Socioeconomic Status, Cardiovascular Risk Factors, and Subclinical Atherosclerosis in Young Adults
The Cardiovascular Risk in Young Finns Study

Paula Kestilä, Costan G. Magnussen, Jorma S.A. Viikari, Mika Kähönen, Nina Hutri-Kähönen, Leena Taittonen, Antti Jula, Britt-Marie Loo, Matti Pietikäinen, Eero Jokinen, Terho Lehtimäki, Mika Kivimäki, Markus Juonala, Olli T. Raitakari

Objective—The goal of this study was to investigate the extent to which socioeconomic status (SES) in young adults is associated with cardiovascular risk factor levels and carotid intima-media thickness (IMT) and their changes over a 6-year follow-up period.

Methods and Results—The study population included 1813 subjects participating in the 21- and 27-year follow-ups of the Cardiovascular Risk in Young Finns Study (baseline age 24–39 years in 2001). At baseline, SES (indexed with education) was inversely associated with body mass index \((P=0.0002)\), waist circumference \((P<0.0001)\), glucose \((P=0.01)\), and insulin \((P=0.0009)\) concentrations; inversely associated with alcohol consumption \((P=0.02)\) and cigarette smoking \((P<0.0001)\); and directly associated with high-density lipoprotein cholesterol levels \((P=0.05)\) and physical activity \((P=0.006)\). Higher SES was associated with a smaller 6-year increase in body mass index \((P=0.001)\). Education level and IMT were not associated \((P=0.58)\) at baseline, but an inverse association was observed at follow-up among men \((P=0.004)\). This became nonsignificant after adjustment with conventional risk factors \((P=0.11)\). In all subjects, higher education was associated with a smaller increase in IMT during the follow-up \((P=0.002)\), and this association remained after adjustments for conventional risk factors \((P=0.04)\).

Conclusion—This study shows that high education in young adults is associated with favorable cardiovascular risk factor profile and 6-year change of risk factors. Most importantly, the progression of carotid atherosclerosis was slower among individuals with higher educational level. (Arterioscler Thromb Vasc Biol. 2012;32:00-00.)

Key Words: risk factors ■ carotid intima-media thickness ■ education ■ socioeconomic status

Cardiovascular disease (CVD) is one of the leading causes of premature death. In prior studies, low socioeconomic status (SES) has been associated with both adverse cardiovascular risk factor profile and increased risk of cardiovascular morbidity. Among middle-aged subjects, increased carotid artery intima-media thickness (IMT), a subclinical marker of atherosclerosis, has been associated with low SES. SES differences in CVD risk factors start to accumulate as early as in childhood and remain stable into adulthood. A range of factors, including lifestyle, social and genetic factors, occupational exposures, and health habits may contribute to these differences.

Over the past few decades CVD morbidity has declined in developed countries. In Finland, mortality rates from CVDs have declined considerably since the early 1970s. Despite the positive trend in mortality the relative differences between socioeconomic groups have remained large and even grown wider. For example, in male upper nonmanual workers, the mortality decline was 72% during 1987 to 2002 and more than 65% among the 2 highest income tertiles, whereas in male manual workers the decline was 57%, and in the lowest income tertile it was 62%.

Although there is a large body of data on SES differences in CVD outcomes, more information is needed on the

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longitudinal effects of SES on cardiovascular risk factors and early atherosclerosis. Therefore, the main aim of this study was to investigate the differences in baseline and 6-year change in risk factor levels and carotid IMT among young adults. Our analysis is based on the Cardiovascular Risk in Young Finns Study, including 1813 subjects participating in clinical examinations in 2001 (baseline age, 24–39 years) and 2007.

Methods

Population
The Cardiovascular Risk in Young Finns Study is an ongoing epidemiological study of atherosclerosis risk factors from childhood to adulthood. The first cross-sectional study took place in 1980, when 4320 children and adolescents at the ages of 3, 6, 9, 12, 15, and 18 were invited to participate. A total of 3596 individuals participated (83.2% participation rate). The study was carried out in all 5 Finnish university hospitals with medical schools (Helsinki, Kuopio, Oulu, Tampere, Turku) and their rural surroundings. In 2001, a total of 2283 (63.3% of the original sample) individuals participated in the 21-year follow-up study (aged 24–39 years) when the ultrasound measurement of IMT was carried out for the first time. In 2007, when the 27-year follow-up and the second IMT measurements were conducted, 2204 (61.2%) individuals participated (aged 30–45 years). For this study, we used data from those participants with information of SES in 2001 (baseline) who attended the physical examination both in 2001 and at the 2007 follow-up (n=1813). The study was approved by local ethics committees. Further details of the study design have been presented elsewhere.

SES
SES was assessed based on participants’ education and occupation according to the 2001 follow-up questionnaires. The classification of educational SES was made using information about participants’ years of education. The first SES group included participants with education of comprehensive school (low); the second group those with secondary, nonacademic education (intermediate); and the third group those with academic education (high). The distribution into different occupational SES groups—(1) manual, (2) lower nonmanual, and (3) higher nonmanual workers—was made using the classification of occupations by the Central Statistical Office of Finland in 2001.5 In addition, a combined variable using both educational and occupational data was constructed as follows: low, if either education or occupation level was low; medium, if both were medium; high, if either education or occupation level was high.

Measurement of Carotid IMT
Ultrasound studies to measure carotid IMT were carried out in 2001 and 2007 using a similar protocol.23 The studies were performed with Sequoia-512 ultrasound mainframes (Acuson, Mountain View, CA). All measurements were performed by the same technician at baseline and follow-up, who was blinded to participant details. The image, from the left common carotid artery, was focused on the posterior wall. To derive mean carotid IMT, at least 4 details. The image, from the left common carotid artery, was focused on the posterior wall. To derive mean carotid IMT, at least 4

Biochemistry
In 2001 and 2007, blood samples were drawn after a 12-hour fast from the right antecubital vein of recumbent participants.28 Serum cholesterol concentrations were determined enzymatically using a cholesterol esterase–cholesterol oxidase method (Cholesterol reagent, Olympus). The same reagent was used for the estimation of high-density lipoprotein cholesterol high-density lipoprotein cholesterol (HDL-C) levels after HDL-C and very low density lipoprotein were precipitated with dextran sulfate-Mg2+. Low-density lipoprotein cholesterol (LDL-C) concentration was calculated using the Friedewald formula.26 The above mentioned analyses were all performed on an AU400-analyzer (Olympus). The determination of the level of serum triglycerides was made using the enzymatic glycerol kinase–glycerol phosphate oxidase method (Triglyceride reagent, Olympus). Glucose levels were determined by the enzymatic hexokinase method (Glucose reagent, Olympus). A microparticle enzyme immunoassay (IMx insulin reagent, Abbott Diagnostics) on an IMx instrument (Abbott) was used in the determination of serum insulin concentrations. High-sensitivity C-reactive protein (CRP) concentrations were determined by latex turbidimetric immunoassay.

Anthropometry and Blood Pressure
Body mass index (BMI) was calculated as weight (kg)/height (m)2. In 2001 and 2007, weight was measured with participants in light clothing and without shoes using a digital scale with an accuracy of 0.1 kg. Height was determined using a wall-mounted stadiometer with 0.5 cm accuracy. Blood pressure was measured using a random-zero sphygmomanometer after 5 minutes of rest. Korotkoff’s first and fifth sounds were used to denote systolic (SBP) and diastolic (DBP) blood pressures, respectively. The measurement was repeated 3 times at the accuracy of the nearest even number. Waist circumference was measured from the level of the umbilicus to an accuracy of 1 millimeter.

Lifestyle Risk Factors
Information about cigarette smoking, physical activity level, and alcohol consumption was obtained from 2001 and 2007 questionnaires. Those who smoked daily were classified as smokers. Physical activity level was measured as metabolic equivalent index, which was assessed by the duration, frequency, and intensity of leisure time physical activity and commuting.27 Alcohol consumption was represented as drinks per day, 1 drink being approximately 14 g of alcohol.

Statistical Methods
Risk factor levels, carotid IMT, and 6-year change between 2001 and 2007 are expressed as mean for continuous variables and frequency for categorical variables. Comparisons across SES groups were performed using 2-way analysis of covariance for continuous variables and χ2 test for categorical variables. Values of serum glucose, triglycerides, CRP, and BMI were log10-transformed before analysis because of skewed distribution. Because the baseline risk factor level may have an effect on the magnitude of change, analyses that used change in risk factors or carotid IMT as the outcome included the baseline variable as a covariate in the model. All analyses were performed using SAS 9.1 with statistical significance inferred at a 2-tailed probability value <0.05.

Results
Associations of SES With Risk Factors
Risk factor levels at baseline and follow-up according to education level groups are shown in Table 1. At baseline, education was significantly and inversely associated with serum glucose, insulin, BMI, waist circumference, alcohol consumption, and cigarette smoking among men and women and with CRP among women. It was also directly associated with HDL-C and physical activity in both men and women. At follow-up, education was significantly and inversely associated with triglyceride, glucose and insulin levels, SBP, BMI, waist circumference, alcohol consumption, and cigarette smoking, and it was directly associated with physical activity. At both baseline and follow-up, waist circumference explained the SES differences in insulin levels (P=0.12 after
Table 1. Cardiovascular Risk Factor Levels in Educational SES Groups at the Baseline (2001) and Follow-Up (2007)

<table>
<thead>
<tr>
<th>SES Group</th>
<th>Year</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
<th>P Value</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
<th>P Value</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>54</td>
<td>596</td>
<td>144</td>
<td></td>
<td>73</td>
<td>746</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>2001</td>
<td>32.6±4.4</td>
<td>31.9±5.1</td>
<td>31.5±4.7</td>
<td>0.43</td>
<td>32.5±4.3</td>
<td>31.9±5.0</td>
<td>31.9±4.7</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Cholesterol (mmol/L)</td>
<td>2001</td>
<td>5.36±1.02</td>
<td>5.24±1.03</td>
<td>5.21±1.04</td>
<td>0.86</td>
<td>5.00±0.82</td>
<td>5.10±0.95</td>
<td>5.11±0.88</td>
<td>0.62</td>
<td>0.95</td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L)</td>
<td>2007</td>
<td>3.61±0.99</td>
<td>3.42±0.91</td>
<td>3.44±0.90</td>
<td>0.47</td>
<td>3.15±0.71</td>
<td>3.16±0.78</td>
<td>3.18±0.74</td>
<td>0.93</td>
<td>0.79</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>2001</td>
<td>1.12±0.28</td>
<td>1.15±0.27</td>
<td>1.16±0.26</td>
<td>0.50</td>
<td>1.34±0.33</td>
<td>1.40±0.31</td>
<td>1.43±0.28</td>
<td>0.10</td>
<td>0.05</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>2001</td>
<td>1.66±1.16</td>
<td>1.50±0.96</td>
<td>1.41±0.81</td>
<td>0.31</td>
<td>1.13±0.51</td>
<td>1.20±0.74</td>
<td>1.11±0.51</td>
<td>0.23</td>
<td>0.15</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>2001</td>
<td>5.61±2.07</td>
<td>5.18±0.60</td>
<td>5.13±0.74</td>
<td>0.001</td>
<td>4.92±0.40</td>
<td>4.92±0.86</td>
<td>4.84±0.44</td>
<td>0.37</td>
<td>0.01</td>
</tr>
<tr>
<td>Insulin (mU/L)</td>
<td>2001</td>
<td>5.81±1.50</td>
<td>5.50±0.97</td>
<td>5.39±0.78</td>
<td>0.004</td>
<td>5.37±1.40</td>
<td>5.20±0.87</td>
<td>5.07±0.49</td>
<td>0.03</td>
<td>0.001</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>2001</td>
<td>26.6±4.57</td>
<td>25.8±3.40</td>
<td>24.7±3.5</td>
<td>0.005</td>
<td>25.2±5.6</td>
<td>24.5±4.4</td>
<td>23.7±4.4</td>
<td>0.02</td>
<td>0.0002</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>2001</td>
<td>127.0±15.5</td>
<td>126.2±13.0</td>
<td>123.1±11.7</td>
<td>0.04</td>
<td>117.1±14.6</td>
<td>116.2±13.4</td>
<td>119.4±14.1</td>
<td>0.42</td>
<td>0.03</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>2001</td>
<td>93.6±13.3</td>
<td>89.9±10.4</td>
<td>87.6±9.9</td>
<td>0.003</td>
<td>81.2±13.7</td>
<td>79.5±10.8</td>
<td>87.6±11.2</td>
<td>0.002</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Alcohol consumption (g/day)</td>
<td>2001</td>
<td>1.6±2.3</td>
<td>1.1±1.3</td>
<td>1.4±1.4</td>
<td>0.03</td>
<td>0.5±0.7</td>
<td>0.5±0.7</td>
<td>0.6±0.7</td>
<td>0.41</td>
<td>0.02</td>
</tr>
<tr>
<td>Physical activity (METs/d)</td>
<td>2001</td>
<td>1.8±2.4</td>
<td>1.3±1.9</td>
<td>1.4±1.3</td>
<td>0.29</td>
<td>0.9±1.0</td>
<td>0.5±0.7</td>
<td>0.5±0.6</td>
<td>0.001</td>
<td>0.02</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>2001</td>
<td>42.2±29.9</td>
<td>29.7±16.7</td>
<td>7.0±7.0</td>
<td>&lt;0.0001</td>
<td>37.5±19.7</td>
<td>19.7±16.7</td>
<td>4.6±3.0</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>2007</td>
<td>47.2±22.4</td>
<td>29.9±16.7</td>
<td>7.0±7.0</td>
<td>&lt;0.0001</td>
<td>37.5±19.7</td>
<td>19.7±16.7</td>
<td>4.6±3.0</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

Statistics are mean±SD for continuous variables and percentage for smoking. P values are from age-adjusted analysis of covariance (ANCOVA) (except for age) and χ² test for smoking. SES indicates socioeconomic status; LDL, low-density lipoprotein; HDL, high-density lipoprotein; CRP, C-reactive protein; BP, blood pressure; BMI, body mass index; MET, metabolic equivalent index.

*P values for both sexes combined from ANCOVA adjusted with age and sex.

adjustment). Differences in baseline HDL-C (P=0.35) and follow-up triglycerides (P=0.60) and SBP (P=0.40) became nonsignificant after adjustment for waist circumference. The difference in CRP among women was attenuated by adjustments for waist circumference (P=0.22) or oral contraception use (P=0.07). At baseline, 75 subjects were unemployed. The results remained essentially similar after additional adjustment for employment status.

The results of occupation are presented in Table I in the online-only Data Supplement. At baseline, occupation was significantly and inversely associated with smoking, BMI, and waist circumference and directly with physical activity. Among women, there was an inverse association with CRP. At follow-up, SES was inversely associated with triglyceride and glucose levels, BMI, waist circumference, and cigarette smoking in the whole cohort and with insulin among women. There was a direct association to physical activity in the whole cohort. At the follow-up, the differences in triglycerides became nonsignificant after adjustment for waist circumference (P=0.33) or physical activity (P=0.09). In the whole cohort and in both study years, the combined variable of educational and occupational status was inversely associated with glucose, BMI and waist circumference and directly with physical activity and smoking (Table II in the online-only Data Supplement). In 2001, a direct association was observed with alcohol consumption and in 2007 an inverse relation with LDL-C, triglycerides, and SBP.

The 6-Year Change of Risk Factor Levels

Changes in risk factor levels between 2001 and 2007 in different education level groups are shown in Table 2 and in different occupation level groups in Table III in the online-
Subjects, 54 596 144 73 746 200

Cholesterol (mmol/L)
Low Intermediate High P Value
Men
32.6 ± 4.4 31.9 ± 5.1 31.5 ± 4.7 0.43
Women
32.5 ± 4.3 31.9 ± 5.0 31.9 ± 4.7 0.57

LDL cholesterol (mmol/L)
Low Intermediate High P Value
Men
−0.13 ± 0.76 −0.03 ± 0.76 −0.09 ± 0.80 0.53
Women
0.02 ± 0.79 −0.16 ± 0.85 −0.19 ± 0.86 0.20

HDL cholesterol (mmol/L)
Low Intermediate High P Value
Men
0.26 ± 0.72 −0.13 ± 0.69 −0.18 ± 0.69 0.38
Women
−0.06 ± 0.75 −0.21 ± 0.64 −0.24 ± 0.62 0.11

Triglycerides (mmol/L)
Low Intermediate High P Value
Men
0.07 ± 0.20 0.05 ± 0.19 0.06 ± 0.21 0.84
Women
0.04 ± 0.26 0.05 ± 0.28 0.05 ± 0.25 0.96

Glucose (mmol/L)
Low Intermediate High P Value
Men
0.21 ± 1.00 0.32 ± 0.74 0.26 ± 0.40 0.44
Women
0.45 ± 1.43 0.28 ± 0.84 0.23 ± 0.46 0.16

Insulin (mU/L)
Low Intermediate High P Value
Men
2.41 ± 12.69 1.98 ± 7.46 2.00 ± 11.30 0.96
Women
1.16 ± 5.02 1.03 ± 8.58 −0.04 ± 5.34 0.22

CRP (mg/L)
Low Intermediate High P Value
Men
−0.11 ± 2.13 0.15 ± 3.60 −0.27 ± 5.00 0.45
Women
−0.10 ± 3.62 −0.33 ± 5.17 0.18 ± 4.17 0.41

Systolic BP (mm Hg)
Low Intermediate High P Value
Men
4.2 ± 12.6 4.9 ± 10.5 3.9 ± 9.5 0.58
Women
5.8 ± 11.3 4.1 ± 11.0 2.5 ± 10.3 0.07

Diastolic BP (mm Hg)
Low Intermediate High P Value
Men
6.8 ± 9.7 6.1 ± 9.1 5.4 ± 8.4 0.52
Women
4.9 ± 8.7 5.1 ± 9.3 3.1 ± 9.4 0.03

BMI (kg/m²)
Low Intermediate High P Value
Men
1.0 ± 2.2 1.1 ± 2.1 0.7 ± 1.9 0.10
Women
1.6 ± 2.7 1.0 ± 2.5 0.5 ± 1.7 0.004

Waist (cm)
Low Intermediate High P Value
Men
4.1 ± 6.7 4.7 ± 6.3 4.4 ± 6.5 0.67
Women
6.3 ± 7.1 4.7 ± 7.3 3.7 ± 5.4 0.02

Alcohol consumption (portions/d)
Low Intermediate High P Value
Men
0.2 ± 2.1 0.2 ± 1.8 0.0 ± 1.3 0.50
Women
0.4 ± 1.0 0.1 ± 0.7 0.0 ± 0.7 0.0003

Physical activity (METs/d)
Low Intermediate High P Value
Men
−0.2 ± 25.2 0.2 ± 21.8 2.9 ± 22.2 0.42
Women
4.2 ± 25.3 −0.3 ± 20.9 0.3 ± 19.0 0.35

Statistics are mean ± SD. P values are from age-adjusted analysis of covariance (ANCOVA) except for age. SES indicates socioeconomic status; LDL, low-density lipoprotein; HDL, high-density lipoprotein; CRP, C-reactive protein; BP, blood pressure; BMI, body mass index; MET, metabolic equivalent index.

*P values for both sexes combined from ANCOVA adjusted with age and sex.

only Data Supplement. Higher baseline education was significantly associated with favorable changes in BMI and DBP in the whole cohort and in waist circumference and alcohol consumption among women. Baseline occupation was significantly and inversely associated with the 6-year change in the whole cohort in blood pressure, BMI, and waist circumference and, among women, in alcohol consumption. The combined baseline SES level was related with favorable changes in triglycerides, DBP, BMI, and waist circumference (Table IV in the online-only Data Supplement).

**S**E**S** and **C**arotid IMT

At baseline, education level was not associated with carotid IMT (Figure 1). At follow-up, there was a significant inverse association between education and carotid IMT among men (P = 0.004) and in the whole cohort (P = 0.04). Although the relation was not statistically significant in women, we found no significant SES × sex interaction effect on IMT (P = 0.64).

When adjusted for age, LDL-C, HDL-C, SBP, BMI, and cigarette smoking, the association among men disappeared (P = 0.11). Similarly, in the whole cohort, the association was attenuated when adjusted for sex and the above-mentioned risk factors (P = 0.31).

Education was significantly and inversely associated with 6-year change in carotid IMT levels among men (P = 0.005) (Figure 2) and the whole cohort (P = 0.002). The association was not significant in women (P = 0.10), and no significant SES × sex interaction was observed (P = 0.64). The associa-

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**Figure 1.** Carotid intima-media thickness (IMT) (mean ± SEM) across educational socioeconomic status (SES) classes in 2001 and 2007 among men (A) and women (B). Probability values are from analysis of covariance.
social patterning of physical activity, diet, and access to in CVD risk factor levels between SES groups. For example, analyses they tended to become more pronounced during 6-years of follow-up.

Several plausible mechanisms may underlie the difference in CVD risk factor levels between SES groups. For example, physical inactivity, and cigarette smoking habits were more common in the lower SES groups of the present study cohort. The use of oral contraceptives has been found to affect CRP levels. In our previous analysis, as well as the present analyses, CRP was inversely associated with educational and occupational level among women. The difference of CRP levels between educational level groups was partially explained by oral contraceptive use, as well as insulin levels and waist circumference. In this cohort, there were no age differences between SES groups, and hence, age had no effect on risk factor differences.

CVD is a slowly progressing disease, and the subclinical signs of CVD can be measured years before the manifest disease. In our previous analyses from the Young Finns cohort using data form year 2001 follow-up, we did not observe an association of childhood or adulthood SES with carotid IMT. Some other studies have reported an inverse association between SES and IMT among white, middle-aged (over 45 years of age) or older populations. In the present analyses, we observed no SES differences in mean carotid IMT at baseline when participants were 24 to 39 years of age. However, after the 6-year follow-up, a significant difference in IMT between educational level groups was observed among men. In addition, the progression of carotid IMT over the 6-year follow-up was faster in lower educational level groups, supporting the results of earlier studies found among middle-aged population.

In this study, SES differences in IMT were mainly explained by the adverse risk factor profile in lower educational level groups. Our results therefore suggest that more aggressive interventions to diminish risk factor burden, especially obesity, in lower SES groups is needed. In the British Whitehall study, it was estimated that the majority of SES differences in cardiovascular mortality would be reduced by a successful implementation of the best-practice interventions across all SES groups, and further preventive benefits could be achieved if the traditional risk factor levels were reduced to primordial levels.

Our study has several potential implications for prevention. Worldwide, CVD remains the leading cause of death. Together with differences in the risk factor levels, the numbers of mortality vary within SES groups. In Finland, there has been a reduction in mortality over time among all SES groups, but the declining trend has been steeper in the highest groups. In the lower SES groups, favorable secular trends have been explained by the change of risk factor levels, and our findings suggest that favorable risk factor profile change is associated with a slower progression of subclinical atherosclerosis. Thus, these data suggest that additional efforts should be allocated to preventive interventions in the lower SES groups.

The major limitations of this study included sample attrition, which can contribute to both under- and overestimation of effects, and racially homogeneous study population, limiting the generalizability of the findings. Details on these limitations have been published elsewhere.
tions in the classifications of SES are also noteworthy. For example, unemployment, poor health, age, and life circumstances may have affected the classification. However, education is considered the best predictor of risk factor levels, which was descriptively evident also in this study. Despite these limitations, this ongoing study is unique in its breadth and duration. The data provide well-standardized possibilities to investigate risk of CVD and SES among young adults without evident clinical CVD.

In conclusion, marked socioeconomic differences in CVD risk factor levels and subclinical signs of atherosclerosis were observed in a contemporary population of young Finns. Education rather than occupational position was predictive of risk factor levels and carotid IMT. The 6-year change in risk factor levels and carotid IMT was most favorable in groups with high educational attainment.

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Disclosures

None.

References


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Socioeconomic status, cardiovascular risk factors and subclinical atherosclerosis in young adults.

The Cardiovascular Risk in Young Finns Study.

Paula Kestilä, Costan G. Magnussen, Jorma S.A. Viikari, Mika Kähönen, Nina Hutri-Kähönen, Leena Taittonen, Antti Jula, Britt-Marie Loo, Matti Pietikäinen, Eero Jokinen, Terho Lehtimäki, Mika Kivimäki, Markus Juonala, Olli T. Raitakari
## Supplemental Table I. Cardiovascular risk factor levels in occupational SES groups at the baseline (2001) and follow-up (2007).

<table>
<thead>
<tr>
<th>SES group</th>
<th>Year</th>
<th>Manual</th>
<th>Lower non-manual</th>
<th>higher non-manual</th>
<th>p-value</th>
<th>Manual</th>
<th>Lower non-manual</th>
<th>higher non-manual</th>
<th>p-value</th>
<th>p-value</th>
</tr>
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<tbody>
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<td>N</td>
<td></td>
<td>301</td>
<td>181</td>
<td>208</td>
<td></td>
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<td>476</td>
<td>156</td>
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<td></td>
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<tr>
<td>Age, y</td>
<td>2001</td>
<td>31.7±4.8</td>
<td>32.8±4.9</td>
<td>31.6±4.9</td>
<td>0.03</td>
<td>31.6±4.8</td>
<td>32.3±4.9</td>
<td>32.4±4.8</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>2001</td>
<td>5.30±1.04</td>
<td>5.21±0.96</td>
<td>5.23±1.03</td>
<td>0.20</td>
<td>5.15±0.94</td>
<td>5.10±0.95</td>
<td>5.10±0.88</td>
<td>0.76</td>
<td>0.23</td>
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<tr>
<td></td>
<td>2007</td>
<td>5.25±0.99</td>
<td>5.18±0.89</td>
<td>5.14±0.90</td>
<td>0.25</td>
<td>5.04±0.87</td>
<td>4.94±0.86</td>
<td>4.92±0.83</td>
<td>0.25</td>
<td>0.07</td>
</tr>
<tr>
<td>LDL-Cholesterol (mmol/l)</td>
<td>2001</td>
<td>3.50±0.95</td>
<td>3.39±0.87</td>
<td>3.42±0.90</td>
<td>0.09</td>
<td>3.23±0.81</td>
<td>3.16±0.76</td>
<td>3.18±0.74</td>
<td>0.53</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>3.35±0.86</td>
<td>3.29±0.79</td>
<td>3.23±0.77</td>
<td>0.28</td>
<td>3.04±0.78</td>
<td>2.95±0.72</td>
<td>2.95±0.70</td>
<td>0.24</td>
<td>0.06</td>
</tr>
<tr>
<td>HDL-Cholesterol (mmol/l)</td>
<td>2001</td>
<td>1.15±0.27</td>
<td>1.18±0.26</td>
<td>1.14±0.27</td>
<td>0.36</td>
<td>1.39±0.29</td>
<td>1.40±0.31</td>
<td>1.44±0.30</td>
<td>0.22</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>1.20±0.28</td>
<td>1.23±0.28</td>
<td>1.21±0.27</td>
<td>0.60</td>
<td>1.43±0.32</td>
<td>1.45±0.34</td>
<td>1.49±0.31</td>
<td>0.17</td>
<td>0.24</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>2001</td>
<td>1.51±1.00</td>
<td>1.47±1.08</td>
<td>1.49±0.68</td>
<td>0.77</td>
<td>1.19±0.59</td>
<td>1.21±0.79</td>
<td>1.07±0.56</td>
<td>0.10</td>
<td>0.25</td>
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<tr>
<td></td>
<td>2007</td>
<td>1.70±1.29</td>
<td>1.49±0.94</td>
<td>1.59±1.00</td>
<td>0.09</td>
<td>1.25±0.71</td>
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<td>1.07±0.48</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>2001</td>
<td>5.24±0.77</td>
<td>5.16±0.52</td>
<td>5.16±0.67</td>
<td>0.19</td>
<td>4.97±0.57</td>
<td>4.90±0.93</td>
<td>4.89±0.45</td>
<td>0.46</td>
<td>0.09</td>
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<td></td>
<td>2007</td>
<td>5.58±1.27</td>
<td>5.44±0.63</td>
<td>5.43±0.73</td>
<td>0.11</td>
<td>5.29±0.80</td>
<td>5.16±0.84</td>
<td>5.08±0.47</td>
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<td>0.003</td>
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<tr>
<td>Body Mass Index (kg/m²)</td>
<td>2001</td>
<td>1.35±2.49</td>
<td>1.38±2.80</td>
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<td>0.88</td>
<td>2.70±5.08</td>
<td>2.39±4.87</td>
<td>1.58±2.49</td>
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<td>2007</td>
<td>1.41±2.43</td>
<td>1.44±2.20</td>
<td>1.46±2.78</td>
<td>0.96</td>
<td>2.20±2.80</td>
<td>2.04±3.59</td>
<td>1.71±3.81</td>
<td>0.42</td>
<td>0.61</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>2001</td>
<td>7.55±6.02</td>
<td>6.96±4.05</td>
<td>7.42±4.00</td>
<td>0.38</td>
<td>8.34±6.99</td>
<td>7.69±5.18</td>
<td>7.39±5.80</td>
<td>0.27</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>9.07±7.79</td>
<td>9.27±11.40</td>
<td>9.40±11.18</td>
<td>0.92</td>
<td>9.26±7.20</td>
<td>8.49±7.95</td>
<td>7.23±5.31</td>
<td>0.03</td>
<td>0.52</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>2001</td>
<td>122.2±12.4</td>
<td>120.5±12.7</td>
<td>120.6±11.6</td>
<td>0.15</td>
<td>112.7±11.8</td>
<td>112.0±12.6</td>
<td>113.0±12.6</td>
<td>0.54</td>
<td>0.22</td>
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<tr>
<td></td>
<td>2007</td>
<td>126.4±13.2</td>
<td>126.9±14.1</td>
<td>124.2±12.2</td>
<td>0.14</td>
<td>117.7±13.6</td>
<td>116.2±13.7</td>
<td>115.1±13.9</td>
<td>0.35</td>
<td>0.03</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>2001</td>
<td>73.0±11.8</td>
<td>72.9±11.3</td>
<td>72.8±10.0</td>
<td>0.69</td>
<td>68.3±9.5</td>
<td>66.6±10.1</td>
<td>69.7±9.9</td>
<td>0.40</td>
<td>0.65</td>
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<tr>
<td></td>
<td>2007</td>
<td>79.2±11.3</td>
<td>79.9±11.3</td>
<td>77.5±11.0</td>
<td>0.17</td>
<td>73.5±11.3</td>
<td>73.4±10.9</td>
<td>73.2±10.4</td>
<td>0.93</td>
<td>0.39</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>2001</td>
<td>25.9±4.4</td>
<td>25.9±3.6</td>
<td>25.4±3.6</td>
<td>0.39</td>
<td>25.1±4.7</td>
<td>24.6±4.5</td>
<td>23.9±4.4</td>
<td>0.02</td>
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<tr>
<td></td>
<td>2007</td>
<td>26.9±4.4</td>
<td>27.0±3.8</td>
<td>26.1±4.2</td>
<td>0.11</td>
<td>26.3±5.0</td>
<td>25.5±4.9</td>
<td>24.4±4.6</td>
<td>0.0006</td>
<td>0.0002</td>
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<tr>
<td>Alcohol consumption (portions/d)</td>
<td>2001</td>
<td>1.2±1.4</td>
<td>1.2±1.4</td>
<td>1.3±1.3</td>
<td>0.33</td>
<td>0.5±0.8</td>
<td>0.5±0.7</td>
<td>0.5±0.7</td>
<td>0.87</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>1.4±2.3</td>
<td>1.2±1.3</td>
<td>1.4±1.7</td>
<td>0.40</td>
<td>0.7±0.9</td>
<td>0.6±0.7</td>
<td>0.5±0.6</td>
<td>0.07</td>
<td>0.31</td>
</tr>
<tr>
<td>Physical activity (METs/d)</td>
<td>2001</td>
<td>15.5±19.7</td>
<td>18.8±22.2</td>
<td>22.5±21.4</td>
<td>0.002</td>
<td>20.2±18.3</td>
<td>18.4±17.3</td>
<td>20.2±18.8</td>
<td>0.42</td>
<td>0.008</td>
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<tr>
<td></td>
<td>2007</td>
<td>15.0±19.3</td>
<td>22.0±25.1</td>
<td>23.5±22.9</td>
<td>&lt;0.0001</td>
<td>21.5±22.5</td>
<td>19.2±20.4</td>
<td>20.5±18.2</td>
<td>0.32</td>
<td>0.008</td>
</tr>
<tr>
<td>Smokers (%)</td>
<td>2001</td>
<td>38.0</td>
<td>26.3</td>
<td>14.2</td>
<td>&lt;0.0001</td>
<td>28.7</td>
<td>16.4</td>
<td>5.9</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>31.3</td>
<td>17.9</td>
<td>11.6</td>
<td>&lt;0.0001</td>
<td>22.5</td>
<td>14.2</td>
<td>4.6</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Statistics are mean±SD for continuous variables and percent for smoking. P-values from age-adjusted ANCOVA (except for age), and chi-square test for smoking.

* P-values genders combined from ANCOVA adjusted with age and sex
Supplemental Table II. Cardiovascular risk factor levels in combined occupational and educational level SES groups at the baseline (2001) and follow-up (2007).

<table>
<thead>
<tr>
<th>SES group</th>
<th>Year</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
<th>p-value</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
<th>p-value</th>
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<tr>
<td><strong>Men</strong></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2001</td>
<td>301</td>
<td>172</td>
<td>246</td>
<td>31.7±4.8</td>
<td>172</td>
<td>246</td>
<td>31.7±4.8</td>
<td>0.02</td>
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<tr>
<td>Age, y</td>
<td>2001</td>
<td>31.7±4.8</td>
<td>32.8±4.9</td>
<td>31.5±4.9</td>
<td>0.26</td>
<td>5.12±0.93</td>
<td>32.1±5.0</td>
<td>31.9±4.8</td>
<td>0.74</td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>2001</td>
<td>5.29±1.04</td>
<td>5.21±0.96</td>
<td>5.20±1.02</td>
<td>0.26</td>
<td>5.08±0.96</td>
<td>5.10±0.87</td>
<td>0.88</td>
<td>0.41</td>
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<tr>
<td>LDL-cholesterol (mmol/l)</td>
<td>2001</td>
<td>3.50±0.95</td>
<td>3.39±0.87</td>
<td>3.39±0.89</td>
<td>0.11</td>
<td>3.20±0.80</td>
<td>3.15±0.76</td>
<td>3.18±0.75</td>
<td>0.65</td>
</tr>
<tr>
<td>HDL-cholesterol (mmol/l)</td>
<td>2001</td>
<td>1.15±0.27</td>
<td>1.18±0.26</td>
<td>1.14±0.27</td>
<td>0.43</td>
<td>1.43±0.31</td>
<td>1.43±0.29</td>
<td>0.20</td>
<td>0.57</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>2001</td>
<td>1.49±0.96</td>
<td>1.47±1.10</td>
<td>1.49±0.84</td>
<td>0.87</td>
<td>1.11±0.54</td>
<td>1.11±0.54</td>
<td>0.14</td>
<td>0.55</td>
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<tr>
<td>Glucose (mmol/l)</td>
<td>2001</td>
<td>5.28±1.11</td>
<td>5.17±0.52</td>
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<td>0.07</td>
<td>4.91±0.98</td>
<td>4.85±0.42</td>
<td>0.25</td>
<td>0.02</td>
</tr>
<tr>
<td>CRP (mg/l)</td>
<td>2001</td>
<td>1.38±2.52</td>
<td>1.42±2.87</td>
<td>1.39±3.89</td>
<td>0.99</td>
<td>2.6±4.91</td>
<td>2.6±4.91</td>
<td>0.15</td>
<td>0.30</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>2001</td>
<td>122.1±12.4</td>
<td>120.7±12.8</td>
<td>120.0±11.5</td>
<td>0.12</td>
<td>112.6±12.1</td>
<td>112.5±12.3</td>
<td>0.78</td>
<td>0.22</td>
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<tr>
<td>Diastolic BP (mmHg)</td>
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<td>72.9±11.8</td>
<td>72.9±11.4</td>
<td>72.9±9.9</td>
<td>0.67</td>
<td>68.4±9.7</td>
<td>68.6±10.1</td>
<td>0.43</td>
<td>0.47</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>2001</td>
<td>25.9±4.4</td>
<td>26.0±3.6</td>
<td>25.2±3.7</td>
<td>0.19</td>
<td>25.0±5.0</td>
<td>24.6±4.4</td>
<td>23.8±4.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>2001</td>
<td>90.3±11.4</td>
<td>90.6±9.6</td>
<td>88.8±10.3</td>
<td>0.30</td>
<td>80.6±12.4</td>
<td>79.6±10.8</td>
<td>77.0±10.6</td>
<td>0.0001</td>
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<tr>
<td>Alcohol consumption (portions/d)</td>
<td>2001</td>
<td>1.1±1.4</td>
<td>1.1±1.3</td>
<td>1.4±1.4</td>
<td>0.10</td>
<td>0.5±0.7</td>
<td>0.5±0.7</td>
<td>0.6±0.7</td>
<td>0.40</td>
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<tr>
<td>Physical activity (METs/d)</td>
<td>2001</td>
<td>15.5±19.7</td>
<td>18.8±22.2</td>
<td>22.4±22.2</td>
<td>0.002</td>
<td>19.1±17.6</td>
<td>18.2±17.3</td>
<td>20.3±18.3</td>
<td>0.0002</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>2001</td>
<td>38.4</td>
<td>27.1</td>
<td>13.2</td>
<td>&lt;0.0001</td>
<td>30.3</td>
<td>16.1</td>
<td>6.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Women</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2001</td>
<td>225</td>
<td>462</td>
<td>252</td>
<td>31.9±4.7</td>
<td>32.1±5.0</td>
<td>31.9±4.8</td>
<td>0.74</td>
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</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>2001</td>
<td>5.24±0.98</td>
<td>5.17±0.89</td>
<td>5.14±0.91</td>
<td>0.34</td>
<td>5.03±0.87</td>
<td>4.98±0.84</td>
<td>4.95±0.86</td>
<td>0.13</td>
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<tr>
<td>LDL-cholesterol (mmol/l)</td>
<td>2001</td>
<td>3.50±0.95</td>
<td>3.39±0.87</td>
<td>3.39±0.89</td>
<td>0.11</td>
<td>3.20±0.80</td>
<td>3.15±0.76</td>
<td>3.18±0.75</td>
<td>0.65</td>
</tr>
<tr>
<td>HDL-cholesterol (mmol/l)</td>
<td>2001</td>
<td>1.15±0.27</td>
<td>1.18±0.26</td>
<td>1.14±0.27</td>
<td>0.43</td>
<td>1.43±0.31</td>
<td>1.43±0.29</td>
<td>0.20</td>
<td>0.57</td>
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<td>Triglycerides (mmol/l)</td>
<td>2001</td>
<td>1.49±0.96</td>
<td>1.47±1.10</td>
<td>1.49±0.84</td>
<td>0.87</td>
<td>1.11±0.54</td>
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<td>0.14</td>
<td>0.55</td>
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<tr>
<td>Glucose (mmol/l)</td>
<td>2001</td>
<td>5.28±1.11</td>
<td>5.17±0.52</td>
<td>5.14±0.63</td>
<td>0.07</td>
<td>4.91±0.98</td>
<td>4.85±0.42</td>
<td>0.25</td>
<td>0.02</td>
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<td>CRP (mg/l)</td>
<td>2001</td>
<td>1.38±2.52</td>
<td>1.42±2.87</td>
<td>1.39±3.89</td>
<td>0.99</td>
<td>2.6±4.91</td>
<td>2.6±4.91</td>
<td>0.15</td>
<td>0.30</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>2001</td>
<td>122.1±12.4</td>
<td>120.7±12.8</td>
<td>120.0±11.5</td>
<td>0.12</td>
<td>112.6±12.1</td>
<td>112.5±12.3</td>
<td>0.78</td>
<td>0.22</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>2001</td>
<td>72.9±11.8</td>
<td>72.9±11.4</td>
<td>72.9±9.9</td>
<td>0.67</td>
<td>68.4±9.7</td>
<td>68.6±10.1</td>
<td>0.43</td>
<td>0.47</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>2001</td>
<td>26.4±5.3</td>
<td>26.4±5.3</td>
<td>25.5±4.8</td>
<td>0.04</td>
<td>24.3±4.5</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>2001</td>
<td>90.3±11.4</td>
<td>90.6±9.6</td>
<td>88.8±10.3</td>
<td>0.30</td>
<td>80.6±12.4</td>
<td>79.6±10.8</td>
<td>77.0±10.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Alcohol consumption (portions/d)</td>
<td>2001</td>
<td>1.1±1.4</td>
<td>1.1±1.3</td>
<td>1.4±1.4</td>
<td>0.10</td>
<td>0.5±0.7</td>
<td>0.5±0.7</td>
<td>0.6±0.7</td>
<td>0.40</td>
</tr>
<tr>
<td>Physical activity (METs/d)</td>
<td>2001</td>
<td>15.5±19.7</td>
<td>18.8±22.2</td>
<td>22.4±22.2</td>
<td>0.002</td>
<td>19.1±17.6</td>
<td>18.2±17.3</td>
<td>20.3±18.3</td>
<td>0.0002</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>2001</td>
<td>38.4</td>
<td>27.1</td>
<td>13.2</td>
<td>&lt;0.0001</td>
<td>30.3</td>
<td>16.1</td>
<td>6.5</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Statistics are mean±SD for continuous variables and percent for smoking. P-values from age-adjusted ANCOVA (except for age), and chi-square test for smoking.
* P-values genders combined from ANCOVA adjusted with age and sex.
Supplemental Table III. Change of risk factor levels between 2001 and 2007 in occupational SES groups.

<table>
<thead>
<tr>
<th>SES group</th>
<th>Men</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Manual</td>
<td>Lower non-</td>
<td>higher non-</td>
<td>p-value</td>
<td>Manual</td>
<td>Lower non-</td>
<td>higher non-</td>
<td>p-value</td>
<td>p-value</td>
<td></td>
<td>p-value</td>
<td></td>
<td>p-value</td>
<td></td>
<td>p-value</td>
<td></td>
<td>p-value</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>301</td>
<td>181</td>
<td>208</td>
<td></td>
<td>176</td>
<td>476</td>
<td>156</td>
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</tr>
<tr>
<td>Age 2001 (y)</td>
<td>31.7±4.8</td>
<td>32.8±4.9</td>
<td>31.6±4.9</td>
<td><strong>0.03</strong></td>
<td>31.8±4.8</td>
<td>32.2±4.9</td>
<td>32.2±4.8</td>
<td>0.70</td>
<td></td>
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</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>-0.05±0.76</td>
<td>-0.03±0.76</td>
<td>-0.09±0.76</td>
<td>0.50</td>
<td>-0.11±0.85</td>
<td>-0.16±0.88</td>
<td>-0.18±0.85</td>
<td>0.69</td>
<td>0.62</td>
<td></td>
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</tr>
<tr>
<td>LDL-Cholesterol (mmol/l)</td>
<td>-0.16±0.73</td>
<td>-0.08±0.73</td>
<td>-0.20±0.66</td>
<td>0.08</td>
<td>-0.19±0.67</td>
<td>-0.20±0.65</td>
<td>-0.23±0.61</td>
<td>0.74</td>
<td>0.30</td>
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<tr>
<td>HDL-Cholesterol (mmol/l)</td>
<td>0.05±0.20</td>
<td>0.05±0.19</td>
<td>0.08±0.20</td>
<td>0.40</td>
<td>0.04±0.27</td>
<td>0.05±0.29</td>
<td>0.05±0.25</td>
<td>0.95</td>
<td>0.64</td>
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<tr>
<td>Triglycerides (mmol/l)</td>
<td>0.19±1.04</td>
<td>0.02±0.96</td>
<td>0.10±0.69</td>
<td>0.17</td>
<td>0.06±0.74</td>
<td>-0.02±0.78</td>
<td>-0.01±0.60</td>
<td>0.41</td>
<td>0.07</td>
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</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>0.34±0.93</td>
<td>0.28±0.55</td>
<td>0.27±0.39</td>
<td>0.47</td>
<td>0.33±0.84</td>
<td>0.26±0.85</td>
<td>0.19±0.47</td>
<td>0.21</td>
<td>0.12</td>
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<td></td>
</tr>
<tr>
<td>Insulin (mU/l)</td>
<td>1.52±7.17</td>
<td>2.32±9.73</td>
<td>1.98±10.16</td>
<td>0.68</td>
<td>0.91±6.61</td>
<td>0.80±7.48</td>
<td>-0.16±5.40</td>
<td>0.23</td>
<td>0.55</td>
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</tr>
<tr>
<td>CRP (mg/l)</td>
<td>0.06±2.96</td>
<td>0.05±2.92</td>
<td>0.00±4.82</td>
<td>0.97</td>
<td>-0.50±5.08</td>
<td>-0.35±5.25</td>
<td>0.13±4.10</td>
<td>0.43</td>
<td>0.69</td>
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<td></td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>4.3±11.4</td>
<td>6.4±9.6</td>
<td>3.5±9.7</td>
<td><strong>0.04</strong></td>
<td>5.0±11.7</td>
<td>4.3±10.9</td>
<td>2.0±9.9</td>
<td>0.02</td>
<td><strong>0.007</strong></td>
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</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>6.1±9.4</td>
<td>7.1±8.3</td>
<td>4.6±9.1</td>
<td>0.02</td>
<td>5.2±9.3</td>
<td>4.8±9.3</td>
<td>3.6±9.0</td>
<td>0.23</td>
<td><strong>0.01</strong></td>
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</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>1.0±2.4</td>
<td>1.1±1.8</td>
<td>0.8±1.8</td>
<td>0.15</td>
<td>1.3±2.8</td>
<td>0.9±2.4</td>
<td>0.5±1.8</td>
<td><strong>0.01</strong></td>
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</tr>
<tr>
<td>Waist (cm)</td>
<td>4.6±6.7</td>
<td>4.1±5.9</td>
<td>4.0±6.1</td>
<td>0.53</td>
<td>5.7±7.8</td>
<td>4.5±6.9</td>
<td>3.3±5.9</td>
<td><strong>0.004</strong></td>
<td><strong>0.01</strong></td>
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<td></td>
</tr>
<tr>
<td>Alcohol consumption (portions/d)†</td>
<td>0.2±2.3</td>
<td>0.0±1.4</td>
<td>0.1±1.4</td>
<td>0.53</td>
<td>0.2±0.8</td>
<td>0.1±0.7</td>
<td>-0.0±0.7</td>
<td><strong>0.02</strong></td>
<td>0.13</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Physical activity (METs/d)</td>
<td>-0.7±20.0</td>
<td>3.5±24.1</td>
<td>1.4±22.7</td>
<td>0.22</td>
<td>0.1±22.8</td>
<td>0.1±19.6</td>
<td>0.4±20.9</td>
<td>0.99</td>
<td>0.48</td>
<td></td>
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</tr>
</tbody>
</table>

Statistics are mean±SD. P-values from age-adjusted ANCOVA (except for age).
* P-values genders combined from ANCOVA adjusted with age and sex
Supplemental Table IV. Change of risk factor levels between 2001 and 2007 in combined occupational and educational level SES groups.

<table>
<thead>
<tr>
<th>SES group</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Intermediate</td>
</tr>
<tr>
<td>N</td>
<td>301</td>
<td>172</td>
</tr>
<tr>
<td>Age 2001 (y)</td>
<td>31.7±4.8</td>
<td>32.8±4.9</td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>-0.05±0.75</td>
<td>-0.04±0.76</td>
</tr>
<tr>
<td>LDL-Cholesterol (mmol/l)</td>
<td>-0.18±0.68</td>
<td>-0.09±0.73</td>
</tr>
<tr>
<td>HDL-Cholesterol (mmol/l)</td>
<td>0.05±0.20</td>
<td>0.04±0.19</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>0.20±1.03</td>
<td>0.02±0.98</td>
</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>0.33±0.94</td>
<td>0.28±0.55</td>
</tr>
<tr>
<td>Insulin (mU/l)</td>
<td>1.61±7.38</td>
<td>2.33±9.96</td>
</tr>
<tr>
<td>CRP (mg/l)</td>
<td>0.07±2.97</td>
<td>0.05±2.99</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>4.3±11.3</td>
<td>6.2±9.6</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>6.2±9.3</td>
<td>7.0±8.3</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>1.0±2.3</td>
<td>1.1±1.8</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>4.7±6.5</td>
<td>4.0±6.0</td>
</tr>
<tr>
<td>Alcohol consumption (portions/d)†</td>
<td>0.3±2.3</td>
<td>0.1±1.4</td>
</tr>
<tr>
<td>Physical activity (METs/d)</td>
<td>-0.3±20.3</td>
<td>3.7±24.7</td>
</tr>
</tbody>
</table>

Statistics are mean±SD. P-values from age-adjusted ANCOVA (except for age). * P-values genders combined from ANCOVA adjusted with age and sex.
교육 수준이 높을수록 심혈관질환 위험인자가 줄어들고 죽상경화가 억제된다.

조 상호 교수
한림대학교 성심병원 순환기내과

Summary

배경
젊은 성인에서 사회경제적 위치(socioeconomic status, SES)가 심혈관계 위험인자와 경동맥 내막-중막 두께(carotid intima-media thickness, C-IMT) 및 그 변화(6년간)와 연관이 있는지를 알아보고자 하였다.

방법 및 결과
본 연구는 핀란드에서 시행한 Cardiovascular Risk in Young Finn Study 6년 추적 관찰 역학 연구의 일부로서 2001년 현재, 24-39세의 젊은 성인 1,813명을 6년간 추적 관찰한 결과이다. 기저에 SES는 체질량 지수(body mass index, BMI) \((P=0.0002)\), 허리둘레(\(P<0.0001\)), glucose \((P=0.01)\), insulin 농도(\(P=0.0009\)), 알코올 소비(\(P=0.02\)), 흡연(\(P<0.0001\))과 역의 상관계계를 보였다. 또한 고밀도 지단백(high-density lipoprotein cholesterol, HDL-C)(\(P=0.05\))과 활동량(\(P=0.006\))과는 양의 상관계계를 보였다.

높은 SES는 6년 후에 BMI가 적게 증가하는 것과 연관 있었다(\(P=0.001\)). 교육 정도와 C-IMT는 기저에서는 서로 관련성이 없었으나 추적 관찰기간 동안 남자에서는 역의 상관계계가 관찰되었다(\(P=0.004\)). 그러나 이는 다른 전통적인 위험인자를 보정한 후에는 더 이상 의미가 없었다(\(P=0.11\)). 모든 대상에서 높은 교육 수준이 추적 관찰시의 C-IMT의 적은 증가와 연관성이 있었고(\(P=0.002\)), 이는 다른 전통적 위험인자를 보정하여도 의미가 있었다(\(P=0.04\)).

결론
이 연구는 젊은 성인에서 교육 수준이 높을수록 6년 후의 위험인자 감소와 연관성이 있음을 보여주고 있다. 가장 중요하게는 교육 수준이 높을수록 경동맥의 죽상경화가 느리게 진행한다는 것이다.
본 연구는 핀란드에서 시행된 전향적 코호트 연구로서 젊은 성인을 6년간 추적 관찰하면서 사회 경제적 요인(SES)에 따라 심혈관계 위험인자 이환과 초기 죽상경화 발생이 다른지 평가한 연구이다. SES는 교육 수준과 직업에 따라 상, 중, 하로 나누었다. 기존의 연구들에서도 낮은 SES의 일반인이 심혈관계질환의 위험인자에 쉽게 이환되며 심혈관계 건 발생이 높다고 보고되었고 이는 주로 생활습관, 식이, 운동, 자기관리, 사회적 유전적 요인, 직업 등이 관여한다고 생각되어 왔다. 본 연구는 기존의 연구들이 중년의 성인을 대상으로 한 것에 반해 젊은 성인을 대상으로하여 초기 죽상경화의 변화에도 SES가 영향을 미치는지를 평가하였다.

주 결과는 6년간의 추적 관찰 기간 동안 심혈관계 위험인자 정도는 혈압, BMI, 허리둘레, 알코올 소비에서 고 SES군에서 더 긍정적으로 변하였고 경동맥 IMT도 남자에서 고 SES인 경우에 더 적게 증가하였다(Figure 1).

이러한 결과는 주로 비만도의 감소에 기인한다. 고 사료되며 이는 복부 즐래뿐만 아니라 CRP 감소의 주 기전이라고 생각되며 결국 C-IMT의 progression의 delay에도 주로 작용하는 것으로 사료된다.

본 연구는 기존의 종년 성인에서 주로 시행되었던 연구 결과에 더하여 교육 정도가 24-39세 젊은 층에서의 초기 죽상경화도 진행을 억제시킨다는 것을 밝혀낸 의미 있는 연구이다. 임상적으로는 교육 수준이 낮은 젊은 성인을 대상으로 하는 생활습관 관리 등 지역 사회 및 범국가적인 노력의 필요성을 이론적으로 추천하는데 의미가 있다고 하겠다.

우리나라도 점차 서구화되어 주로 저학력, 저소득 층에서 비만, 무절제한 생활습관 등, 본 유럽 연구와 비슷한 결과가 도출될 가능성이 높으므로 젊은 층에서, 특히 교육 수준이 낮은 계층에게 식이 및 비만, 흡연, 음주 관리에 대한 교육 프로그램이 우선적으로 도입될 필요성이 있겠다.

REFERENCES
Socioeconomic Status, Cardiovascular Risk Factors, and Subclinical Atherosclerosis in Young Adults
The Cardiovascular Risk in Young Finns Study

Paula Kestilä, Costan G. Magnussen, Jorma S.A. Viikari, Mika Kähönen, Nina Hutri-Kähönen, Leena Taittonen, Antti Jula, Britt-Marie Loo, Matti Pietikäinen, Eero Jokinen, Terho Lehtimäki, Mika Kiviluoma, Markus Juonala, Olli T. Raitakari

Objective—The goal of this study was to investigate the extent to which socioeconomic status (SES) in young adults is associated with cardiovascular risk factor levels and carotid intima-media thickness (IMT) and their changes over a 6-year follow-up period.

Methods and Results—The study population included 1813 subjects participating in the 21- and 27-year follow-ups of the Cardiovascular Risk in Young Finns Study (baseline age 24–39 years in 2001). At baseline, SES (indexed with education) was inversely associated with body mass index ($P=0.0002$), waist circumference ($P<0.0001$), glucose ($P=0.01$), and insulin ($P=0.0009$) concentrations; inversely associated with alcohol consumption ($P=0.02$) and cigarette smoking ($P<0.0001$); and directly associated with high-density lipoprotein cholesterol levels ($P=0.05$) and physical activity ($P=0.006$). Higher SES was associated with a smaller 6-year increase in body mass index ($P=0.001$). Education level and IMT were not associated ($P=0.58$) at baseline, but an inverse association was observed at follow-up among men ($P=0.004$). This became nonsignificant after adjustment with conventional risk factors ($P=0.11$). In all subjects, higher education was associated with a smaller increase in IMT during the follow-up ($P=0.002$), and this association remained after adjustments for conventional risk factors ($P=0.04$).

Conclusion—This study shows that high education in young adults is associated with favorable cardiovascular risk factor profile and 6-year change of risk factors. Most importantly, the progression of carotid atherosclerosis was slower among individuals with higher educational level. (Arterioscler Thromb Vasc Biol. 2012;32:815-821.)

Key Words: risk factors ■ carotid intima-media thickness ■ education ■ socioeconomic status

Cardiovascular disease (CVD) is one of the leading causes of premature death.1,2 In prior studies, low socioeconomic status (SES) has been associated with both adverse cardiovascular risk factor profile and increased risk of cardiovascular morbidity.3-10 Among middle-aged subjects, increased carotid artery intima-media thickness (IMT), a subclinical marker of atherosclerosis, has been associated with low SES.5,11,12 SES differences in CVD risk factors start to accumulate as early as in childhood and remain stable into adulthood.6,13-15 A range of factors, including lifestyle, social and genetic factors, occupational exposures, and health habits may contribute to these differences.16-18

Over the past few decades CVD morbidity has declined in developed countries.19,20 In Finland, mortality rates from CVDs have declined considerably since the early 1970s. Despite the positive trend in mortality the relative differences between socioeconomic groups have remained large and even grown wider. For example, in male upper nonmanual workers, the mortality decline was 72% during 1987 to 2002 and more than 65% among the 2 highest income tertiles, whereas in male manual workers the decline was 57%, and in the lowest income tertile it was 62%.21

Although there is a large body of data on SES differences in CVD outcomes, more information is needed on the
longitudinal effects of SES on cardiovascular risk factors and early atherosclerosis. Therefore, the main aim of this study was to investigate the differences in baseline and 6-year change in risk factor levels and carotid IMT among young adults. Our analysis is based on the Cardiovascular Risk in Young Finns Study, including 1813 subjects participating in clinical examinations in 2001 (baseline age, 24–39 years) and 2007.

**Methods**

**Population**

The Cardiovascular Risk in Young Finns Study is an ongoing epidemiological study of atherosclerosis risk factors from childhood to adulthood. The first cross-sectional study took place in 1980, when 4320 children and adolescents at the ages of 3, 6, 9, 12, 15, and 18 were invited to participate. A total of 3596 individuals participated (83.2% participation rate). The study was carried out in all 5 Finnish university hospitals with medical schools (Helsinki, Kuopio, Oulu, Tampere, Turku) and their rural surroundings. In 2001, a total of 2283 (63.3% of the original sample) individuals participated in the 21-year follow-up study (aged 24–39 years) when the ultrasound measurement of IMT was carried out for the first time. In 2007, when the 27-year follow-up and the second IMT measurements were conducted, 2204 (61.2%) individuals participated (aged 30–45 years). For this study, we used data from those participants with information of SES in 2001 (baseline) who attended the physical examination both in 2001 and at the 2007 follow-up (n=1813). The study was approved by local ethics committees. Further details of the study design have been presented elsewhere.

**SES**

SES was assessed based on participants’ education and occupation according to the 2001 follow-up questionnaires. The classification of educational SES was made using information about participants’ years of education. The first SES group included participants with education of comprehensive school (low); the second group those with secondary, nonacademic education (intermediate); and the third group those with academic education (high). The distribution into different occupational SES groups—(1) manual, (2) lower nonmanual, and (3) higher nonmanual workers—was made using the classification of occupations by the Central Statistical Office of Finland in 2001. In addition, a combined variable using both educational and occupational data was constructed as follows: low, if either education or occupation level was low; medium, if both were medium; high, if either education or occupation level was high.

**Measurement of Carotid IMT**

Ultrasound studies to measure carotid IMT were carried out in 2001 and 2007 using a similar protocol. The studies were performed with Sequoia-512 ultrasound mainframes (Acuson, Mountain View, CA). All measurements were performed by the same technician at baseline and follow-up, who was blinded to participant details. The image, from the left common carotid artery, was focused on the posterior wall. To derive mean carotid IMT, at least 4 reproducibility was assessed, measurements were taken approximately 10 mm proximal to the carotid bifurcation. Intraindividual reproducibility was assessed, with the average absolute difference and standard deviation between measurements of 0.05±0.04 mm. Detailed information on the measurement has been presented elsewhere.

**Biochemistry**

In 2001 and 2007, blood samples were drawn after a 12-hour fast from the right antecubital vein of recumbent participants. Serum cholesterol concentrations were determined enzymatically using a cholesterol esterase–cholesterol oxidase method (cholesterol reagent, Olympus). The same reagent was used for the estimation of high-density lipoprotein cholesterol high-density lipoprotein cholesterol (HDL-C) levels after HDL-C and very low density lipoprotein were precipitated with dextran sulfate-Mg\(^{2+}\). Low-density lipoprotein cholesterol (LDL-C) concentration was calculated using the Friedewald formula. The above mentioned analyses were all performed on an AU400-analyzer (Olympus). The determination of the level of serum triglycerides was made using the enzymatic glycerol kinase–glycerol phosphate oxidase method (triglycerides reagent, Olympus). Glucose levels were determined by the enzymatic hexokinase method (glucose reagent, Olympus). A microparticle enzyme immunoassay (IMx insulin reagent, Abbott Diagnostics) on an IMx instrument (Abbott) was used in the determination of serum insulin concentrations. High-sensitivity C-reactive protein (CRP) concentrations were determined by latex turbidometric immunoassay.

**Anthropometry and Blood Pressure**

Body mass index (BMI) was calculated as weight (kg)/height (m)\(^2\). In 2001 and 2007, weight was measured with participants in light clothing and without shoes using a digital scale with an accuracy of 0.1 kg. Height was determined using a wall-mounted stadiometer with 0.5 cm accuracy. Blood pressure was measured using a random-zero sphygmomanometer after 5 minutes of rest. Korotkoff’s first and fifth sounds were used to denote systolic (SBP) and diastolic (DBP) blood pressures, respectively. The measurement was repeated 3 times at the accuracy of the nearest even number. Waist circumference was measured from the level of the umbilicus to an accuracy of 1 millimeter.

**Lifestyle Risk Factors**

Information about cigarette smoking, physical activity level, and alcohol consumption was obtained from 2001 and 2007 questionnaires. Those who smoked daily were classified as smokers. Physical activity level was measured as metabolic equivalent index, which was assessed by the duration, frequency, and intensity of leisure time physical activity and commuting. Alcohol consumption was represented as drinks per day, 1 drink being approximately 14 g of alcohol.

**Statistical Methods**

Risk factor levels, carotid IMT, and 6-year change between 2001 and 2007 are expressed as mean for continuous variables and frequency for categorical variables. Comparisons across SES groups were performed using 2-way analysis of covariance for continuous variables and \(\chi^2\) test for categorical variables. Values of serum glucose, triglycerides, CRP, and BMI were log10-transformed before analysis because of skewed distribution. Because the baseline risk factor level may have an effect on the magnitude of change, analyses that used change in risk factors or carotid IMT as the outcome included the baseline variable as a covariate in the model. All analyses were performed using SAS 9.1 with statistical significance inferred at a 2-tailed probability value <0.05.

**Results**

**Associations of SES With Risk Factors**

Risk factor levels at baseline and follow-up according to education level groups are shown in Table 1. At baseline, education was significantly and inversely associated with serum glucose, insulin, BMI, waist circumference, alcohol consumption, and cigarette smoking among men and women and with CRP among women. It was also directly associated with HDL-C and physical activity in both men and women. At follow-up, education was significantly and inversely associated with triglyceride, glucose and insulin levels, SBP, BMI, waist circumference, alcohol consumption, and cigarette smoking, and it was directly associated with physical activity. At both baseline and follow-up, waist circumference explained the SES differences in insulin levels (\(P=0.12\) after
adjustment). Differences in baseline HDL-C (P = 0.35) and follow-up triglycerides (P = 0.60) and SBP (P = 0.40) became nonsignificant after adjustment for waist circumference. The difference in CRP among women at baseline was attenuated by adjustments for waist circumference (P = 0.22) or oral contraception use (P = 0.07). At baseline, 75 subjects were unemployed. The results remained essentially similar after additional adjustment for employment status.

The results of occupation are presented in Table I in the online-only Data Supplement. At baseline, occupation was significantly and inversely associated with smoking, BMI, and waist circumference and directly with physical activity. Among women, there was an inverse association with CRP. At follow-up, SES was inversely associated with triglyceride and glucose levels, BMI, waist circumference, and cigarette smoking in the whole cohort and with insulin among women.

There was a direct association to physical activity in the whole cohort. At the follow-up, the differences in triglycerides became nonsignificant after adjustment for waist circumference (P = 0.33) or physical activity (P = 0.09). In the whole cohort and in both study years, the combined variable of educational and occupational status was inversely associated with glucose, BMI and waist circumference and directly with physical activity and smoking (Table II in the online-only Data Supplement). In 2001, a direct association was observed with alcohol consumption and in 2007 an inverse relation with LDL-C, triglycerides, and SBP.

The 6-Year Change of Risk Factor Levels

Changes in risk factor levels between 2001 and 2007 in different education level groups are shown in Table 2 and in different occupation level groups in Table III in the online-
Table 2. Six-y Change of Risk Factor Levels in Educational SES Groups

<table>
<thead>
<tr>
<th>SES Group</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
<th>P Value</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
<th>P Value</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
<td>54</td>
<td>596</td>
<td>144</td>
<td></td>
<td>73</td>
<td>746</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 2001 (y)</td>
<td>32.6±4.4</td>
<td>31.9±5.1</td>
<td>31.5±4.7</td>
<td>0.43</td>
<td>32.5±4.3</td>
<td>31.9±5.0</td>
<td>31.9±4.7</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Cholesterol (mmol/L)</td>
<td>−0.13±0.76</td>
<td>−0.03±0.76</td>
<td>−0.09±0.80</td>
<td>0.53</td>
<td>0.02±0.79</td>
<td>−0.16±0.85</td>
<td>−0.19±0.86</td>
<td>0.20 0.41</td>
<td></td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L)</td>
<td>−0.26±0.72</td>
<td>−0.13±0.69</td>
<td>−0.18±0.69</td>
<td>0.38</td>
<td>−0.06±0.75</td>
<td>−0.21±0.64</td>
<td>−0.24±0.62</td>
<td>0.11 0.38</td>
<td></td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>0.07±0.20</td>
<td>0.05±0.19</td>
<td>0.06±0.21</td>
<td>0.84</td>
<td>0.04±0.26</td>
<td>0.05±0.28</td>
<td>0.05±0.25</td>
<td>0.96 0.89</td>
<td></td>
</tr>
<tr>
<td>Triglycerides (mmol/L)</td>
<td>0.16±0.99</td>
<td>0.15±0.96</td>
<td>0.08±0.65</td>
<td>0.65</td>
<td>0.07±0.57</td>
<td>0.00±0.76</td>
<td>−0.01±0.66</td>
<td>0.70 0.71</td>
<td></td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>0.21±1.00</td>
<td>0.32±0.74</td>
<td>0.26±0.40</td>
<td>0.44</td>
<td>0.45±1.43</td>
<td>0.28±0.84</td>
<td>0.23±0.46</td>
<td>0.16 0.38</td>
<td></td>
</tr>
<tr>
<td>Insulin (mU/L)</td>
<td>2.41±12.69</td>
<td>1.98±7.46</td>
<td>2.00±11.30</td>
<td>0.96</td>
<td>1.16±5.02</td>
<td>1.03±8.58</td>
<td>−0.04±5.34</td>
<td>0.22 0.45</td>
<td></td>
</tr>
<tr>
<td>CRP (mg/L)</td>
<td>−0.11±2.13</td>
<td>0.15±3.60</td>
<td>−0.27±5.00</td>
<td>0.45</td>
<td>−0.10±3.62</td>
<td>−0.33±5.17</td>
<td>0.18±4.17</td>
<td>0.41 0.92</td>
<td></td>
</tr>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>4.2±12.6</td>
<td>4.9±10.5</td>
<td>3.9±9.5</td>
<td>0.58</td>
<td>5.8±11.3</td>
<td>4.1±11.0</td>
<td>2.5±10.3</td>
<td>0.07 0.10</td>
<td></td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>6.8±9.7</td>
<td>6.1±9.1</td>
<td>5.4±8.4</td>
<td>0.52</td>
<td>4.9±8.7</td>
<td>5.1±9.3</td>
<td>3.1±9.4</td>
<td>0.03 0.03</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>1.0±2.2</td>
<td>1.1±2.1</td>
<td>0.7±1.9</td>
<td>0.10</td>
<td>1.6±2.7</td>
<td>1.0±2.5</td>
<td>0.5±1.7</td>
<td>0.004 0.001</td>
<td></td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>4.1±6.7</td>
<td>4.7±6.3</td>
<td>4.4±6.5</td>
<td>0.67</td>
<td>6.3±7.1</td>
<td>4.7±7.3</td>
<td>3.7±5.4</td>
<td>0.02 0.08</td>
<td></td>
</tr>
<tr>
<td>Alcohol consumption (portions/d)</td>
<td>0.2±2.1</td>
<td>0.2±1.8</td>
<td>0.0±1.3</td>
<td>0.50</td>
<td>0.4±1.0</td>
<td>0.1±0.7</td>
<td>0.0±0.7</td>
<td>0.0003 0.06</td>
<td></td>
</tr>
<tr>
<td>Physical activity (METs/d)</td>
<td>−0.2±25.2</td>
<td>0.2±21.8</td>
<td>2.9±22.2</td>
<td>0.42</td>
<td>4.2±25.3</td>
<td>−0.3±20.9</td>
<td>0.3±19.0</td>
<td>0.35 0.44</td>
<td></td>
</tr>
</tbody>
</table>

Statistics are mean±SD. P values are from age-adjusted analysis of covariance (ANCOVA) (except for age). SES indicates socioeconomic status; LDL, low-density lipoprotein; HDL, high-density lipoprotein; CRP, C-reactive protein; BP, blood pressure; BMI, body mass index; MET, metabolic equivalent index.

*P values for both sexes combined from ANCOVA adjusted with age and sex.

only Data Supplement. Higher baseline education was significantly associated with favorable changes in BMI and DBP in the whole cohort and in waist circumference and alcohol consumption among women. Baseline occupation was significantly and inversely associated with the 6-year change in the whole cohort in blood pressure, BMI, and waist circumference and, among women, in alcohol consumption. The combined baseline SES level was related with favorable changes in triglycerides, DBP, BMI, and waist circumference (Table IV in the online-only Data Supplement).

**SES and Carotid IMT**

At baseline, education level was not associated with carotid IMT (Figure 1). At follow-up, there was a significant inverse association between education and carotid IMT among men (P=0.004) and in the whole cohort (P=0.04). Although the relation was not statistically significant in women, we found no significant SES×sex interaction effect on IMT (P=0.64). When adjusted for age, LDL-C, HDL-C, SBP, BMI, and cigarette smoking, the association among men disappeared (P=0.11). Similarly, in the whole cohort, the association was attenuated when adjusted for sex and the above-mentioned risk factors (P=0.31).

Education was significantly and inversely associated with 6-year change in carotid IMT levels among men (P=0.005) (Figure 2) and the whole cohort (P=0.002). The association was not significant in women (P=0.10), and no significant SES×sex interaction was observed (P=0.64). The associa-

![Figure 1](http://atvb.ahajournals.org/Downloaded from)  
Figure 1. Carotid intima-media thickness (IMT) (mean±SEM) across educational socioeconomic status (SES) classes in 2001 and 2007 among men (A) and women (B). Probability values are from analysis of covariance.
tion among men (P = 0.04) and in the whole cohort (P = 0.04) remained statistically significant after adjustment for 6-year change of LDL-C, HDL-C, SBP, BMI and baseline age, sex, IMT and cigarette smoking.

Occupational level was not associated with baseline IMT (whole cohort P = 0.39), follow-up IMT (whole cohort P = 0.88), or 6-year change in IMT (whole cohort P = 0.15). The combined variable of educational and occupational level was not related with baseline or follow-up IMT (P = 0.55 and P = 0.44), whereas it was significantly associated with 6-year change (P = 0.03). This association became nonsignificant after adjustments for 6-year change of LDL-C, HDL-C, SBP, and BMI and baseline age, sex, IMT, and cigarette smoking (P = 0.21).

**Discussion**

This population-based prospective study of young adults suggests that SES, as indicated by educational level, is inversely related to risk factor levels and subclinical signs of CVD among young adults in Finland. In addition, the 6-year changes in risk factor levels and carotid IMT were the most favorable among those with a high baseline educational level.

An inverse relation between SES and CVD risk factor levels has been found across different populations. Several recent investigations have reported a widening of cardiovascular mortality rates and risk factor differences between SES groups. Our data show that these differences can be observed already among young adults. SES differences in risk factors were observed in study subjects aged 24 to 39 years, and based on our longitudinal analyses they tended to become more pronounced during 6-years of follow-up.

Several plausible mechanisms may underlie the difference in CVD risk factor levels between SES groups. For example, social patterning of physical activity, diet, and access to medical care may influence risk factor levels. Obesity has been associated with adverse lipid profile and higher levels of blood pressure. In the present study, waist circumference explained the SES differences in lipid, insulin, and SBP levels in the whole cohort and CRP level differences among women. In line with previous studies, we found that alcohol consumption over recommended levels, physical inactivity, and cigarette smoking habits were more common in the lower SES groups of the present study cohort. The use of oral contraceptives has been found to affect CRP levels. In our previous analysis, as well as the present analyses, CRP was inversely associated with educational and occupational level among women. The difference of CRP levels between educational level groups was partially explained by oral contraceptive use, as well as insulin levels and waist circumference. In this cohort, there were no age differences between SES groups, and hence, age had no effect on risk factor differences.

CVD is a slowly progressing disease, and the subclinical signs of CVD can be measured years before the manifest disease. In our previous analyses from the Young Finns cohort using data from year 2001 follow-up, we did not observe an association of childhood or adulthood SES with carotid IMT. Other studies have reported an inverse association between SES and IMT among white, middle-aged (over 45 years of age) or older populations. In the present analyses, we observed no SES differences in mean carotid IMT at baseline when participants were 24 to 39 years of age. However, after the 6-year follow-up, a significant difference in IMT between educational level groups was observed among men. In addition, the progression of carotid IMT over the 6-year follow-up was faster in lower educational level groups, supporting the results of earlier studies found among middle-aged population.

In this study, SES differences in IMT were mainly explained by the adverse risk factor profile in lower educational level groups. Our results therefore suggest that more aggressive interventions to diminish risk factor burden, especially obesity, in lower SES groups is needed. In the British Whitehall study, it was estimated that the majority of SES differences in cardiovascular mortality would be reduced by a successful implementation of the best-practice interventions across all SES groups, and further preventive benefits could be achieved if the traditional risk factor levels were reduced to primordial levels.

Our study has several potential implications for prevention. Worldwide, CVD remains the leading cause of death. Together with differences in the risk factor levels, the numbers of mortality vary within SES groups. In Finland, there has been a reduction in mortality over time among all SES groups, but the declining trend has been steeper in the highest groups. In the lower SES groups, favorable secular trends have been explained by the change of risk factor levels, and our findings suggest that favorable risk factor profile change is associated with a slower progression of subclinical atherosclerosis. This, these data suggest that additional efforts should be allocated to preventive interventions in the lower SES groups.

The major limitations of this study included sample attrition, which can contribute to both under- and overestimation of effects, and racially homogeneous study population, limiting the generalizability of the findings. Details on these limitations have been published elsewhere. Some limita-
tions in the classifications of SES are also noteworthy. For example, unemployment, poor health, age, and life circumstances may have affected the classification.¹,²,³,⁸ However, education is considered the best predictor of risk factor levels,¹,²,³,⁸ which was descriptively evident also in this study. Despite these limitations, this ongoing study is unique in its breadth and duration. The data provide well-standardized possibilities to investigate risk of CVD and SES among young adults without evident clinical CVD.

In conclusion, marked socioeconomic differences in CVD risk factor levels and subclinical signs of atherosclerosis were observed in a contemporary population of young Finns. Education rather than occupational position was predictive of risk factor levels and carotid IMT. The 6-year change in risk factor levels and carotid IMT was most favorable in groups with high educational attainment.

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Disclosures
None.

References


