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Original Contribution

The Relation between Components of Adult Height and Intimal-Medial Thickness in Middle Age

The Atherosclerosis Risk in Communities Study

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The authors aimed to investigate the relation between components of adult height (leg and trunk length) and atherosclerosis in middle age, using data from 12,254 participants (aged 44–65 years) in the Atherosclerosis Risk in Communities (ARIC) Study. Intimal-medial thickness (IMT) as measured by B-mode ultrasound was the outcome, and exposures were trunk and leg lengths as estimated (using sitting height and the difference between sitting and standing height) at the first study examination in 1987–1989. The mean IMT was 0.73 (standard deviation, 0.17) mm. Greater leg length was associated with lower IMT, with the largest difference being for Black men (a 0.045 (95% confidence interval: 0.023, 0.068)-mm lower IMT per 10-cm higher leg length). Greater trunk length was associated with higher IMT, with the largest difference being for White men (a 0.024 (95% confidence interval: 0.005, 0.044)-mm higher IMT per 10-cm higher trunk length). Although the effect sizes were small, leg length was inversely associated with atherosclerosis, consistent with the results of other studies with cardiovascular disease outcomes.

body height; coronary artery diseases; leg; socioeconomic factors

Abbreviations: ARIC, Atherosclerosis Risk in Communities; CI, confidence interval; IMT, intimal-medial thickness.

Tall stature is associated with decreased risk of both coronary heart disease and stroke (1–8). Proposed explanations include genetic factors influencing both growth and cardiovascular disease risk, smaller and more easily blocked coronary artery diameter among shorter persons (1), reduction of height due to cardiovascular disease-induced ill health and immobility (reverse causality) (9), and other factors affecting both intrauterine or childhood growth and cardiovascular disease risk (10, 11).

The height-cardiovascular disease association can be further explored by examining the specific associations of the components of height (leg length and trunk length) with cardiovascular disease. Leg length may be a useful biomarker of prepubertal environmental influences on childhood growth, since up until puberty increases in leg length form the larger proportion of increase in total height (11, 12). Further, the dramatic increases in height in industrialized countries over the last century, which are the result of improvements in nutrition and reductions in serious infections, arose more from increases in leg than trunk length (13). If there is a specific association between leg length and cardiovascular disease, then this is unlikely to be explained by shrinkage and reverse causation, since shrinkage occurs mainly in the trunk. Neither is it likely to reflect differences in vessel diameter, since it is unlikely that leg length, but not trunk length, would be related to vessel

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diameter. Finally, since the magnitudes of the associations between birth weight and each component of height (leg length and trunk length) are the same, an association specifically between leg length and cardiovascular disease, but not between trunk length and cardiovascular disease, is unlikely to be a reflection of the association with birth weight (14).

Few studies have assessed the association between components of adult height and cardiovascular disease. In one study of middle-aged men, leg length was found to explain the height-coronary heart disease association (14), and similar results were found in a study of older women (15). In a third study, leg length measured in childhood (boys and girls aged 2–14 years) was also found to be inversely associated with cardiovascular disease mortality over 52 years of follow-up (16). In studies of adults, leg length has been found to be the component of height that is specifically associated with cardiovascular disease risk factors, in particular, insulin resistance, abnormal lipids, and diabetes (14, 17, 18) and pulse pressure and systolic blood pressure (19).

We aim to examine the relation between components of adult height and carotid intimal-medial thickness (IMT) in the Atherosclerosis Risk in Communities (ARIC) Study participants. This will be the first study to examine the association between components of adult height and subclinical cardiovascular disease outcome in a study population containing both women and men. In addition, the ARIC Study includes a large sample size, a mixed ethnic population, a continuous measure of presymptomatic disease as an outcome measure, and information on childhood and adult socioeconomic position.

MATERIALS AND METHODS

A subset of the ARIC Study was included (20). Briefly, 15,792 members aged between 45 and 64 years from four US communities had a baseline examination in 1987–1989, followed by three examinations at 3-year intervals. Information collected at baseline included past and current health problems, smoking history, educational level, age, sex, sitting and standing height, and ethnic group. At each clinical examination, information was collected on blood pressure, weight, high density lipoprotein and low density lipoprotein cholesterol, presence of diabetes (fasting blood glucose, $\geq$126 mg/dl, nonfasting glucose, $\geq$200 mg/dl, physician diagnosis of diabetes, or being on diabetes medication), and use of antihypertensive medications.

B-mode real-time ultrasound (Biosound 2000 II SA; Biosound, Inc., Indianapolis, Indiana) measurements of IMT (mm) were made at examination 1. Measurements were made at each of six sites (left and right internal carotid artery, common carotid artery, and the carotid bifurcation). Standard interrogation angles were used, and details of the ultrasound scanning and reading techniques have been published previously (21). If a participant was missing one or more IMT measurements, these have been imputed on the basis of the participant's race, sex, age, and body mass index and adjusted for measurement trends and reader differences. Where the participant had no IMT measurements at all, none was imputed, and that participant was not included in the analysis. The outcome variable here was the average of IMT values at the six sites, where each of these values was either imputed (as above) or was the raw site-specific IMT value, adjusted for measurement trends and reader differences.

At the first visit, anthropometric measurements included height, sitting height, weight, and waist and hip circumferences. Subjects' weight and height were measured without shoes being worn. Height was measured to the nearest centimeter using a wall-mounted ruler. Seated height was measured to the nearest centimeter with the participant seated on a stool against a wall-mounted ruler. The stool height was measured and adjusted daily. Trunk length was estimated as overall seated height minus stool height. Leg length was estimated as overall height minus sitting height. Weight was measured to the nearest pound by use of a balance scale and has been converted to kilograms for this analysis. Waist and hip circumferences were measured to the nearest centimeter with the participant standing. The waist circumference was taken at the level of the umbilicus, and hip circumference was taken at the level of the maximum protrusion of the gluteal muscles.

Potential confounding factors or factors potentially on the causal pathway included the following: parental cardiovascular disease risk factors, adult cardiovascular disease risk factors, and adult sociodemographic and anthropometric factors. Information on all these factors was taken from data collected at the first examination, unless stated otherwise. Parental risk factors were the participant's recall of maternal and paternal diabetes and cardiovascular disease (high blood pressure, heart attack, stroke). Adult baseline cardiovascular disease risk factors (potentially on the causal pathway between leg/trunk length and IMT unless stated otherwise) included current smoking status and cigarette-years of smoking (potential confounders); diabetes; triglycerides; total, low density lipoprotein, and high density lipoprotein cholesterol (Système International units); systolic and diastolic blood pressure; and hypertension and cholesterol medications. Adult sociodemographic (potential confounders) and anthropometric factors included weight, waist/hip ratio, participant's educational attainment (a measure of socioeconomic position in early adult life), and field center. All analyses were restricted to the sample with complete data on all confounders.

Those with ethnic origin other than Black or White were excluded ($n = 74$), as were Black participants at the Minneapolis, Minnesota, or Washington County, Maryland, field centers ($n = 55$), as the numbers of Black participants in these field centers were too small to support models including both ethnicity and field center. Those with no IMT data at the first visit were also excluded ($n = 1,075$), as were those with no anthropometric measurements at the first visit ($n = 8$).

We also adjusted for maximum parental education at the participant's birth or for the maximum education of the two adults caring for the child if these were not the parents (a measure of early childhood socioeconomic position). These data were obtained at examination 4 and, therefore, for these analyses, those not attending the fourth visit were also excluded ($n = 3,885$).

TABLE 1. Distribution of carotid intimal-medial thickness and leg and trunk lengths, by sex and race, Atherosclerosis Risk in Communities Study, 1987–1999

Variable	Black women (n = 2,301)	White women (n = 5,761)	Black men (n = 1,441)	White men (n = 5,111)
Intimal-medial thickness, mm (mean (SD*))	0.71 (0.15)	0.68 (0.16)	0.76 (0.18)	0.78 (0.20)
Intimal-medial thickness of >1 mm, no. (%)	109 (5)	256 (4)	120 (8)	584 (11)
Height, m (mean (SD))	1.63 (0.06)	1.62 (0.06)	1.76 (0.07)	1.76 (0.06)
Leg length, m (mean (SD))	0.79 (0.04)	0.76 (0.04)	0.86 (0.05)	0.83 (0.04)
Trunk length, m (mean (SD))	0.84 (0.03)	0.86 (0.03)	0.90 (0.04)	0.93 (0.03)
Weight, kg (mean (SD))	80.5 (16.99)	69.3 (14.49)	84.7 (15.91)	84.7 (13.37)
Waist/hip ratio (mean (SD))	0.90 (0.08)	0.89 (0.08)	0.94 (0.06)	0.97 (0.05)
Correlations (95% CI*) between				
Leg and trunk length	0.22 (0.18, 0.26)	0.33 (0.30, 0.35)	0.29 (0.24, 0.34)	0.35 (0.32, 0.37)
Leg length and weight	0.18 (0.14, 0.22)	0.17 (0.14, 0.19)	0.22 (0.18, 0.27)	0.31 (0.28, 0.33)
Trunk length and weight	0.27 (0.23, 0.31)	0.30 (0.28, 0.32)	0.46 (0.42, 0.50)	0.44 (0.42, 0.47)
Leg length and waist/hip ratio	0.04 (−0.003, 0.08)	−0.02 (−0.05, 0.007)	−0.01 (−0.06, 0.04)	0.01 (−0.02, 0.03)
Trunk length and waist/hip ratio	−0.12 (−0.16, −0.08)	−0.15 (−0.18, −0.13)	−0.05 (−0.10, 0.003)	−0.07 (−0.10, −0.05)

* SD, standard deviation; CI, confidence interval.

With regard to statistical analysis, the associations between exposures (height, leg and trunk lengths) and the outcome (IMT) were each examined in univariate analyses by use of standard statistical models (linear regression). Separate models were then fitted for each of the four sex/ethnic groups—Black women, White women, Black men, and White men.

This modeling procedure was repeated several times, adding more confounding or potential mediating variables each time. The first extended model included field center, age, ethnicity, and sex. Subsequent models included potential parental confounders (see above); potential confounders measured on the participant (educational level, number of pack-years smoked); metabolic risk factors that might be on the causal pathway (systolic blood pressure, diastolic blood pressure, diabetes, antihypertensive medication, high density lipoprotein and low density lipoprotein cholesterol, arterial depth (as this may be related to whether IMT is missing or not, due to difficulties correctly visualizing deep arteries)); and all the above plus weight and the waist/hip ratio. Each group of potential confounders/mediators was added to the model simultaneously, and the association between IMT and components of height was examined again. The assumption of linear relations between IMT and leg and trunk lengths was examined by use of augmented component-plus-residual plots. Collinearity between explanatory variables was investigated by calculating the variance inflation factors for each explanatory variable in the model, with a variance inflation factor greater than 10 indicating collinearity.

The analysis was then repeated excluding those not attending the fourth visit (n = 3,885) and including early childhood socioeconomic position (maximum parental education at the participant's birth, which was collected only at the fourth visit) as a potential confounder.

RESULTS

All ARIC Study participants who had data from the first examination and who satisfied the inclusion criteria (refer to Materials and Methods) were included, giving a sample of 12,254 participants. The mean IMT varied by sex and ethnic group, being highest in White men and lowest in White women (table 1). Men were taller than women, with little difference between ethnic groups (table 1). Leg length and weight were highest in Black men and lowest in White women, whereas trunk length was greatest in White men and lowest in Black women (table 1). The correlation between leg length and trunk length was higher in White than Black participants and somewhat higher in men compared with women (table 1). Correlations between trunk length and both weight and waist/hip ratio were of greater magnitude than were those between leg length and weight or waist/hip ratio, and both of the sets of correlations were lower in women compared with men (table 1).

The distributions of participants' characteristics are shown in table 2, by sex and ethnic group. There were negative relations between age and both leg and trunk length, with an overall decrease in leg length of 0.02 (95 percent confidence interval (CI): 0.01, 0.04) cm and in trunk length of 0.12 (95 percent CI: 0.11, 0.13) cm per 1-year increase in age.

We examined the relations between IMT and leg and trunk lengths separately by sex and ethnic group (tables 3 and 4). There was some evidence for an interaction between sex and leg length ($p = 0.11$) and trunk length ($p = 0.18$) and for an interaction between ethnic group and trunk length ($p = 0.09$). There was little evidence for an interaction between ethnic group and leg length ($p = 0.91$).

Black women were the only group showing a positive univariate relation between leg length and IMT, which was attenuated toward the null on adjustment for confounders

TABLE 2. Distribution of sociodemographic characteristics and cardiovascular risk factors, by sex and race, Atherosclerosis Risk in Communities Study, 1987–1999

Variable*	Black women ($n = 2{,}301$)	White women ($n = 5{,}761$)	Black men ($n = 1{,}441$)	White men ($n = 5{,}111$)
Age, years (mean (SD†))	53.4 (5.75)	54.0 (5.70)	53.9 (5.97)	54.8 (5.71)
Mother had diabetes, no. (%)	510 (24.1)	916 (16.2)	275 (21.1)	764 (15.5)
Father had diabetes, no. (%)	216 (11.3)	596 (10.9)	112 (9.7)	456 (9.5)
Mother had cardiovascular disease, no. (%)‡	1,405 (64.0)	3,355 (58.7)	724 (53.4)	2,531 (50.1)
Father had cardiovascular disease, no. (%)‡	1,015 (50)	3,036 (54.3)	522 (42.3)	2,589 (52.3)
Highest educational level of parents, no. (%)§				
Grades 0–3	85 (7.0)	92 (2.1)	46 (7.0)	70 (1.9)
Grades 4–8	591 (48.4)	1,471 (34.0)	326 (49.3)	1,172 (31.7)
Grades 9–11	252 (20.6)	817 (18.9)	147 (22.2)	679 (18.3)
Grade 12 or higher	293 (24.0)	1,945 (45.0)	142 (21.5)	1,781 (48.1)
Educational level of participant, no. (%)				
Grade school/no years of education	372 (16.2)	256 (4.5)	382 (26.6)	378 (7.4)
High school but no degree	548 (23.9)	682 (11.9)	270 (18.8)	563 (11.0)
High school graduate	512 (22.3)	2,465 (42.8)	273 (19.0)	1,501 (29.4)
College/vocational school	865 (37.7)	2,354 (40.9)	511 (35.6)	2,662 (52.2)
Systolic blood pressure, mmHg (mean (SD))¶	124.1 (19.78)	114.5 (16.57)	128.2 (21.31)	118.4 (15.19)
Diastolic blood pressure, mmHg (mean (SD))¶	76.1 (11.04)	68.8 (9.55)	81.2 (12.69)	72.7 (9.55)
On antihypertensive medication, no. (%)	1,089 (47.6)	1,503 (26.2)	503 (35.1)	1,243 (24.5)
Current smoker, no. (%)	565 (24.6)	1,458 (25.3)	562 (39.0)	1,262 (24.7)
Former smoker, no. (%)	407 (17.7)	1,396 (24.3)	488 (33.9)	2,419 (47.3)
Pack-years if ever smoked (mean (SD))	19 (18.3)	24 (18.5)	29 (24.9)	34 (23.7)
Diabetes, no. (%)#	424 (19.0)	448 (7.8)	258 (18.3)	504 (9.9)
High density lipoprotein cholesterol, mmol/liter (mean (SD))	1.50 (0.46)	1.49 (0.44)	1.32 (0.45)	1.11 (0.32)
Low density lipoprotein cholesterol, mmol/liter (mean (SD))	3.55 (1.11)	3.50 (1.02)	3.56 (1.10)	3.62 (0.92)

* Denominators for individual variables may differ because of missing data.

† SD, standard deviation.

‡ Participant's recollection of whether parent had high blood pressure, heart attack, or stroke or whether parent died of heart attack or stroke.

§ Information collected at visit 4 only.

¶ For those participants not on antihypertensive medication.

Based on fasting glucose and recorded diabetes medication use; refer to Materials and Methods.

(table 3). In all other groups, an inverse univariate relation was seen, with some attenuation on adjustment for confounders in White men and women. The final model showed that a 10-cm higher leg length for White women, Black men, and White men was associated with a 0.014-mm, 0.045-mm, and 0.015-mm lower IMT, respectively (table 3). For comparison, the increase in IMT per year increase in age was approximately 0.006 mm. Thus, a 1-standard deviation higher leg length of 4 cm (table 1) would be associated with differences in IMT equivalent to a difference in age of approximately 1 year lower (White men and women) and 2.5 years lower (Black men).

For trunk length, univariate analysis showed an inverse relation with IMT in each sex/ethnic group (table 4). For all groups except Black men, this relation became positive on adjustment for confounders. For Black women, the final model showed a trunk length of 10 cm higher to be associated with an IMT of 0.015 mm higher (thus, a trunk length of 1 standard deviation higher was associated with a higher IMT corresponding to approximately 9 months' difference in age). The relation between trunk length and IMT was strongest in White women and men, with a trunk length of 10 cm higher being associated with a difference in IMT of 0.022 mm and 0.025 mm, respectively (table 4). Thus, a 1-standard deviation higher trunk length is associated with a higher IMT corresponding to an increase in age of approximately 14 months. The relation between trunk length and IMT in Black men was weaker than the relation with leg length, with a wide confidence interval crossing zero (table 4).

No evidence was found of nonlinearity or multicollinearity in the data. Estimates for the final adjusted model were similar (and within the confidence intervals for the effects shown in tables 3 and 4) when early childhood socioeconomic position was included as a confounder and only those attending the fourth visit were included. The differences in IMT per

TABLE 3. Increase in intimal-medial thickness per 10-cm increase in leg length, by sex and race, Atherosclerosis Risk in Communities Study, 1987–1999

Variables included in each model	Increase in intimal-medial thickness (mm) per 10-cm increase in leg length (95% confidence interval)			
	Black women (*n* = 1,623)	White women (*n* = 5,187)	Black men (*n* = 969)	White men (*n* = 4,475)
Univariate	0.018 (0.001, 0.035)	−0.021 (−0.032, −0.010)	−0.042 (−0.066, −0.019)	−0.024 (−0.037, −0.011)
Trunk length, field center, and age (years)	0.013 (−0.003, 0.030)	−0.021 (−0.032, −0.009)	−0.045 (−0.068, −0.022)	−0.020 (−0.034, −0.007)
As above, plus mother's diabetes and cardiovascular disease and father's diabetes and cardiovascular disease	0.014 (−0.003, 0.031)	−0.020 (−0.031, −0.008)	−0.045 (−0.068, −0.022)	−0.020 (−0.033, −0.006)
As above, plus educational level, smoking status and pack-years smoked, systolic blood pressure, diastolic blood pressure, diabetes, antihypertensive medication, high density lipoprotein cholesterol, low density lipoprotein cholesterol, and arterial depth	0.008 (−0.008, 0.024)	−0.011 (−0.022, −0.0005)	−0.040 (−0.062, −0.018)	−0.010 (−0.023, 0.003)
As above, plus weight and waist/hip ratio	0.009 (−0.008, 0.025)	−0.014 (−0.025, −0.003)	−0.045 (−0.068, −0.023)	−0.015 (−0.028, −0.001)

10-cm increase in leg length were as follows: −0.006 (95 percent CI: −0.027, 0.014) for Black women; −0.014 (95 percent CI: −0.025, 0.002) for White women; −0.041 (95 percent CI: −0.075, 0.008) for Black men; and −0.021 (95 percent CI: −0.035, 0.006) for White men. The differences in IMT per 10-cm increase in trunk length were as follows: 0.009 (95 percent CI: −0.020, 0.037) for Black women; 0.019 (95 percent CI: −0.004, 0.034) for White

TABLE 4. Increase in intimal-medial thickness per 10-cm increase in trunk length, by sex and race, Atherosclerosis Risk in Communities Study, 1987–1999

Variables included in each model	Increase in intimal-medial thickness (mm) per 10-cm increase in trunk length (95% confidence interval)			
	Black women (*n* = 1,623)	White women (*n* = 5,187)	Black men (*n* = 969)	White men (*n* = 4,475)
Univariate	−0.022 (−0.044, −0.001)	−0.021 (−0.035, −0.008)	−0.056 (−0.087, −0.025)	−0.020 (−0.037, −0.003)
Leg length, field center, and age	0.007 (−0.015, 0.029)	0.023 (0.009, 0.036)	−0.003 (−0.035, 0.028)	0.027 (0.009, 0.044)
As above, plus mother's diabetes and cardiovascular disease and father's diabetes and cardiovascular disease	0.006 (−0.015, 0.028)	0.023 (0.009, 0.036)	−0.004 (−0.034, 0.028)	0.028 (0.010, 0.045)
As above, plus educational level, smoking status and pack-years smoked, systolic blood pressure, diastolic blood pressure, diabetes, antihypertensive medication, high density lipoprotein cholesterol, low density lipoprotein cholesterol, and arterial depth	0.013 (−0.008, 0.034)	0.024 (0.011, 0.037)	0.002 (−0.029, 0.032)	0.025 (0.008, 0.042)
As above, plus weight and waist/hip ratio	0.015 (−0.008, 0.037)	0.022 (0.008, 0.036)	−0.015 (−0.050, 0.020)	0.024 (0.005, 0.044)

women; 0.014 (95 percent CI: −0.034, 0.063) for Black men; and 0.025 (95 percent CI: 0.004, 0.046) for White men.

DISCUSSION

Using data from the ARIC Study, we have found evidence of an inverse association between leg length and atherosclerosis in middle age, as estimated by carotid intimal-medial thickness measured by B-mode ultrasound. We found evidence of differences in the magnitude of this association between ethnic groups and sexes. The negative association between leg length and carotid atherosclerosis was strongest in Black men and weakest in Black women. In all cases, the associations were fairly small, with the largest (in Black men) implying that a 1-standard deviation lower leg length is associated with a higher IMT corresponding to approximately 2.5 years' difference in age.

The measurements used for trunk and leg lengths here are both estimates (estimated from sitting height minus stool height and difference between sitting and standing height). The estimate of trunk length, thus, also includes head and neck length. The estimate of leg length may be affected by weight and body composition. However, although this measurement error may have biased these associations toward the null, it is unlikely to account for the difference in directions of associations with leg and trunk lengths. Trunk length is likely to be measured with more error than is leg length (because of the addition of head and neck length in the estimate of trunk length and our inability to take account of kyphosis or scoliosis).

The strengths of this study include the large cohort size, data on parental education (used here as a measure of parental socioeconomic position) and cardiovascular risk, and data on childhood education and cardiovascular risk factors measured in adult life. One limitation of the ARIC Study is that information on childhood socioeconomic position (one of the potential confounders in our models) was not sought until the fourth follow-up visit. This and the cross-sectional nature of the study may have resulted in survival bias. However, provided that the risk factors relating to survival (including age, sex, and adult socioeconomic position) are included in the models, the likelihood-based methods used here should yield unbiased results (22). The correlations for Black women and White women reported here among adult leg length, trunk length, weight, and the waist/hip ratio were similar to those reported for women in the British Women's Heart and Health Study (23). The correlations for Black men and White men between adult leg and trunk lengths reported here were similar to those reported for middle-aged men in the Caerphilly Study (14).

Our a priori hypothesis was that leg length would be inversely associated with IMT. Among White women and men and Black men, we found inverse associations between leg length and IMT in both univariable and multivariable models. These associations are consistent with those of previous studies among White women and men with coronary heart disease outcomes (15, 23) and in White women with diabetes outcomes (18).

There may be genetic factors that determine growth patterns and are also associated with cardiovascular disease risk. However, these factors would have to be associated differently with leg and trunk growth. Further, the findings of a recent study with adult anthropometric data on two generations suggest that genetic factors were not important in the associations between components of height and cardiovascular disease risk factors (blood pressure and cholesterol), since adjustment for parental height had very little effect on these associations (17).

In a detailed assessment of the association of early life factors with adult leg and trunk lengths, investigators of a 1946 British birth cohort found that breastfeeding and high-energy diets at age 4 years were associated with longer adult leg length (24). Other prospective cohort studies have also found that breastfeeding, high-energy diets at age 2 years, and affluent childhood social circumstances are all specifically associated with longer leg length (25, 26). These findings of prepubertal early life exposures affecting adult leg length are consistent with the known physiologic fact that, up until puberty, a much greater proportion of the increase in total height is due to increases in leg length (11, 12). The inverse association between leg length and atherosclerosis may therefore reflect a protective effect of breastfeeding and childhood affluence, and it is consistent with studies showing lower adult total cholesterol and blood pressure among persons who were breastfed (27, 28) and greater cardiovascular disease risk among those from poorer childhood backgrounds (29).

We anticipated no association between trunk length and IMT. In univariable analyses, there were weak inverse associations in all sex and ethnic groups, which became positive upon adjustment for potential confounding factors. There is some evidence from previous studies of weak positive associations between trunk length and coronary heart disease (14) and between trunk length and insulin resistance and type II diabetes (18). Smoking and factors associated with osteoporosis (age, sex, estrogen deficiency) will result in reduced adult trunk length. These adult risk factors would mostly be associated with increased cardiovascular disease risk and therefore cannot explain the positive association found here between trunk length and atherosclerosis. Since our association of trunk length and IMT was not anticipated a priori, emerging only upon adjustment for other covariates, and since trunk length derived from sitting height in adulthood is likely to be measured with some considerable measurement error, these findings should be treated with caution. Of note, in the Boyd Orr study, leg length measured directly in childhood was found to be inversely associated with cardiovascular disease mortality over 52 years of follow-up, whereas there was no association between trunk length measured directly in childhood and cardiovascular disease mortality in later life (16). In that study, trunk length was measured from the base of the spine to the neck and would not (in children) be affected by osteoporosis.

In conclusion, we have shown leg length to be inversely associated with atherosclerosis. This is consistent with the results of other studies with cardiovascular disease outcomes and provides some support for the hypothesis that early life factors, such as breastfeeding and childhood nutrition, which are associated with greater prepubertal linear growth, may reduce cardiovascular disease risk.

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