CVD morbidity and mortality.

Acknowledgments

Acknowledgement of grant support

The YFS has been financially supported by the Academy of Finland (126925, 121584, 124282, 129378, 117797, and 41071), the Social Insurance Institution of Finland, Kuopio, Tampere, and Turku University Hospital Medical Funds, Juho Vainio Foundation, Paavo Nurmi Foundation, Finnish Foundation of Cardiovascular Research and Finnish Cultural Foundation, Sigrid Juselius Foundation, Orion-Farmos Research Foundation, Tampere Tuberculosis Foundation, and Emil Aaltonen Foundation.

The CDAH study was funded by grants from the Australian National Health and Medical Research Council, the Australian National Heart Foundation, the Tasmanian Community Fund and Veolia Environmental Services. We gratefully thank the CDAH study sponsors (Sanitarium Health Food Company, ASICS Oceania and Target Australia). A.V. receives a National Health and Medical Research Council Career Development Fellowship (APP 1008299). C.G.M. receives a National Health and Medical Research Council Early Career Fellowship (APP 1037559).

The PFS was supported by the American Heart Association (National) 9750129N; National Institutes of Health (NIH), National Heart, Lung and Blood Institute (NHLBI) contract N01-2-HV-2914L; and NIH/NHLBI grants HL62394, HL55025, and HL48941.

Biostatisticians Ville Aalto and Irina Lisinen are acknowledged for statistical advice.

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Figure 1.

Age- and sex-adjusted mean (SEM) of the ideal cardiovascular health index according to childhood parental risk factors (smoking, low socioeconomic status); a) YFS, b) CDAH study.

Table 1

Description of the ideal cardiovascular health metrics.

Metric	AHA criterion	YFS	CDAH	PFS
Blood pressure	120/80 mmHg	120/80 mmHg	120/80 mmHg	120/80 mmHg
Total cholesterol	5.17 mmol/l	5.17 mmol/l	5.17 mmol/l	5.17 mmol/l
Glucose	<5.6 mmol/l	<5.6 mmol/l	<5.6 mmol/l	<5.6 mmol/l
BMI	<25 kg/m ²	<25 kg/m ²	<25 kg/m ²	<25 kg/m ²
Non-smoking	never smoked or quit >1 year ago	never smoked or quit >1 year ago	never smoked or quit >1 year ago	never smoked or quit >1 year ago
Physical activity	150 min/wk moderate or 75 min/wk vigorous or combination	120 min/wk moderate or combination or 60 min/wk vigorous	150 min/wk moderate or combination or 75 min/wk vigorous	150 min/wk combination or 75 min/wk vigorous
Diet	4 / 5 components expressed for a 2000-kcal diet	4 / 5 components scaled for caloric intake	3 / 4 components	4 / 5 components scaled for caloric intake
<i>Fruits and vegetables</i>	4.5 cups per day	450 g/day	4.5 servings/day	4.5 servings/day
<i>Fish</i>	two 3.5-oz servings/wk	two servings (100 g)/wk	two fin fish servings/wk	saturated fat intake <7 E%
<i>Whole grains</i>	three 1-oz servings/day	three servings (30 g)/day of whole grain rye bread	3 servings/day	3 servings (30 g)/day
<i>Sodium</i>	<1500 mg/day	<1500 mg/day	not available	<1500 mg/day
<i>Sugared drinks</i>	450 kcal/wk	450 kcal/wk	4 servings/wk	sugar from sweets 12.8 E %/day

Table 2

Characteristics of participants at baseline and distribution of adult ideal cardiovascular health metrics for YFS, CDAH, and PFS cohorts.

Characteristic	YFS		CDAH		PFS	
	N	Statistic	N	Statistic	N	Statistic
Age(y)	1883	10.8(5.0)	1803	11.1(2.5)	723	12.5(3.3)
Male(%)		44.2		48.5		45.2
African-American(%)	1883	0	1883	0	723	29.1
Socioeconomic status indicators						
Family income (low/medium/high)(%)	1812	26/52/22		-		-
Parental education *	1859	10.7(3.6)	1758	38.5/31.9/29.7	719	1.4/9.5/11.3/38.4/19.1/12.1/8.3
Parental occupation, % [†]	1865	13.6/5.1/22.3/41.8/17.2		0.9/23.1/18.3/57.7	693	3.3/19.3/18.0/16.0/19.3/13.1/10.8
Smoking indicators						
Parental smoking(%)	1765	72.9	1409	42.5		-
Smokers(%)	949	21.9	1406	9.4	497	11.3
Diet indicators						
Vegetable consumption(times/week)	1869	6.2(2.9)	1128	15.7(14.5)		-
Fruit consumption(times/week)	1866	6.9(2.8)	1128	6.2(6.9)		-
Fish consumption(times/week)	1867	1.1(1.1)	1128	0.3(1.6)		-
Low-fat milk consumption(times/week)		-	1128	0.7(3.0)		-
Milk and milk product consumption(times/week)		-	1128	12.3(10.5)		-
Physical activity indicators						
Physical activity index, 3–6yr [‡]	569	16.1(2.4)		-		-
Physical activity index, 9–18yr [‡]	1256	9.0(1.8)		-		-
Physical activity(hrs/wk)		-	1417	7.3(6.9)		-
Clinical indicators						
BMI(kg/ m ²)	1883	17.9(3.1)	1802	18.1(2.7)	669	19.9(4.4)
Systolic blood pressure(mmHg)	1876	113(12)	609	109(13)	497	104(13)
Diastolic blood pressure(mmHg)	1606	69(9)	607	78(12)	497	62(12)
LDL-cholesterol(mmol/l)	1867	3.4(0.8)	397	2.7(0.7)	706	2.8(0.8)
HDL-cholesterol(mmol/l)	1867	1.6(0.3)	399	1.5(0.3)	702	1.4(0.3)

Characteristic	YFS		CDAH		PFS	
	N	Statistic	N	Statistic	N	Statistic
Triglycerides(mmol/l)	1868	0.7(0.3)	401	0.7(0.4)	723	0.9(0.4)
Adult ideal cardiovascular health metrics						
Ideal health behaviors						
Ideal smoking status(%)	1883	72.3	1803	76.3	723	70.4
Ideal BMI(%)	1883	47.4	1803	51.5	723	33.2
Ideal physical activity(%)	1883	51.1	1803	46.0	723	85.3
Ideal diet score(%)	1883	6.3	1803	4.6	723	0.7
Ideal health factors						
Ideal total cholesterol status(%)	1883	57.0	1803	64.3	723	61.6
Ideal blood pressure status(%)	1883	45.9	1803	54.2	723	41.5
Ideal fasting plasma glucose(%)	1883	71.5	1803	92.6	723	84.2

Data are mean (SD) for continuous variables and percent for categorical variables.

* Parental education in YFS measured as years (mean(SD)); in CDAH classified from 1 to 3 (3 is highest; shown as %); in PFS classified from 1 to 7 (7 is highest; shown as %)

† Parental occupation in YFS classified from 1 to 5 (5 is highest), in CDAH from 1 to 4 (4 is highest), and in PFS from 1 to 7 (7 is highest)

‡ range 9–22 † range 5–14

Table 3

Age- and sex-adjusted associations between individual baseline metrics and ideal cardiovascular health index in adulthood in the YFS, CDAH, and PFS cohorts.

Childhood regressor variable	YFS			CDAH			PFS		
	N	β (SE)	p-value	N	β (SE)	p-value	N	β (SE)	p-value
Socioeconomic status indicators									
Family income(low/medium/high)	1812	0.26(0.05)	<0.0001	-	-	-	-	-	-
Parental education *	1859	0.05(0.01)	<0.0001	1758	0.1(0.04)	<0.001	719	0.18(0.03)	<0.0001
Parental occupation [†]	1865	0.14(0.03)	<0.0001	1794	0.1(0.03)	<0.001	693	0.12(0.03)	<0.0001
Smoking indicators									
Parental smoking(no/yes)	1765	-0.30(0.07)	<0.0001	1406	-0.43(0.12)	<0.001	-	-	-
Smoking(no/yes)	949	-0.23(0.12)	0.06	1409	-0.18(0.07)	0.006	497	-0.19(0.23)	0.41
Diet indicators									
Vegetable consumption(times/week)	1869	0.03(0.01)	0.02	1128	-0.001(0.003)	0.60	-	-	-
Fruit consumption(times/week)	1866	0.04(0.01)	0.0002	1128	0.003(0.005)	0.56	-	-	-
Fish consumption(times/week)	1867	0.05(0.03)	0.09	1128	0.013(0.023)	0.57	-	-	-
Low-fat milk consumption(times/week)	-	-	-	1128	0.004(0.012)	0.76	-	-	-
Milk and milk product consumption(times/week)	-	-	-	1128	0.002(0.004)	0.58	-	-	-
Physical activity indicators									
Physical activity index	1810	0.01(0.03)	0.81	-	-	-	-	-	-
Physical activity(hrs/wk)	-	-	-	1417	-0.01(0.01)	0.24	-	-	-
Clinical indicators									
BMI(kg/ m ²)	1883	-0.10(0.01)	<0.0001	1802	-0.11(0.01)	<0.001	669	-0.09(0.01)	<0.0001
Systolic blood pressure(10mmHg)	1876	-0.20(0.03)	<0.0001	609	-0.13(0.04)	0.001	497	-0.14(0.05)	0.005
Diastolic blood pressure(10mmHg)	1606	-0.10(0.04)	0.002	607	-0.07(0.04)	0.07	497	-0.05(0.05)	0.29
LDL-cholesterol(mmol/l)	1867	-0.29(0.04)	<0.0001	397	-0.39(0.09)	<0.001	706	-0.22(0.06)	0.0002
HDL-cholesterol(mmol/l)	1867	0.11(0.11)	0.31	399	0.59(0.21)	0.005	702	0.44(0.15)	0.003
Triglycerides(mmol/l)	1868	-0.56(0.11)	<0.0001	401	-0.17(0.15)	0.26	723	-0.38(0.11)	0.0006

Regression coefficients and standard errors for a 1-unit change in the covariate.

* Parental education in YFS measured as years (mean(SD)); in CDAH classified from 1 to 3 (3 is highest), in PFS classified from 1 to 7 (7 is highest),

† Parental occupation in YFS classified from 1 to 5 (5 is highest), in CDAH from 1 to 4 (4 is highest), and in PFS from 1 to 7 (7 is highest)

Table 4

Multivariable age- and sex-adjusted associations between individual baseline metrics and ideal cardiovascular health index in adulthood in the YFS, CDAH, and PFS cohorts.

Childhood regressor variable	YFS (N=1668)		CDAH (N=1365)		PFS (N=659)	
	β (SE)	p-value	β (SE)	p-value	β (SE)	p-value
Family socioeconomic status [*]	0.21(0.05)	<0.0001	0.13(0.04)	0.002	0.12(0.04)	0.001
Parental smoking (no vs. yes)	-0.26(0.07)	0.0006	-0.10(0.07)	0.12	-	-
Own smoking(no/yes)	-	-	-0.38(0.11)	0.001	-	-
Vegetable consumption(times/week)	0.01(0.01)	0.27	-	-	N.A.	
Fruit consumption(times/week)	0.01(0.01)	0.42	-	-	N.A.	
BMI(kg/m ²)	-0.08(0.02)	<0.0001	-0.10(0.01)	<0.001	-0.07(0.01)	<0.0001
Systolic BP(10mm/Hg)	-0.09(0.03)	0.007	-	-	N.A. [‡]	
LDL-cholesterol(mmol/l)	-0.25(0.05)	<0.0001	N.A. [‡]		-0.10(0.06)	0.09
HDL-cholesterol (mmol/l)	-	-	N.A. [‡]		0.27(0.16)	0.09
Triglycerides(mmol/l)	-0.17(0.12)	0.16	N.A. [‡]		-0.09(0.12)	0.45
Race(White vs. African-American)	. [‡]	-	. [‡]	-	-0.16(0.11) [‡]	0.18
Sex(female vs. male)	-1.06(0.07)	<0.0001	-0.99(0.06)	<0.001	-0.83(0.09)	<0.0001
Age(years)	-0.004(0.010)	0.67	0.06(0.02)	0.002	0.03(0.01)	0.09

Regression coefficients and standard errors are for a 1-unit change in the covariate;

^{*} Indicators of parental socioeconomic status were family income (YFS, 1 to 3) or parental education (CDAH, 1 to 3 and PFS, 1 to 7);

[‡] Race = 33% African American in Princeton, 0% Young Finns and 0% in CDAH; Nonsignificant variables (see Table 2) were not included in the analysis;

N.A.=Not Available;

N.A.[‡]=Available only from a subcohort, hence not included in this analysis.