Adult Socioeconomic Position and the Association Between Height and Coronary Heart Disease Mortality: Findings From 33 Years of Follow-Up in the Whitehall Study

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In the Whitehall Study, which followed 17 139 male civil servants over 33 years, the association between tall stature and coronary heart disease (CHD) mortality differed between employment grades. In men without CHD at study entry, the hazard ratio per 15-cm increase in height was 0.77 (95% confidence interval [CI]=0.69, 0.85; *P*<0.001) for the highest grades, but 0.84 (95% CI=0.69, 1.03; *P*=.10) for middle and 0.95 (95% CI=0.75, 1.20; *P*=.65) for low grades, suggesting that childhood and adult social conditions may interact in their influence on coronary risk. (*Am J Public Health*. 2005;95:628–632. doi: 10.2105/2004.046219)

Early case-control[1–3] and cohort studies[4–7] reported an inverse association between adult height and coronary heart disease (CHD). Supporting evidence is now available from more recent cohort studies of men,[5,8–15] women,[16] or both.[17–21] Studies also have reported an association with cerebrovascular disease but these findings have been somewhat discrepant.[14,20–22] The few studies to explore the influence of height on mortality in participants with prevalent CHD have yielded conflicting results for prognosis after myocardial infarction.[23–26]

Atherosclerosis and cardiovascular risk start in early life,[27] and growth-limiting fac-

TABLE 1—Association of Height and 33-Year Cardiovascular Mortality, by Employment Grade, in Men Without CHD at Baseline: Whitehall Study, 1967–1970

Outcome	Mean Height, cm (SE)	n	Deaths	Age-Adjusted[a]		Multiple-Adjusted[b]	
				HR (95% CI)	*P*	HR (95% CI)	*P*
Cardiovascular disease							
All employment grades	175.9 (0.1)	13 885	3975	0.89 (0.83, 0.95)	<.001	0.91 (0.85, 0.98)	.009
High employment grades	176.6 (0.1)	10 408	2784	0.84 (0.77, 0.91)	<.001	0.87 (0.80, 0.95)	.002
Middle employment grades	174.0 (0.1)	2 234	763	0.96 (0.82, 1.13)	.79	0.97 (0.83, 1.15)	.73
Low employment grades	173.2 (0.2)	1 243	428	1.05 (0.87, 1.26)	.52	1.03 (0.85, 1.25)	.75
Test for interaction				*P* = .02		*P* = .05	
Coronary heart disease							
All employment grades	175.9 (0.1)	13 885	2530	0.81 (0.74, 0.88)	<.001	0.84 (0.77, 0.92)	<.001
High employment grades	176.6 (0.1)	10 408	1781	0.77 (0.69, 0.85)	<.001	0.81 (0.73, 0.90)	<.001
Middle employment grades	174.0 (0.1)	2 234	478	0.84 (0.69, 1.03)	.10	0.87 (0.71, 1.07)	.19
Low employment grades	173.2 (0.2)	1 243	271	0.95 (0.75, 1.20)	.65	0.94 (0.74, 1.19)	.59
Test for interaction				*P* = .09		*P* = .21	
Stroke							
All employment grades	175.9 (0.1)	13 885	738	0.91 (0.78, 1.08)	.28	0.90 (0.76, 1.06)	.21
High employment grades	176.6 (0.1)	10 408	517	0.82 (0.67, 1.01)	.06	0.82 (0.67, 1.00)	.05
Middle employment grades	174.0 (0.1)	2 234	146	1.18 (0.82, 1.72)	.37	1.17 (0.80, 1.70)	.42
Low employment grades	173.2 (0.2)	1 243	75	1.06 (0.68, 1.66)	.80	1.01 (0.64, 1.60)	.95
Test for interaction				*P* = .13		*P* = .16	

Note. CHD = coronary heart disease; HR = hazard ratio; CI = confidence interval.
[a]Analysis of all grades combined also is adjusted for grade.
[b]Multiple adjustment is for age, smoking habit, cholesterol, systolic and diastolic blood pressure, body mass index, forced expiratory volume in 1 second (adjusted for height), glucose intolerance, and diabetes.

tors have been suggested to contribute to the origins of these risks through early biological changes in the developing vasculature.[28–30] But height is also an indicator of childhood social conditions,[30–32] and shorter people may have greater cardiovascular vulnerability through continuing social disadvantage.[33] Earlier analyses suggested weaker height-related effects with longer follow-up, possibly attributable to selective premature mortality of ill participants with height reduction before study entry.[34] We investigated whether the association between height and cardiovascular mortality differs by adult socioeconomic circumstances and compared associations by follow-up period.

METHODS

Between 1967 and 1970, 19 019 male civil servants aged 40 to 69 years completed a standard questionnaire and participated in a physical examination as part of the Whitehall Study of British male civil servants.[35–38] Prevalent CHD at baseline was defined by electrocardiogram abnormalities, symptoms, or both.[39] The National Health Service Central Register notified us of all deaths that had occurred by the end of 2002. Cause of death was classified according to the *International Classification of Diseases, Eighth Revision* (*ICD-8*),[40] including mortality from CHD (*ICD-8* codes 410–414), stroke (*ICD-8* codes 430–438), and cardiovascular disease (*ICD-8* codes 390–458). Eight percent of deaths were coded using the corresponding codes of the *ICD* ninth and tenth revisions.[41,42]

Of the 19 016 participants with known height and age, we excluded 167 for whom there was no follow-up, 44 with unknown cause of death, 863 from the diplomatic service and the British Council for whom employment grading was not comparable, and 803 with missing information on covariates, resulting in a total of 17 139 subjects. We examined linear associations between height and mortality by fitting proportional hazards models separately for participants with and without CHD at baseline. Separate height effects were estimated by employment grade and were tested for interaction using likelihood ratio tests. We examined the effect of height on mortality according to follow-up periods (0–9 y, 10–19 y, 20–29 y, ≥30 y) using an interaction term of height by time period.

RESULTS

Height was inversely related to mortality from total cardiovascular disease (CVD) (hazard ratio [HR] associated with each 15-cm increase in height=0.89; 95% confidence interval [CI]=0.83, 0.95; $P<.001$). This effect was stronger for CHD mortality (HR=0.81; 95% CI=0.74, 0.88; $P<.001$) than for stroke (HR=0.91; 95% CI=0.78, 1.08; P=0.28) (Table 1). Associations were strongest for participants in high employment grades but weaker and nonsignificant for those in middle and low grades. The test for interaction was significant for mortality from CVD (P=.02)

TABLE 2—Association of Height and 33-Year Cardiovascular Mortality, by Employment Grade, in Men With Prevalent CHD at Baseline: Whitehall Study, 1967–1970

Outcome	Mean Height, cm (SE)	N	Deaths	Age-Adjusted[a] HR (95% CI)	Age-Adjusted[a] P	Multiple-Adjusted[b] HR (95% CI)	Multiple-Adjusted[b] P
Cardiovascular disease							
All employment grades	174.9 (0.1)	3254	1466	0.78 (0.70, 0.87)	<0.001	0.80 (0.72, 0.90)	<0.001
High employment grades	175.9 (0.1)	2207	960	0.75 (0.65, 0.86)	<0.001	0.75 (0.65, 0.87)	<0.001
Middle employment grades	173.3 (0.3)	601	280	0.84 (0.65, 1.09)	0.19	0.93 (0.72, 1.20)	0.58
Low employment grades	171.8 (0.4)	446	226	0.83 (0.64, 1.08)	0.16	0.84 (0.65, 1.10)	0.21
Test for interaction				P = .41		P = .27	
Coronary heart disease							
All employment grades	174.9 (0.1)	3254	1000	0.74 (0.65, 0.85)	<0.001	0.77 (0.67, 0.88)	<0.001
High employment grades	175.9 (0.1)	2207	644	0.66 (0.55, 0.79)	<0.001	0.67 (0.56, 0.80)	<0.001
Middle employment grades	173.3 (0.3)	601	196	0.91 (0.66, 1.23)	0.53	1.00 (0.74, 1.36)	0.98
Low employment grades	171.8 (0.4)	446	160	0.88 (0.65, 1.20)	0.42	0.90 (0.66, 1.24)	0.52
Test for interaction				P = .06		P = .03	
Stroke							
All employment grades	174.9 (0.1)	3254	214	0.76 (0.56, 1.02)	0.07	0.76 (0.56, 1.03)	0.07
High employment grades	175.9 (0.1)	2207	153	0.76 (0.53, 1.09)	0.13	0.74 (0.50, 1.07)	0.10
Middle employment grades	173.3 (0.3)	601	37	0.74 (0.37, 1.49)	0.40	0.80 (0.41, 1.53)	0.49
Low employment grades	171.8 (0.4)	446	24	0.80 (0.36, 1.79)	0.58	0.81 (0.34, 1.91)	0.63
Test for interaction				P = .93		P = .81	

Note. CHD = coronary heart disease; HR = hazard ratio; CI = confidence interval.
[a]Analysis of all grades combined is also adjusted for grade.
[b]Multiple adjustment is for age, smoking habit, cholesterol, systolic and diastolic blood pressure, body mass index, forced expiratory volume in 1 second (adjusted for height), glucose intolerance, and diabetes.

but not CHD (P=.09) or stroke (P=.13). Further adjustments had only a small effect on these results. The pattern of results was similar in men with existing CHD (Table 2), but none of the associations with stroke mortality reached conventional levels of statistical significance.

Associations between height and mortality did not differ significantly between periods of follow-up (all tests for interaction, P>.22, data not shown).

DISCUSSION

Our results indicate that short stature is not only an important influence on the development of CHD in an asymptomatic healthy population but also an influence on the prognosis in men with prevalent CHD. We found no evidence that the adverse effect of height is restricted to participants with differential shrinkage before study entry and selective premature mortality in the early years of follow-up. This finding is supported by studies from Scotland[21] and the United States[2] where height was assessed at university entry, minimizing potential bias.

The adverse effect of shorter stature on CHD was strongest in those of higher employment grades, in contrast to a study of Finnish men that suggested that those with poor prenatal growth were more vulnerable to the effects of low socioeconomic status on CHD.[43] However, the comparability of the 2 populations is questionable. Size at birth and height, although weakly correlated, are markers of growth phases with different determinants and duration and may represent separate influences on cardiovascular risk.[10,44]

People moving to a higher socioeconomic class are on average taller than the class they leave and shorter than the class they join, resulting in a decrease in mean height in the higher employment grades and narrowing of height inequalities between grades in adulthood.[45] In the Whitehall population, there was substantial intergenerational social mobility: children of manual workers became clerical officers and, to a lesser extent, higher-grade civil servants.[46] Degree of upward mobility was related to attained adult height.[47] Within high employment grades, shorter participants thus represent the upwardly mobile, and their childhood environment and cardiovascular risk differs from the taller participants of continuously high social position. In addition, the relative contribution of early disadvantage to adult cardiovascular risk may be smaller in men in lower employment grades who have increased risk factors and higher absolute mortality.

The generalizability of findings from men of socioeconomic status higher than the general population average—and thus of taller stature and with lower mortality rates—is limited and may underestimate the association between height and CHD. However, our results suggest that the association between height and CHD may be stronger in socially homogenous cohorts.[2,8,21,37] Although associations of height with ischemic and hemorrhagic stroke may differ,[11,22,48] insufficient information on stroke subtypes restricted separate investigation in this study.

Short height is an important influence on the development of CHD in both asymptomatic healthy men and those with evident CHD. Differences in these associations between employment grades show the importance of bringing together studies of the influence of poor growth and socioeconomic position to consider their interactive effects. ■

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Contributors

All of the authors contributed to interpreting the analyses and writing the article. C. Langenberg developed the study aim and wrote the initial draft. M.J. Shipley ran the statistical analysis of the data.

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Human Participant Protection

At the time the Whitehall Study was conducted, there was no requirement to obtain ethical approval for scientific studies of this kind.

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