Does financial disadvantage at older ages eliminate the potential for better health?

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Objective: Taller adult stature reflects early life advantages and is an indicator of improved economic and health outcomes, and thus the potential for better health, including reduced depression risk. As inadequate retirement pension provision is an increasing concern, we investigated whether health potential (indicated by height) was realised among those experiencing financial disadvantage in later life.

Design, setting and participants: Cross-sectional study of the population in England aged over 50 years and not resident in an institution. Participants (n = 9106) were members of the English Longitudinal Study of Ageing.

Main outcome measure: Depression assessed using the eight-item Center for Epidemiological Studies Depression Scale.

Results: Stratification by the lowest quintile of the net financial assets distribution defined adversity, and stature was dichotomised at the shortest quintile of height (sex standardised). After adjustment for sex, qualifications, occupation type, whether currently employed, age, ethnic origin and chronic illness, taller stature was associated with a statistically significant reduced risk of depression with an odds ratio of 0.7 (95% confidence interval 0.6 to 0.9) among those without financial disadvantage. No protection against depression was associated with taller stature among those with financial disadvantage (odds ratio 1.0; 95% confidence interval 0.8 to 1.3). Interaction testing confirmed effect modification by financial disadvantage for the association of height with depression (p = 0.005).

Conclusions: Although taller stature, indicating favourable childhood conditions, is associated with a decreased risk of depression, this benefit is eliminated by financial disadvantage at older ages. Adequate financial provision for older people is required to maximise the health potential imparted by beneficial conditions in earlier life.

Depression is an important cause of disease with significant implications for health service resources¹ and, as the elderly population grows, depression among this group assumes greater importance. One of the well-established risks for depression is financial adversity;^{2–3} as the adequacy of retirement pension provision is likely to diminish, financial hardship at older ages may become more common, increasing the risk of depression among older people. Depression is an important disease in itself, reducing quality of life and increasing the use of health care resources, but it may also increase the risk of physical disease and excess morbidity and mortality^{4–5} through a number of putative mechanisms. Financial adversity in old age may thus have profound consequences for the health of the population and for health care provision.

Some conditions and exposures in early life can have significant consequences for development and for health in later life. Although influenced by genetic factors, growth in childhood and subsequent adult height are affected by environmental exposures. While childhood nutrition is important, other factors, such as psychosocial stress, can impair growth,⁶ independent of diet.⁷ Early stressful exposures that impair growth may programme the stress response to greater reactivity and therefore reduce an individual's ability to cope with stress (thus increasing depression risk); this may adversely influence health, indicated by increased systolic blood pressure on exposure to chronic stress among those with impaired growth.⁸ Inadequate nutrition, reflected by impaired growth, may be directly relevant to depression. Coeliac disease can restrict childhood growth by impairing absorption of nutrients, and one possible explanation for the association of coeliac disease with depression is the effect of malnutrition on the developing brain.⁹ Taller stature is associated with

continuing advantage through life,^{10–11} so that the early and continuing associations with tall stature help to explain the reduced risks for a variety of diseases, including coronary heart disease and cardiovascular disease, among taller people.^{12–14} Taller adult stature may therefore indicate a variety of characteristics that confer protection against disease and, as it may be considered an indicator of positive *health potential*, we examined whether taller stature is associated with a reduced risk of depression at older ages.

Our previous research into health potential indicated by height, using data from the USA, unexpectedly found that financial disadvantage in adult life may eliminate the health potential relevant to the risk of developing angina pectoris.¹⁴ This led us to speculate that financial adversity may eliminate health potential relevant to angina risk through mechanisms such as increased levels of psychosocial stress and depression. Thus, in this study our outcome measure is depression.

The specific research question addressed by this paper is: as taller stature resulting from beneficial childhood circumstances indicates health potential including a reduced risk of depression, does financial disadvantage at older ages diminish the benefits of such health potential? In this study we examined if taller stature was associated with a reduced risk of depression among those with and without an objective measure of financial disadvantage at older ages in a representative sample of the general population who were not resident in an institution and living in England.

METHODS

Participants

These data are from the first cross-sectional sweep of the English Longitudinal Study of Ageing (ELSA), a multipurpose

study following respondents to the Health Surveys for England from 1998, 1999 and 2001, who are ages 50 years or older.^{15 16} Information was collected by interview from 12 100 men and women who were not living in an institution and who were aged 50 years or older and living in England in 2002. This sample was restricted to respondents who could be directly interviewed themselves, a total of 11 244, and reduced to 9106 (81%) after exclusion of those with missing information required for the analysis.

Measures

Depression was assessed using the eight-item Center for Epidemiological Studies Depression Scale,¹⁷ dichotomised, with a score of 3 or more indicating depression. Economic adversity was assessed by a measure of financial "wealth" obtained adding the value of all assets, benefits and income and then subtracting debts. The distribution for the entire target population was divided into fifths, and this was the variable supplied by ELSA. We dichotomised this five-value variable to identify the lowest 20% who met our definition of economic adversity. Height was measured and divided into equal fifths separately for males and females to achieve sex standardisation. This was dichotomised at the lowest fifth, so that all those with taller stature could be compared with the group most likely to have restricted growth.

Other measures are most recently held occupation coded into managerial, intermediate and routine; whether currently employed; age; and ethnic origin coded into white and non-white (less than 2% of the sample were non-white). Highest educational level was categorised into NVQ4/NVQ5/degree or equivalent; higher education below degree level; NVQ3/GCE A-level or equivalent; NVQ2/ GCE O-level or equivalent; NVQ1/ CSE or equivalent; and no qualifications. Those with foreign or other qualifications were coded into a separate category. Long-standing illness was divided into non-limiting and limiting.

Ethics approval was not required for this secondary analysis of data as no information enabling identification of individuals was involved.

Statistical analysis

Logistic regression was used to assess the associations of all variables used in the analysis with depression: height, economic adversity, sex, age, employment status, occupational classification, level of education and ethnic origin. Mutual simultaneous adjustment was conducted for these measures. The measures were modelled as series of binary dummy variables, except for age, which was included as a continuous measure to ensure comprehensive adjustment for age.

To assess effect modification by economic adversity for the association of height with depression, the analysis described above was stratified by economic adversity. To confirm that the *difference* in estimates between strata was statistically significant, interaction testing was used.¹⁸ This tested the association with depression for the interaction of height with financial disadvantage after adjustment for the main effects (height and financial disadvantage)¹⁸ as well as the other potential confounding factors.

Home ownership

We performed further analysis to identify if lack of home ownership was the specific characteristic of financial disadvantage that eliminated health potential. First a dichotomous measure of home ownership was added to the interaction model described above. Then a new interaction model examined the interaction of home ownership with height adjusted for the main effects and the potential confounding factors. One version of this model included the dichotomous

financial disadvantage variable, while a second version excluded it.

RESULTS

Table 1 shows that financial disadvantage, routine employment, long-standing illness (particularly if limiting) and female sex are statistically significantly associated with a raised risk of depression, independently of each other as well as of ethnic group and level of education. Taller stature and being currently employed are independently associated with a statistically significant reduction in the risk of depression.

The unadjusted odds ratios (95% CI) for the association with depression for financial assets in fifths (compared with the most affluent group) were 3.68 (3.13 to 4.33), 2.58 (2.18 to 3.04), 1.89 (1.59 to 2.24) and 1.44 (1.21 to 1.72). After adjustment for the potential confounding factors, these odds ratios were reduced to 2.38 (1.99 to 2.85), 1.75 (1.45 to 2.10), 1.55 (1.29 to 1.86) and 1.25 (1.04 to 1.50). Compared with the shortest fifth, taller subjects (divided into fifths) were less likely to be depressed, but the odds ratios show a plateau effect both when unadjusted (0.81 (0.70 to 0.94), 0.61 (0.53 to 0.71), 0.62 (0.53 to 0.72), 0.63 (0.54 to 0.73)) and when adjusted (0.87 (0.75 to 1.02), 0.72 (0.61 to 0.85), 0.76 (0.64 to 0.89) and 0.84 (0.71 to 0.99)).

Table 2 shows that, among those without financial disadvantage, there was a statistically significant negative association between taller stature and depression risk, independent of the potential confounding factors. In contrast, there was no such association of height with depression among those who were experiencing financial disadvantage. The effect modification by financial disadvantage for the association of height with depression was confirmed as statistically significant by interaction testing. After adjustment for the main effects and all of the potential confounding factors, the difference in estimates (interaction of height with financial disadvantage) is statistically significant ($p = 0.005$).

When divided according to sex, the effect modification was similar in both sexes, but somewhat more pronounced among women. Despite adjustment for ethnic origin in the main analysis, we also excluded the small proportion (less than 2%) with a "non-white" ethnic origin and this did not alter the results notably.

Home ownership

A total of 4585 subjects (50%) were home owners, who tended to be more affluent as only 7% of home owners were in the financial disadvantage category, compared with 31% of those who did not own their homes. Addition of the home ownership variable to the adjusted model for the association with depression for the interaction of financial disadvantage and height had no influence on the odds ratio for interaction or the associated confidence interval: 1.50 (1.13 to 2.00). An alternative model examined the association with depression for the interaction of home ownership (home owners as the reference group) with height, adjusted for the main effects and the potential confounding factors. The association of the interaction term with depression is 1.26 (0.99 to 1.61) when the measure of financial disadvantage is included and 1.27 (0.99 to 1.62) when it is excluded. These estimates are not statistically significant and are lower in magnitude than the estimate for the interaction of financial disadvantage with height, indicating that home ownership is not the sole factor explaining the effect modification associated with financial disadvantage.

DISCUSSION

Taller stature is associated with a lower risk of depression in later life, so here we describe this characteristic as indicating

Table 1 Associations with depression among English men and women aged over 50 years

	Not depressed	Depressed (%)	Unadjusted odds ratio (95% CI)	p Value	Adjusted odds ratio* (95% CI)	p Value
Financial disadvantage						
No	5839	1541 (21)	Ref.		Ref.	
Yes	1091	635 (37)	2.2 (2.0 to 2.5)	<0.001	1.7 (1.5 to 1.9)	<0.001
Height						
Shorter	1270	549 (30)	Ref.		Ref.	
Taller	5660	1627 (22)	0.7 (0.6 to 0.7)	<0.001	0.8 (0.7 to 0.9)	<0.001
Most recent occupation						
Managerial	2336	473 (17)	Ref.		Ref.	
Intermediate	1676	463 (22)	1.4 (1.2 to 1.6)	<0.001	1.0 (0.9 to 1.2)	0.597
Routine	2918	1240 (30)	2.1 (1.9 to 2.4)	<0.001	1.3 (1.1 to 1.5)	0.001
Currently employed						
No	4399	1705 (28)	Ref.		Ref.	
Yes	2531	471 (16)	0.5 (0.4 to 0.5)	<0.001	0.7 (0.6 to 0.8)	<0.001
Long-standing illness						
None	3488	567 (14)	Ref.		Ref.	
Non-limiting	1673	370 (18)	1.4 (1.2 to 1.6)	<0.001	1.3 (1.1 to 1.5)	<0.001
Limiting	1769	1239 (41)	4.3 (3.8–4.8)	<0.001	3.6 (3.2 to 4.1)	<0.001
Sex						
Male	3364	824 (20)	Ref.		Ref.	
Female	3566	1352 (28)	1.5 (1.4 to 1.7)	<0.001	1.6 (1.4 to 1.7)	<0.001
Total	6930	2176 (24)				

*Adjusted for all variables shown, as well as level of education, ethnic origin and age.
Ref., reference category.

“health potential”. Using an objective measure of financial circumstances, we observed that financial disadvantage in later life entirely eliminated the reduction in depression risk associated with taller stature. It should be stressed that the reduction in association is not due to differences in statistical power as the *difference* in estimate for the association of stature with depression across the two financial groups is highly statistically significant, as confirmed by interaction testing (effect modification).¹⁸ The elimination of health potential by financial disadvantage in later life was independent of multiple potential confounding factors relevant to advantage or disadvantage earlier in the life course, including education, occupation, employment status and home ownership.

Height reflects some childhood exposures that influence health potential and is a useful marker of such childhood exposures in a cross-section study of adults as concerns about recall bias are reduced. Some childhood exposures may confer health potential themselves,⁸ and the initiation of this important process must begin in early life; however, as non-impaired growth is also associated with higher levels of social capital,^{19–21} the ensuing social and economic trajectory may result in continued accumulation of health potential through adult life. This paper is concerned with whether financial disadvantage in later life eliminates the health potential

associated with taller stature. To reduce the risk of other aspects of current or earlier life confounding the influence of financial disadvantage on depression risk, we adjusted for a variety of measures reflecting life course trajectory, such as education and employment type, as well as current circumstances including employment status and chronic illness. As both height and current financial adversity are strongly associated with potential confounding factors included in the analysis, such as education and employment, it is likely that our models may be overadjusted, thus producing conservative estimates of the effect modification by economic adversity for the association of height with depression.

One reason for conducting this study was that we unexpectedly found a similar result in our previous research into angina pectoris risk using data from the USA.¹⁴ In that study our *a priori* hypothesis was that taller stature (indicating favourable childhood exposures and higher health potential) would in later life confer resilience against low income, which increases the risk of angina. We unexpectedly found that low income in adult life eliminated the reduction in angina risk associated with taller stature. In an attempt to explain this finding, we speculated that stress or depression associated with economic disadvantage eliminated the health potential relevant to angina risk that is associated with taller stature. The results of the

Table 2 The association of height with depression, stratified by financial disadvantage

	Not depressed	Depressed (%)	Unadjusted odds ratio (95% CI)	p Value	Adjusted odds ratio* (95% CI)	p Value
<i>No financial disadvantage</i>						
Height						
Shorter	1026	400 (28)	Ref.		Ref.	
Taller	4813	1141 (19)	0.6 (0.5 to 0.7)	<0.001	0.7 (0.6 to 0.9)	< 0.001
<i>Financial disadvantage</i>						
Height						
Shorter	244	149 (38)	Ref.		Ref.	
Taller	847	486 (37)	0.9 (0.7 to 1.2)	0.599	1.0 (0.8 to 1.3)	0.980

*Adjusted for most recent occupation, current employment status, sex, level of education, ethnic origin, age and presence of a long-standing illness.
Ref., reference category.

present study using ELSA data suggest that depression caused by economic disadvantage in later life may help to explain why the protective effect against angina of taller stature is lost among those experiencing economic disadvantage.

Although partly genetically determined, adult height also reflects conditions and exposures in infancy and childhood.^{10–11–22} Adverse exposures, including psychosocial stress,^{6–7} can impair growth in childhood and, although catch-up growth often occurs, adult stature may be limited by childhood adversity. Shorter stature, reflecting early life adversity, is also associated with excess morbidity and mortality, for example from cardiovascular and coronary heart disease,^{12–14} as well as the depression risk shown here, so it can be a useful marker of health potential. The explanation for the associations of height with such outcomes is unlikely to be because of the influence of height itself. For example, childhood growth is far more strongly associated with adult blood pressure than adult height,⁸ indicating that exposures influencing childhood growth also have life-long implications for blood pressure control mechanisms. Thus, using adult height as a marker of health potential is likely to represent a conservative measure compared with childhood growth.

Height (reflecting growth) may be associated with depression risk through a number of potential mechanisms. Childhood adversity can be reflected in adult height, and psychosocial stress caused by experiences such as parental divorce in childhood is associated with poorer mental health in later life, including depression.²³ Such stress has been shown to impair growth,^{6–7} so this is one mechanism linking shorter stature with adult depression. There is evidence that some forms of childhood malnutrition that potentially influence growth could influence depression risk,⁹ possibly by impairing development of the brain. Less direct mechanisms are plausible, as shorter stature (reflecting childhood exposures and not a direct consequence of stature) is associated with adversity throughout life, such as a greater risk of unemployment,²¹ which can increase depression risk.²⁴ The exposures impairing childhood growth can adversely affect the development of cognitive function, education and perhaps other psychological characteristics relevant to labour market success.^{19–21} Thus, the benefits of taller stature in old age may reflect an accumulation of advantage that begins in early life and continues throughout life. Despite this long-term accumulation of advantage, the benefits of taller stature may be eliminated by financial disadvantage at older ages.

Home ownership was strongly associated with a reduced risk of financial disadvantage, and it is possible that lack of home ownership, rather than other aspects of disadvantage, was responsible for the observed effect modification for the association of height with depression. Home ownership was not included in the initial interaction model due to its collinearity with financial disadvantage, but the addition of this measure did not alter the effect modification, indicating the importance of financial disadvantage in general, rather than a specific effect of home ownership. This concept was further tested by replacing financial disadvantage with home ownership in the interaction term. This interaction test produced an estimate that was lower in magnitude and not statistically significant, confirming that financial disadvantage in general, rather than home ownership specifically, is responsible for the elimination of health potential.

In previous studies of stature, those in the shortest height fifth were most likely to experience adverse outcomes^{8–21} representing depression risks,²⁴ and this height group was most strongly associated with exposure to psychosocial stress in childhood.⁶ For these reasons, those in the shortest height fifth were chosen to represent a group at greater risk of depression,

What is already known about this topic

Social advantage in early life is reflected in taller stature. The early advantage associated with taller stature tends to result in advantages throughout life, decreasing the risk of disease, including depression, in later life.

What the paper adds

Financial disadvantage at older ages may eliminate some of the advantages for health indicated by taller stature, thus increasing the risk of depression and depression-related disease. Financial disadvantage in old age may result in increase in morbidity that unexpectedly eliminates health improvements associated with social improvements in earlier life.

Policy implications

As inadequate retirement pension provision may have serious and unexpected implications for health and health service provision, greater investment in pensions by government may offset increasing health service costs.

while the remainder of the population were considered to have higher health potential.

A disadvantage of this study is the use of cross-sectional data as only the first wave of ELSA data were available, so there is uncertainty about the direction of causation. However, to minimise the risk that the results are confounded by previous adult experiences, we adjusted for important markers of conditions and opportunities, including level of education, type of occupation and whether currently employed. Multiple adjustment for potential confounding factors in the interaction model also reduces the possibility of differential selection into the two economic disadvantage strata accounting for the results. The objective measure of economic disadvantage available among ELSA data identifies those with the lowest 20% of economic resources: this may not represent extreme disadvantage for all in this group, so again our results may be somewhat conservative.

The childhood conditions that influence height also directly and indirectly influence susceptibility to depression at older ages. The psychosocial stress associated with financial disadvantage in later life appears to eliminate the lower risk of depression that is normally observed in those with the higher levels of health potential associated with taller stature. This loss of health potential due to financial disadvantage may result in an unexpected increase in the burden of depression among the elderly population. Some other health improvements in old age due to higher levels of health potential originating in better childhood conditions may also be unexpectedly lost. Not only depression, but other health outcomes, including cardiovascular disease, may be affected, as depression may increase the risk of cardiovascular and coronary heart disease.^{4–5} Thus, inadequate pension provision may have profound and unexpected consequences for disease risk and health care provision amongst the elderly population.

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