When does cardiovascular risk start? Past and present socioeconomic circumstances and risk factors in adulthood

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Abstract

***Study objectives*—To compare associations of childhood and adult socioeconomic position with cardiovascular risk factors measured in adulthood. To estimate the effects of adult socioeconomic position after adjustment for childhood circumstances.**

***Design*—Cross sectional survey, using the relative index of inequality method to compare socioeconomic differences at different life stages.**

***Setting*—The Whitehall II longitudinal study of men and women employed in London offices of the Civil Service at study baseline in 1985–88.**

***Participants*—4774 men and 2206 women born in the period 1930–53 who were administered questions on early socioeconomic circumstances.**

***Main results*—Adult occupational position (employment grade) was inversely associated (high status–low risk) with current smoking and leisure time physical inactivity, with waist/height, and with metabolic risk factors HDL cholesterol, triglycerides, post-load glucose and fibrinogen. Associations of these variables with childhood socioeconomic position (father's Registrar General Social Class) were weaker or absent, with the exception of smoking in women. Childhood social position was associated with adult weight in both sexes and with current smoking, waist/height, HDL cholesterol and fibrinogen in women. Height, a measure of health capital or constitution, was weakly linked with father's social class and more strongly linked with own employment grade. The combination of childhood disadvantage (low father's class) together with a low status clerical occupation in men was particularly associated with higher body mass index as an adult (interaction test p<0.001). Adjustment for earlier socioeconomic position—using father's class and own education level simultaneously—did not weaken the effects of adult socioeconomic position, except in the case of smoking in women, when the grade effect was reduced by 59 per cent.**

***Conclusions*—Cardiovascular risk factors in adulthood were in general more strongly related to adult than to childhood socioeconomic position. Among women but not men there was a strong but unexplained link between father's class and adult smoking habit. In both sexes degree of obesity was associated with both childhood and adulthood social position. These findings suggest that the socially patterned accumulation of health capital and cardiovascular risk begins in childhood and continues, according to socioeconomic position, during adulthood.**

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Socioeconomic conditions are key determinants of health.[1 2] In relation to cardiovascular disease there is copious evidence that a variety of adverse biological and social factors linked with low adult socioeconomic position are associated with increased morbidity and mortality. Less is known about the processes leading to accumulation of risk. Barker and coworkers' biological programming concept[3] emphasises the links between poor early development and later adult cardiovascular disease. This view raises questions about the influence on risk of the intervening years, which are being investigated in research taking the life course approach.[4] This model admits the possibility of critical periods but emphasises the accumulation of risk resulting from exposure to adverse environments during childhood, adolescence and adulthood.

Few studies have examined the link between childhood socioeconomic circumstances and cardiovascular disease, and only one included women.[5] Most[5–10] but not all[11] suggest that childhood conditions are important predictors of risk regardless of social class destination in adulthood. Among men in the West of Scotland Collaborative study, for example, both father's social class and class at screening predicted cardiovascular (and all cause) mortality when analysed simultaneously.[10] Analysis of risk factors measured at the baseline examination of the Scottish cohort of men born 1906–38 generated two key observations:[12] health behaviours were associated primarily with adult social position, while physiological and metabolic risk factors were associated both with past and present social circumstances. Degree of obesity was particularly related to childhood conditions among these men. Our previous analysis of plasma fibrinogen levels at the Whitehall II study baseline showed associations with both father's social class and current employment grade.[13] This study examines these associations in the Whitehall II cohort, born 1930–53, with a broad range of risk factors in women as well as men.

Table 1 Social mobility among 4774 men and 2206 women in the Whitehall II cohort. Social class of origin for those in each grade of employment shown in parentheses (column percentages)

	Men				Women			
	Own employment grade				Own employment grade			
Father's RGSC	Administrative	Professional/ executive	Clerical/ support	Total	Administrative	Professional/ executive	Clerical/ support	Total
I and II	837 (48.1)	993 (38.8)	153 (32.5)	1983 (41.5)	138 (69.4)	380 (42.7)	283 (25.4)	801 (30.3)
III non-man	292 (16.8)	439 (17.1)	79 (16.8)	810 (17.0)	26 (13.1)	117 (13.1)	127 (11.4)	270 (12.2)
III man	479 (27.5)	849 (33.2)	168 (35.7)	1496 (31.3)	33 (16.6)	296 (33.2)	491 (44.0)	820 (37.2)
IV and V	134 (7.7)	280 (10.5)	71 (15.1)	485 (10.1)	2 (1.0)	98 (11.0)	215 (19.3)	315 (14.3)
Total	1742	2561	471		199	891	1116	

RGSC: Registrar General Social Class.

Methods

SUBJECTS

Demographic and other health related characteristics of the 10 308 Whitehall II subjects at baseline are published.[14 15] The cohort was recruited from 20 London based Civil Service departments. The overall response rate was 73%, though likely to be higher because detailed investigation in one department showed that 4% of those present on the list of employees had moved before our study. The results presented are from phases 1 (1985–88) and 3 (1991–1993). Phase 1 provided most of the measurements used here and phase 3 (83% particpation rate) provided waist and hip circumferences, serum HDL cholesterol and triglycerides, two hour post-load glucose and plasma fibrinogen.[16]

CARDIOVASCULAR RISK FACTORS

Screening examinations were carried out according to standard protocols.[14 17] The 75 g oral glucose tolerance test was administered after an overnight fast or in the afternoon after no more than a light fat free breakfast taken before 08 00. Venepuncture of the left antecubital vein was performed with tourniquet. After preparation, samples were immediately frozen at −80°C and stored until assay. Serum for lipid analysis was refrigerated at 4°C and assayed within 72 hours. Cholesterol and triglycerides were measured in a centrifugal analyser by enzymic colorimetric methods. HDL cholesterol was determined after dextran sulphate-magnesium chloride precipitation of non-HDL cholesterol. Glucose was determined in fluoride plasma by an electrochemical glucose oxidase method. Fibrinogen was determined in citrated plasma by an automated modification of the Clauss method.[17] At phase 3 technical error was estimated by assaying blinded duplicate samples for 5% of subjects. A sub-sample of 323 subjects returned after 2–4 weeks to estimate reliability (within person variability and measurement error as a proportion of total variability). All results were acceptable.[16] Post-load glucose levels showed a diurnal variation and were therefore adjusted for time of day.[16]

Smoking status was determined by the self report questionnaire response to the question "Do you smoke cigarettes now?". Leisure time physical inactivity was determined from the responses to two questions on the average number of hours per week spent in "moderately energetic" and "vigorous" activities. Examples of sports, recreational and domestic activities were provided. Subjects were classified as physically inactive if they reported zero hours in both questions.

SOCIOECONOMIC POSITION

The phase 1 questionnaire provided current Civil Service employment grade title for all subjects. Participants were assigned to one of six employment grades. Senior administrators occupied "Unified Grades", which applied to all Civil Service departments. Grade 1 consists of those in Unified Grades 1–6 (annual salary range at 1 August 1992: £28 904–87 620), grade 2 is equivalent to Unified Grade 7 (£25 330–36 019), grade 3 is Senior Executive Officer (£18 082–25 554), grade 4 is Higher Executive Officer (£14,456–20,850), grade 5 Executive Officer (£8517–16 668) and grade 6 Clerical and Office Support staff (£6483–11 917). For clarity, analyses of social mobility (table 1) and prevalence of smoking and physical inactivity by past and present social position (table 2) used three or four strata: three for own employment grade (administrative (grades 1 and 2), professional/executive (grades 3, 4 and 5) and clerical/office support (grade 6)) and four for father's social class, by combining classes I and II, and classes IV and V. Father's main occupation was included in versions 3 and 4 of the questionnaire that was administered to the last 7697 subjects (5187 men, 2510 women) screened. Father's social class was coded to the Registrar General's classification[18] from the question "what is/was your father's main job?" and additional questions on training, employment status and supervisory responsibility. Responses were missing on 413 men and 304 women, resulting in a final dataset for analysis of 4774 men and 2206 women. The proportions with missing data for father's social class in the adminstrative, professional/executive and clerical/support grades were respectively 7%, 8%, 10% for men and 8%, 10%, 15% for women. Education level was obtained on the same subset, providing age at completion of full time education: before age 17, age 17—18, after age 18.

STATISTICAL METHODS

Adjusted prevalences for current smoking and physical inactivity by father's social class and own employment grade were obtained using least squares means from a linear regression model. Tests for trend in these proportions were obtained using Cochran-Mantel-Haenszel tests. Initial analyses by father's social class and own employment grade had shown

Table 2 Age adjusted and mutually adjusted prevalence of current smoking and leisure time physical inactivity† by father's social class and own employment grade*

	Men				Women			
	Current smoker prevalence (%) (SE)‡		Physically inactive prevalence (%) (SE)		Current smoker prevalence (%) (SE)		Physically inactive prevalence (%) (SE)	
	Age adjusted	Mutually adjusted*	Age adjusted	Mutually adjusted	Age adjusted	Mutually adjusted	Age adjusted	Mutually adjusted
Father's social class								
I and II	15.1	15.9 (0.8)	9.8	10.5 (0.7)	15.0	16.1 (1.5)	25.5	27.8 (1.6)
III non-man	15.5	15.5 (1.3)	12.2	12.1 (1.1)	21.3	21.5 (2.5)	26.6	27.2 (2.7)
III man	15.7	15.1 (0.9)	10.9	10.5 (0.8)	27.2	26.5 (1.5)	27.9	26.5 (1.6)
IV and V	21.2	19.8 (1.6)	14.6	13.1 (1.4)	32.4	31.1 (2.4)	33.4	30.7 (2.5)
trend p	0.01	0.3	0.01	0.3	<0.001	<0.001	0.02	>0.5
Own employment grade								
Administrative	9.6	9.6 (0.9)	6.2	6.2 (0.7)	12.3	16.4 (3.0)	17.4	17.6 (3.2)
Professional/executive	17.0	17.0 (0.7)	10.4	10.4 (0.6)	19.4	20.2 (1.4)	20.4	21.4 (1.5)
Clerical/support	34.0	33.9 (1.7)	33.6	33.5 (1.4)	27.3	25.9 (1.3)	35.5	35.4 (1.4)
trend p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*Prevalences by father's social class are adjusted for age and employment grade, and those by employment grade are adjusted for age and father's social class. †Physical inactivity: no moderate or vigorous leisure time physical activity. ‡Figures in parentheses give standard error for mutually adjusted prevalences. Standard errors for age adjusted prevalence are not presented but are similar.

the relation of all the variables of interest to be adequately described using linear trends. To compare the trends in the physiological and metabolic variables across father's social class with those across subject's own employment grade, we used the relative index of inequality based on these two measures. This index[19] reflects the experience of the whole sample, is sensitive to the distribution of subjects across the strata (enabling men and women to be compared directly), and is independent of the mean level of the outcome measure. For each measure, the socioeconomic position of each group within each five year age band was assigned a value between zero and one according to the proportion of subjects in the study population who were above the midpoint of that group. Values of zero and one therefore correspond to subjects who are at the top and bottom of the socioeconomic hierarchy. Risk factor differences estimated by this method therefore show the difference for subjects at the bottom of the socioeconomic hierarchy compared with those at the top. Mutually adjusted prevalences (table 2) and adjusted differences (table 4) were determined in models with terms present for father's RGSC and own employment grade. Education level was additionally included, with father's RGSC, to obtain maximal adjustment for earlier socioeconomic position in the final model of the adult socioeconomic effects (table 5). All statistical analyses were performed using the statistical package SAS.

Results

SOCIAL MOBILITY

Social mobility between father's social class and phase 1 employment grade is shown in table 1. The column percentages show the distribution of origins within each grade. By comparison with the MRC National Survey of Health and Development (NSHD, the British 1946 Birth Cohort), the proportion of participants from a manual background in Whitehall II is smaller but still substantial (men 41.4% in Whitehall II versus 74.0% in NSHD, women 51.5% versus 74.6%) (Diana Kuh, personal communication). There was substantial upward mobility among men, with 58.5% originating from class IIIN and below, but only 9.9% currently in the clerical grade. Among women 63.7% originated from classes IIIN–V, but a much larger proportion (50.6%) were employed in the clerical grade, and upward mobility was therefore relatively less. Downward mobility is evident, with approximately a third of men and a quarter of women in the

Table 3 Age adjusted differences in physiological and metabolic factors between lowest and highest level of father's social class and own employment grade*

	Men				Women			
	Father's social class difference (SE)‡	trend p	Own employment grade difference (SE)	trend p	Father's social class difference (SE)	trend p	Own employment grade difference (SE)	trend p
Physiological factors								
Height (cm)	−0.63 (0.35)	0.07	−4.68 (0.34)	<0.001	−1.73 (0.50)	<0.001	−5.52 (0.52)	<0.001
Weight (kg)	1.31 (0.56)	0.02	−2.68 (0.55)	<0.001	3.64 (0.86)	<0.001	1.58 (0.93)	0.09
Wt adj ht† (kg)	1.78 (0.49)	<0.001	0.91 (0.50)	0.07	4.66 (0.82)	<0.001	4.98 (0.90)	<0.001
BMI (kg/m^2)	0.60 (0.16)	<0.001	0.43 (0.16)	0.006	1.91 (0.31)	<0.001	2.23 (0.34)	<0.001
Waist (cm)	1.02 (0.54)	0.06	1.08 (0.53)	0.04	4.54 (1.03)	<0.001	5.15 (1.06)	<0.001
Hip (cm)	0.74 (0.36)	0.04	−1.43 (0.35)	<0.001	3.51 (0.86)	<0.001	1.90 (0.88)	0.03
Waist/height ($\times 10^3$)	7.8 (3.1)	0.01	19.0 (3.1)	<0.001	34.3 (6.5)	<0.001	46.8 (6.7)	<0.001
WHR ($\times 10^3$)	3.3 (3.5)	0.34	23.8 (3.5)	<0.001	17.5 (6.2)	0.005	38.4 (6.3)	<0.001
Diastolic BP (mm Hg)	0.1 (0.5)	>0.5	1.6 (0.5)	0.001	0.0 (0.8)	>0.5	−0.1 (0.8)	>0.5
Metabolic factors								
Total cholest (mmol/l)	0.03 (0.06)	>0.5	0.06 (0.06)	0.32	0.19 (0.08)	0.02	0.02 (0.09)	>0.5
HDL cholest (mmol/l)	−0.04 (0.02)	0.03	−0.06 (0.02)	0.003	−0.23 (0.04)	<0.001	−0.29 (0.04)	<0.001
Triglycerides (mmol/l)	0.01 (0.07)	>0.5	0.37 (0.07)	<0.001	0.17 (0.07)	0.01	0.24 (0.07)	<0.001
2 h glucose (mmol/l)	0.09 (0.11)	0.38	0.37 (0.11)	<0.001	0.23 (0.17)	0.16	0.59 (0.17)	<0.001
Fibrinogen (g/l)	0.03 (0.03)	0.41	0.17 (0.03)	<0.001	0.21 (0.05)	<0.001	0.30 (0.06)	<0.001

*Differences between lowest and highest socioeconomic status based on relative index of inequality (see methods). †Weight adjusted for height. ‡Standard error given in parentheses.

clerical grade originating from classes I and II. It should be borne in mind that employment grade may not be an accurate measure of current household circumstances, for example, among women in clerical employment.

BEHAVIOURAL RISK FACTORS

Table 2 shows the age adjusted prevalence of current smokers and physically inactive men and women by father's class and current grade. Mutually adjusted prevalences are also shown, derived from models in which each measure of social position is adjusted for the other. Among men smoking was strongly associated with lower occupational status and weakly associated with father's class. Among women smoking was associated both with lower current grade and lower father's class. In both sexes physical inactivity was more strongly associated with own occupational status than with father's social class.

PHYSIOLOGICAL AND METABOLIC FACTORS

Table 3 shows age adjusted differences in physiological and metabolic factors between highest and lowest category of father's social class and own employment grade based on relative index of inequality. A positive difference indicates higher values of the variable in lower strata, and vice versa. For father's social class, risk factors showed a more consistent pattern of association among women than men. Diastolic blood pressure and post-load glucose were unrelated to father's social class in both sexes. Total cholesterol and fibrinogen were associated with father's class among women only. Among men height was weakly related to father's social class. The height difference is consistent with that seen in the 1946 birth cohort at age 43 (Michael Wadsworth, personal communication). For own employment grade, all risk factors were associated in the expected direction (higher grade–lower risk) with the exceptions of total cholesterol in both sexes and blood pressure in women. Shorter height was strongly linked with lower grade, and therefore the associations of weight adjusted for height, and waist/height ratio, with both measures of socioeconomic position are presented for comparison with results for body mass index and waist-hip ratio. Pearson correlations of height with serum cholesterol and triglycerides and plasma fibrinogen at phase 1, adjusted for age and menopausal status, were in the range 0 to −0.11.

KEY POINTS

- Excess cardiovascular risk may accumulate during life as a result of adverse socioeconomic circumstances, starting in childhood.
- In the Whitehall II cohort, enduring effects of childhood circumstances were strongest for overweight and obesity in both sexes, and smoking rates, waist/height, HDL cholesterol and fibrinogen among women.
- Current rather than childhood socioeconomic disadvantage seemed to be the more important influence on most risk factors: physical inactivity, metabolic and haemostatic profile, and smoking among men.
- While the childhood origins of cardiovascular disease are important for public health policy, we provide indirect evidence that risk may be modified substantially in adult life.

Table 4 shows the same set of results as in table 3, but the differences by father's social class are adjusted for age and employment grade, and those by employment grade are adjusted for age and father's social class. All measures of obesity except waist-hip ratio were more strongly related to social position among women than men, as was HDL cholesterol level. Among women the adjusted differences (table 4) tend to be smaller than the unadjusted differences (table 3), whereas in men the effect of adjustment was not consistent. This reflects in part the stronger correspondence between father's class and own grade in women compared with men[20] (table 1). In both sexes adjusted differences by own grade for height, waist-hip ratio, triglycerides, two hour glucose

Table 4 Adjusted differences in physiological and metabolic factors between lowest and highest level of father's social class and own employment grade*

	Men				*Women*			
	Father's social class difference (SE)‡	*trend p*	*Own employment grade difference (SE)*	*trend p*	*Father's social class difference (SE)*	*trend p*	*Own employment grade difference (SE)*	*trend p*
Physiological factors								
Height (cm)	−0.02 (0.35)	>0.5	−4.68 (0.34)	<0.001	−0.23 (0.51)	>0.5	−5.45 (0.55)	<0.001
Weight (kg)	1.69 (0.56)	0.003	−2.89 (0.56)	<0.001	3.52 (0.90)	<0.001	0.46§ (0.97)	>0.5
Wt adj ht† (kg)	1.69 (0.50)	<0.001	0.70 (0.50)	0.16	3.66§ (0.85)	<0.001	3.82§ (0.93)	<0.001
BMI (kg/m^2)	0.55 (0.16)	<0.001	0.36 (0.16)	0.02	1.42§ (0.33)	<0.001	1.78§ (0.35)	<0.001
Waist (cm)	0.90 (0.54)	0.10	0.96 (0.54)	0.07	3.32§ (1.08)	0.002	4.10§ (1.11)	<0.001
Hip (cm)	0.94 (0.36)	0.009	−1.55 (0.36)	<0.001	3.25§ (0.90)	<0.001	0.87§ (0.93)	0.35
Waist/height (×10^3)	5.5 (3.1)	0.08	18.3 (3.1)	<0.001	22.4§ (6.8)	0.001	39.8§ (7.0)	<0.001
WHR (×10^3)	0.2 (3.5)	>0.5	23.8 (3.5)	<0.001	6.7 (6.4)	0.30	36.2 (6.6)	<0.001
Diastolic BP (mm Hg)	−0.1 (0.5)	>0.5	1.6 (0.5)	0.001	0.1 (0.8)	>0.5	−0.2 (0.9)	>0.5
Metabolic factors								
Total cholest (mmol/l)	0.02 (0.06)	>0.5	0.06 (0.06)	0.35	0.20 (0.09)	0.02	−0.04 (0.10)	>0.5
HDL cholest (mmol/l)	−0.04 (0.02)	0.08	−0.06 (0.02)	0.006	−0.16§ (0.04)	<0.001	−0.24§ (0.04)	<0.001
Triglycerides (mmol/l)	−0.04 (0.07)	>0.5	0.38 (0.07)	<0.001	0.11 (0.07)	0.11	0.21 (0.07)	0.004
2 h glucose (mmol/l)	0.05 (0.11)	>0.5	0.36 (0.11)	<0.001	0.06 (0.18)	>0.5	0.57 (0.18)	0.002
Fibrinogen (g/l)	0.01 (0.03)	>0.5	0.17 (0.03)	<0.001	0.14§ (0.06)	0.02	0.26 (0.06)	<0.001

*Differences between lowest and highest socioeconomic status based on relative index of inequality (see methods). Differences by father's social class are adjusted for age and employment grade and those by employment grade are adjusted for age and father's social class. †Weight adjusted for height. ‡Standard error given in parentheses. §Test for heterogeneity of effects by sex p<0.05.

Table 5 Differences in behavioural, physiological and metabolic factors between lowest and highest employment grade adjusted for (a) age, and (b) age and earlier socioeconomic status (father's social class and level of education), and percentage change between these estimates*

Adjustment	Men				Women			
	Age difference	Age and earlier SES difference (SE)‡	trend p	% change†	Age difference	Age, earlier SES difference (SE)	trend p	% change
Current smoker (%)	23.4	21.4 (2.0)	<0.001	−8	20.4	8.4 (3.8)	0.03	−59
No mod/vig activity (%)	22.1	22.2 (1.7)	<0.001	+1	28.6	30.1 (4.1)	<0.001	+5
BMI (kg/m^2)	0.16§	−0.06 (0.19)	>0.5	—	2.23	1.82 (0.37)	<0.001	−18
WHR (×10^3)	23.8	22.7 (3.7)	<0.001	−5	38.3	43.4 (7.1)	<0.001	+13
Diastolic BP (mm Hg)	1.6	1.5 (0.5)	0.005	−4	−0.2	0.1 (1.0)	>0.5	—
Total cholesterol (mmol/l)	0.06	0.02 (0.06)	>0.5	—	0.03	−0.16 (0.10)	0.13	—
HDL cholesterol (mmol/l)	−0.06	−0.06 (0.02)	0.01	−10	−0.30	−0.27 (0.05)	<0.001	−7
Triglycerides (mmol/l)	0.37	0.38 (0.07)	<0.001	+2	0.24	0.21 (0.08)	0.007	−14
2 h glucose (mmol/l)	0.37	0.40 (0.11)	<0.001	+8	0.58	0.66 (0.20)	<0.001	+13
Fibrinogen (g/l)	0.17	0.17 (0.03)	<0.001	0	0.30	0.31 (0.06)	<0.001	+6

*Differences between lowest and highest socioeconomic status based on relative index of inequality (see methods). †Percentage change in grade effect on adjustment for earlier socioeconomic status. This is not reported if the age adjusted trend p>0.05. ‡Standard error given in parentheses. §Clerical/support grade excluded.

and fibrinogen were highly significant, but none of these risk factors was associated with father's class. In both sexes body mass index and HDL cholesterol were associated with both father's class and own grade, while among men weight adjusted for height was related only to father's class. Adjusted diastolic blood pressure was not associated with father's social class. Among men only there was a statistically significant but small difference by own grade.

EFFECTS OF ADULT SOCIOECONOMIC POSITION AFTER ADJUSTMENT FOR CHILDHOOD CIRCUMSTANCES

Table 5 shows the attenuation of the effects of current employment grade on key behavioural, physiological and metabolic variables after simultaneous adjustment for father's social class and additionally education level. Education level is included in these models as an additional variable to make the maximum possible adjustment for childhood circumstances in the estimation of the effects of adult socioeconomic position. Standard errors were similar for the univariate (age adjusted) coefficients and those after adjustment for childhood circumstances, and are therefore shown only once. For degree of obesity among men there was an interaction (p<0.001) between the effects of father's class and own grade (relative index of inequality for father's class (SE) was in administrators: 0.26 (0.27), professional/ executive 0.41 (0.22), clerical/support 2.45 (0.50) kg/m^2). The clerical/support grade was therefore omitted from this analysis because multivariate adjustment would not be valid. Leaving aside body mass index in men, all variables remained related to grade after the more complete adjustment. No attenuation of the grade effects exceeded 18 per cent, with the exception of current smoking in women. Differences across the employment grade hierarchy were similar to those obtained when father's class only was adjusted for (table 4).

Discussion

The effects of current adult socioeconomic position appear, in this study, to be central to the understanding of social inequalities in cardiovascular risk and to consideration of public health policies to reduce this important cause of preventable ill health. Using two measures of earlier socioeconomic position, father's social class and education level, we show that the inverse associations between current social position and risk factors are, in general, remarkably robust to adjustment for circumstances in the first 20 years of life. Our findings suggest that, regardless of social origin, contemporaneous factors associated with income and occupation are important determinants of cardiovascular risk status. At the same time, we find further evidence that adverse childhood circumstances exert a lasting influence on some aspects of cardiovascular risk in adulthood.[13]

Our overall research aim is to improve understanding of how the social environment affects behaviour and biology to generate inequalities in health. We have previously shown that differences in smoking rates, blood pressure and blood cholesterol levels, although important influences on an individual's risk, do not provide a good explanation for the cardiovascular mortality differences between classes.[21] More recent findings identify some of the biological changes that are specifically associated with lower socioeconomic position in adulthood,[16] and show that the psychosocial work environment explains statistically the hierarchical coronary risk differences in the Whitehall II study.[22] Our results suggest that social organisation, and in particular the nature of power relations characterised in our occupational cohort by the level of control at work, may influence the relevant biological pathways by neuroendocrine mechanisms to increase cardiovascular risk.[23] Markers of these homeostatic changes, namely glucose intolerance, raised serum triglycerides, low HDL cholesterol, central obesity and higher plasma fibrinogen levels are included in this analysis. In accord with this, prevalence of the metabolic syndrome, as previously defined,[16] had an inverse employment grade gradient in both sexes (age adjusted relative index of inequality (RII) across grades in men 2.0, 95% confidences intervals 1.4 to 3.0, women 3.0, 95% CI 1.5 to 6.0, in this sub-sample). With full adjustment for childhood circumstances (including father's social class and own education level in the model), the grade gradient was attenuated by 27% in men and 38% in women. Poorer childhood circumstances were more strongly associated with the metabolic syndrome in women than men. Adjusted for current grade, father's class was inversely related to prevalence of the metabolic syndrome in women (RII = 2.7, 95% CI 1.3 to 5.4) but not in men (RII = 1.3, 95% CI 0.9 to 1.9).

Though the psychosocial hypothesis has not been directly tested, this analysis is one step toward its integration with life course perspectives.[4] Whatever the salient features of the adult socioeconomic environment may be, it seems they are equally or more important than circumstances in childhood in determining the levels of the risk factors in question. Future analyses using clinically verified disease events will assess the explanatory power of the measured biological factors in this context.

In this study we have attempted to distinguish between the influences of childhood and adult socioeconomic conditions on adult cardiovascular risk factors using multiple regression analysis. The validity of this approach depends on statistical independence of the two socioeconomic effects, as well as the adequacy of measurement of socioeconomic position itself. Analyses of mortality in the Collaborative study[10 24] suggest that the excess cardiovascular risk associated with lower socioeconomic position at given points in the life course is additive, and not dependent on the direction of social class change. This finding argues for cumulative rather than interactive effects of socioeconomic circumstances over the life course, at least under recent historical conditions. Few studies have looked for interactions of socioeconomic effects on risk factors, as compared with clinical events, at different stages of the life course. Such effect modification was observed with plasma fibrinogen in a Finnish study,[25] when poor childhood conditions were linked to high adult fibrinogen level only among those men who had low incomes in adult life. Forsdahl argued for a different interaction: that poverty in childhood followed by later prosperity is linked, via high cholesterol, with excess cardiovascular risk.[26] This phenomenon has not been seen in subsequent studies.[8 9 27]

In Whitehall II there is evidence for interaction between childhood and current socioeconomic circumstances only in the case of male body mass index (see below), and so our multivariate approach seems valid. It should be noted however, that exact quantitative comparison of effects is not possible because the two measures of socioeconomic position are different and hence the estimated differences (lowest minus highest level) are not directly comparable. The relative index of inequality method does permit male-female comparisons, bearing in mind that occupational status rather than a household measure has been used. Socioeconomic differences in several risk factors in childhood an adulthood are in fact greater among women than men. These findings may in part be attributable to additional health advantage among higher status women compared with men, and to gender differences in social mobility[20]; they further suggest that occupational status is a suitable measure of socioeconomic position among women in our study sample.

Childhood social position may have been measured less precisely than current position. Thus, in multivariate analysis effects in adulthood would be weakly attenuated by adjustment for childhood, and conversely adjustment for adult position would tend to attenuate childhood effects to a greater degree. If both effects were equal, social differences in the risk factors according to father's class would be greater than those according to own grade. The former differences involve comparison of Registrar General Social Classes I to V, whereas the employment grade differences are among non-manual workers only. The lack of comparability of our social status measures is mitigated by the change in occupational structure that has taken place in the past 50 years. As manual work has declined, unskilled non-manual work with low decision authority and low wages has expanded. Clerical and other support staff in the civil service thus may be seen to occupy the lower social ranks in the 1990s, just as unskilled and semi-skilled manual employees did in the childhoods of Whitehall II subjects.[28]

The influence of parental origins and early life circumstances is evident within the Whitehall II cohort. Firstly, overweight and obesity in both sexes are linked with childhood circumstances, and the statistical interaction between father's class and own grade in men indicates that the combination of relative childhood disadvantage together with a low status occupation[29] is particularly associated with high relative weight as an adult. This finding adds to evidence that the link between childhood disadvantage and adult obesity is a deferred one, with onset in early adulthood rather than in childhood.[30 31] Secondly, in women, central obesity and low HDL cholesterol are linked with father's social class. These associations are consistent with tracking of the metabolic syndrome pattern of risk factors[16] from early into later life.[32 33] Thirdly, smoking behaviour among women is strongly associated with earlier circumstances, as has been shown elsewhere.[34] Childhood socioeconomic circumstances account statistically for 60% of the difference in female smoking rates across employment grades, but only 8% in men. It may be that the gender difference in smoking rates is attributable to the influence of maternal smoking patterns on their daughters' smoking behaviour. A clear inverse social gradient in smoking prevalence among British women did not appear, however, until the 1970s,[35] by which time our cohort was 20–40 years of age, suggesting that wider social and cultural influences may be responsible.

Our finding of an association between height and father's class provides further evidence that acquisition of health capital (constitution) in childhood, indexed by height, continues to be important for the cohort born around 1940. Extensive literature[36] shows a strong link between adult height and socioeconomic position in childhood, with factors such as economic hardship, large family and family conflict all linked to short stature in

Table 6 Which is more important? Comparison of size of childhood and adulthood socioeconomic status effects in Whitehall II and West of Scotland Collaborative studies

	Whitehall II born 1930–53	*West Scotland born 1906–38*
Men		
Smoking	adulthood	adulthood
Exercise	adulthood	adulthood
Body mass index	both	childhood
Diastolic BP	neither	both
Cholesterol	neither	adulthood*

*Total cholesterol has a direct association with childhood and adulthood social position in the Collaborative study.

adulthood.[37 38] In a previous study of civil servants height was inversely related to coronary death in particular, but also to all cause and non-coronary mortality.[39] We repeat the finding that height was related to father's class as well as to own grade,[39] and extend it to women.

We do not entirely replicate the findings among men in the Scottish cohort[12] (table 6, note, data for women not available). Health related behaviours smoking and physical activity are linked predominantly with own position in both studies. In the more recent Whitehall II cohort, obesity is linked with adult as well as childhood position, while it was not in the Collaborative cohort. Population surveys[40 41] suggest period rather than geographical differences account for the disparities between the two studies. Among men born in the earlier part of the century, a direct association is seen between serum cholesterol and adult social position in Scotland[12] and England.[21 42] In contrast, no social gradient in cholesterol is evident within younger cohorts in either country.[15 40 41] Similarly, there is little evidence for a social gradient in blood pressure in recent surveys.[43] A possibility, supported by analysis of Collaborative study deaths, is that the influence of childhood social position may operate independently of conventional risk factors.[27]

The Collaborative study sample is divided equally between manual and non-manual workers, while in Whitehall II the participants are all in non-manual occupations, and many have thus been upwardly mobile (table 1). Although this intergenerational mobility may be less significant in psychosocial and economic terms than might first appear,[28] it may be that if non-mobile manual workers were represented within Whitehall II, a stronger association of childhood circumstances with height and with adult risk factors might be seen.

In conclusion, height, a measure of health capital linked to lower cardiovascular risk, was here weakly associated with father's class, and more strongly linked with own grade, suggesting that height may have an influence on employment destination. The height-grade association raises the possibility that other effects may be attributable to selective social mobility. It is easy to see mechanisms, such as possession or attribution of psychological characteristics, operating with height, but less easy to see how selection would operate with metabolic factors, given the weak correlations with height.

Our study has used the relative index of inequality method, which in part takes account of the differing scales of socioeconomic position used here, to compare associations of childhood and adult position with cardiovascular risk factors measured in adulthood. In men, favourable adult health related behaviours and metabolic risk factors seem highly dependent on current social circumstances. In women, however, more than half the social gradient in current smoking could be accounted for by circumstances early in the lifecourse, and metabolic risk factors HDL cholesterol and fibrinogen remained related to father's class after adjustment for own grade. We repeat previous observations that adult degree of obesity is strongly associated with childhood conditions in both sexes. Our study suggests that interventions designed to alter the social distribution of cardiovascular risk are appropriate throughout the life course, including adulthood. Analyses of incident cardiovascular disease in relation to socioeconomic conditions in childhood and adulthood are required to consolidate our findings.

Conflicts of interest: none

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