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Factors across life associated with remaining free from functional limitations despite lifelong exposure to socioeconomic adversity

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ABSTRACT

Background There are substantial socioeconomic inequalities in functional limitations in old age. Resilience may offer new insights into these inequalities by identifying constellations of factors that protect some individuals from developing functional limitations despite socioeconomic adversity.

Methods Data from 1973 participants in the Medical Research Council National Survey of Health and Development (Great Britain), followed from birth until age 60–64, were used. Functional limitations were defined as reporting difficulty with at least 1 of 16 activities at age 60–64. Lifetime socioeconomic adversity was based on socioeconomic trajectories, categorised into three adversity levels. Analysis of covariance and regression models were used to compare psychosocial factors and health-related behaviours between a 'Resilient' group (high adversity but no functional limitations) and five groups with other combinations of adversity and limitations.

Results Prevalence of functional limitations in high, intermediate and low adversity groups was 44%, 30% and 23% in men, and 61%, 55% and 49% in women, respectively. Compared with the other high adversity group, the resilient group had a lower prevalence of childhood illness (12% vs 19%) and obesity throughout ages 43–64 (70% vs 55%). Partially adjusted models also showed higher adolescent self-management, lower neuroticism, higher prevalence of volunteer work and physical activity (age 60–64) and lower prevalence of smoking (age 43) in the resilient. Marital status and contact frequency were not associated with resilience.

Conclusion Results suggest protection against childhood illness, health-behavioural factors and self-regulation as targets for interventions across life that may particularly benefit those with long-term exposure to socioeconomic adversity.

INTRODUCTION

There is consistent evidence that socioeconomic adversity is associated with substantially higher risks of developing functional limitations.^{1–3} This evidence applies to multiple aspects of socioeconomic adversity, including hierarchical measures (eg, education and occupational class) and material deprivation (eg, poor housing conditions).^{4,5} Moreover, socioeconomic inequalities in functional limitations emerge as early as age 40.^{6,7} Functional limitations are defined as difficulties in carrying out fundamental physical tasks of daily

life. Self-reports of functional limitations provide an indicator of age-related disability which may ultimately lead to restrictions in performing social roles, a greater demand for care and support, and higher healthcare costs.^{8,9} As such, functional limitations constitute an important indicator for public health.¹⁰

Previous research suggests that psychological, social and health-behavioural factors across life may explain a substantial proportion of the observed variation in risk of functional limitations between socioeconomic groups.^{11–13} Examples of specific factors related to physical health in later life are self-control,^{14,15} emotional stability,^{16,17} social support and social participation,^{18,19} partner status,²⁰ smoking, obesity, and physical activity.^{19,21}

However, although such factors partly explain average differences in physical capability between socioeconomic groups, there is currently little understanding of the substantial variation in physical capability that may exist *within* groups exposed to different levels of socioeconomic adversity, and this variation has been shown to be particularly large in the lowest socioeconomic strata.²² Research on resilience focuses on this variation and aims to understand why some individuals who have been exposed to adversity function better than would be expected on the basis of this exposure.²³ One premise of resilience is that specific constellations of protective factors distinguish individuals with favourable outcomes despite adversity from those who experience the ill effects of adversity. Such factors may reside at the individual (eg, personality characteristics), social (eg, interpersonal relationships) and societal (eg, social security arrangements) levels.^{23,24} Applying this perspective to socioeconomic inequalities in physical capability, the current study asks which specific factors across life are associated with remaining free from functional limitations in older age despite exposure to socioeconomic adversity.

As the previous literature on socioeconomic inequalities in functional limitations demonstrates, answering this research question requires a life course perspective that considers the role of multiple socioeconomic conditions and protective factors and their timing in the life course. Therefore, the present study examines resilience on the basis of lifetime trajectories of socioeconomic adversity and psychological, social and behavioural



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factors observed in childhood and adulthood. These factors are based on previous research on explanations of general socioeconomic inequalities in functional limitations^{11 12} and on conceptual work on resilience.^{25 26} Our key question is which of these factors distinguish a ‘resilient’ group from other groups.

METHODS

Study sample

Data came from the Medical Research Council National Survey of Health and Development (NSHD), a socially stratified sample of all singleton births across England, Scotland and Wales in a single week in March 1946 (n=5362). Since birth, participants have been followed up to 24 times.²⁷ We use data collected up to age 60–64 (2006–2010). At this age, 2661 of a target sample of 3163 completed a postal questionnaire and/or underwent clinical assessment.²⁸ Attrition up to age 60–64 was on average 8% per 10 years.²⁹ About 33% of this attrition was due to death, 40% to moving abroad or to an unknown address, and 27% to refusal.²⁸ Response rates relative to the target samples at each consecutive wave were on average 87%.²⁹ At age 60–64, the NSHD remained generally representative when compared with the general England Census reference population, although in the NSHD a larger percentage were employed and owned their house.

Measures

Functional limitations

At age 60–64, participants indicated to what extent they experienced difficulty performing 16 different daily activities³⁰: holding something heavy, walking a quarter of a mile, walking up and down stairs, keeping balance, bending down and straightening up, preparing a hot meal, washing hands and face, bathing or showering, dressing and undressing, getting in and out of a chair, getting in and out of bed, getting to the toilet, using the toilet, feeding oneself, carrying a shopping bag in each hand, and doing heavy housework. Because response options for some items were restricted to either yes or no, for consistency we dichotomised all items as any (1) versus no difficulty (0). A sum score denoting the number of difficulties was calculated for all respondents who provided valid responses on at least 12 out of 16 activities. For those with one to four items missing (n=82), these items were assumed to be zero. Given our focus on those who remained completely free from functional limitations despite adversity, we contrasted those with no limitations versus those with one or more limitations. However, a sensitivity analysis with a higher cut-off point (≥ 2 vs < 2 limitations) was carried out to assess sensitivity of the results to this dichotomisation.

Socioeconomic adversity

Our measure of socioeconomic adversity was based on previous research (Kok, Cooper, Cosco, Huisman, Deeg, Kuh and Stafford; *Lifetime trajectories of socioeconomic adversity and their associations with psychosocial factors and attitudes towards social class*; for details see online supplement material), in which seven distinct trajectories of socioeconomic adversity were identified using latent class growth analysis. These trajectories were based on the number of adverse conditions experienced at six consecutive ages. At ages 4, 11 and 15, these were low father’s occupational class, living in any type of rented accommodation not owned by the family or the council, having few household amenities, and overcrowding. At ages 36, 43 and 53, these were low household occupational class, living in rented

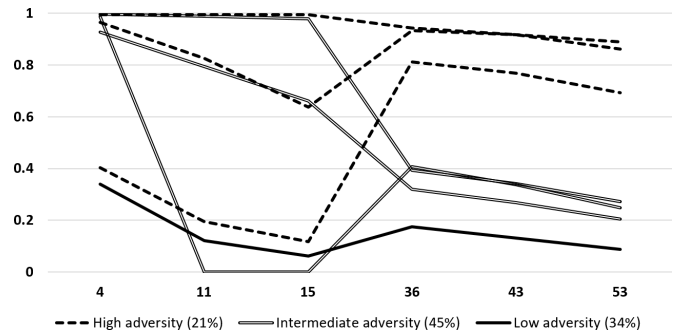


Figure 1 Trajectories of socioeconomic adversity (for details see online supplementary material) categorised into three levels of lifetime exposure to adversity.

accommodation and experiencing financial hardship. Additionally, trajectories were determined by parental and own education.

To obtain sufficient statistical power for group comparisons, we collapsed the seven trajectories into three levels of lifetime exposure to socioeconomic adversity (figure 1). ‘Low adversity’ experienced few adverse conditions at any age. ‘Intermediate adversity’ experienced adverse conditions only at age 4, or showed a decrease in adversity. As trajectories with increasing adversity are associated with higher risks of functional limitations than trajectories with decreasing adversity,⁴ we decided to consider the increasing adversity trajectory as ‘High’ exposure, and combined this with a group who experienced persistently high adversity and a relapse into high adversity in adulthood (for more details, see online supplement material).

Childhood factors

Childhood factors were selected based on a conceptual model of resilience in children with a low socioeconomic position (SEP), which emphasised the importance of socialisation and self-control.²⁵ As nurturing parenting may stimulate health-promoting behaviours, and parental involvement in their child’s education may attenuate negative effects of a disadvantaged background,³¹ we included indices of parental interest in the child’s primary and secondary education. These indices were derived from information collected from mothers and school teachers, and ranged from 0 (no school visits of parents) to 50 (very frequent school visits).³¹ Self-management at age 15 was measured by teacher’s assessment of the child’s attitude to work, daydreaming, neatness and concentration, combined into a factor score in previous research (range –2 to 3; higher scores indicate higher self-management³²). We also included the absence of disease in childhood as a potential correlate of resilience. This was based on reports of any serious illness necessitating hospital admission for 28 days or more before age 15.

Adulthood psychosocial and behavioural factors

Adulthood factors were selected on the basis of a previous literature review and data availability.¹⁹ Neuroticism (emotional stability) was measured at age 26 using Eysenck’s short Maudsley Personality Inventory³³ (range 0–12; higher means lower emotional stability). Educational qualifications at age 26 were dichotomised as any qualification versus none.

Social and behavioural factors included the frequency of social contacts, marital status, voluntary work, smoking, obesity and physical activity. These factors were measured at ages 43, 53 and 60–64, except voluntary work, which was not measured at age 53. Unfortunately, we could not include

Table 1 Characteristics of the study sample (N=1973)

Variable	Measured at age (years)	Observed		After imputation (N=1973)			
		n	% missing	Men (n=944)		Women (n=1029)	
				M/%	SD	M/%	SD
One or more functional limitation(s)	60–64	1973	0.0	30.3		53.8***	
Two or more functional limitation(s)	60–64	1973	0.0	16.6		32.5***	
Socioeconomic adversity	4–53	1973					
Low		662	0.0	33.3		33.8	
Intermediate		896	0.0	46.3		44.6	
High		415	0.0	20.4		21.6	
Childhood							
No serious illness before age 15 (%)	0–15	1973	0.0	85.3		87.0	
Parental interest in primary education (0–50)	11	1773	10.1	32.0	13.6	33.5*	12.9
Parental interest in secondary education (0–50)	13	1470	25.5	24.6	13.3	26.1*	13.1
Adolescent self-management (–2 to 3)	15	1769	10.3	0.05	0.79	0.21*	0.75
Adulthood							
Obtained any educational qualification	26	1897	3.9	67.4		68.9	
Neuroticism	26	1827	7.4	5.2	3.7	7.2***	3.6
Often met friends: throughout three waves (%)	43–64	1785	9.5	48.7		55.1*	
At age 43	43	1969	<1.0	77.7		76.1	
At age 53	53	1862	5.6	76.1		80.5*	
At age 60–64	60–64	1887	4.4	69.6		79.7***	
Voluntary work at age 43 and/or 60–64 (%)	43/60–64	1971	<1.0	23.1		32.3***	
At age 43	43	1964	<1.0	8.6		12.3**	
At age 60–64	60–64	1806	8.5	23.6		30.3**	
Married: throughout three waves (%)	43–64	1725	2.6	72.0		69.0	
At age 43	43	1972	<1.0	85.3		83.8	
At age 53	53	1896	3.9	84.7		81.0*	
At age 60–64	60–64	1782	9.7	83.3		76.3***	
Did not smoke: throughout three waves (%)	43–64	1747	11.5	70.7		72.4	
At age 43	43	1969	<1.0	75.2		76.9	
At age 53	53	1896	3.9	82.1		81.7	
At age 60–64	60–64	1810	8.3	88.5		88.4	
Was not obese: throughout three waves (%)	43–64	1855	6.0	67.4		64.1	
At age 43	43	1960	<1.0	90.5		88.3	
At age 53	53	1884	4.5	79.7		75.4*	
At age 60–64	60–64	1949	1.2	71.8		68.8	
Physically active: throughout three waves (%)	43–64	1845	6.2	24.4		21.4	
At age 43	43	1973	0.0	55.8		47.0***	
At age 53	53	1896	3.9	56.8		55.1	
At age 60–64	60–64	1918	2.5	35.8		37.4	

P value for differences between men and women: * <0.05 , ** <0.01 , *** <0.001 .

several measures before age 36, as these were measured slightly differently. Dichotomisation was often necessary to resolve differences in response categories across waves.

The frequency of meeting friends or relatives was dichotomised as at least once a week versus less. Voluntary work was dichotomised from no, less than monthly, monthly and weekly into whether the respondent did such work or not. Marital status expressed whether the respondent was married and living with a spouse or not. Smoking was dichotomised as not currently smoking versus currently smoking. Body mass index (BMI) was calculated from nurse-measured heights and weights, and dichotomised as not obese (BMI <30 kg/m²) versus obese (BMI ≥ 30 kg/m²). Leisure time physical activity

was dichotomised as having engaged in any sports, vigorous leisure activities or exercise at least once in the past month versus no such activity.

To examine the importance of timing, the prevalence of these psychosocial and behavioural factors was analysed at each age separately. To examine the importance of duration, we constructed summary scores indicating whether these factors were present throughout all three measurement waves versus less often. However, because of a low prevalence of voluntary work at both measurement waves, we constructed a variable expressing voluntary work at 'one or both waves' (1) versus 'never' (0).

Table 2 Six groups based on socioeconomic adversity and at least one versus no functional limitation (N=1973)

	Without functional limitations (n=1133; 58%)	With functional limitation(s) (n=840; 42%)
High adversity (n=415; 21%)	'Resilient' n=196 (9.9%), men: 11.5%, women: 8.5%	'High Adversity/Limitations' n=219 (11.1%), men: 8.9%, women: 13.1%
Intermediate adversity (n=896; 45%)	'Intermediate Adversity/No Limitations' n=517 (26.2%), men: 32.6%, women: 20.3%	'Intermediate Adversity/Limitations' n=379 (19.2%), men: 13.7%, women: 24.3%
Low adversity (n=662; 34%)	'Low adversity/No Limitations' n=420 (21.3%), men: 25.5%, women: 17.4%	'Low Adversity/Limitations' n=242 (12.3%), men: 7.7%, women: 16.4%

Other covariates

As the prevalence of functional limitations differs strongly between men and women, we adjusted all analyses for sex. Sensitivity analyses showing that the factors we found to be associated with resilience did not differ between men and women supported the conceptualisation of sex as a confounding rather than moderating factor.

Analytic strategy

Of the 2661 assessed at age 60–64, we included 1973 participants who had sufficient data on functional limitations and for whom a socioeconomic trajectory was available in our analyses. To avoid further decreases in sample size, we handled missing data on covariates with multiple imputation in SPSS version 22, following guidelines from the literature.³⁴ We generated 20 imputed data sets, and analyses were run across these and estimates were pooled using Rubin's rules.³⁵

To examine factors related to resilience, we first divided the study sample into six groups, that is, those with or without functional limitations at a low, intermediate or high level of socioeconomic adversity. Those with high adversity but no functional limitations were defined as 'Resilient', and were the reference group in all main analyses. Identification of factors associated with resilience involved three steps.

First, we estimated group differences in each potential protective factor separately, adjusted for sex only. Second, we selected only factors in which the resilient differed significantly ($p < 0.05$) from individuals with high adversity and functional limitations. Subsequently, we tested group differences in these factors again in models that adjusted for all selected factors. Differences between the resilient and groups with intermediate and low adversity were also examined to assess whether the characteristics of the resilient could be considered exceptional. Tests of statistical significance and adjusted means and proportions were obtained through analysis of covariance and linear regression (continuous factors) and logistic regression (dichotomous factors) models.

Sensitivity analyses were undertaken to examine whether (1) the same protective factors were identified when a higher cut-off point for functional limitations was used (≥ 2 vs < 2 limitations); (2) the same protective factors were identified in those with intermediate adversity who remained free from functional limitations; and (3) results differed in the sample with complete data on covariates. Results were reported in the online supplement material.

RESULTS

In total, 2235 participants had sufficient data on functional limitations, and for 1973 within this sample a socioeconomic trajectory had been calculated. The 262 excluded participants did not differ from the latter participants in terms of their functional limitations, SEP, sex and potential protective factors.

The prevalence of at least one functional limitation was lower in men (30%) than in women (54%) ($p < 0.001$; table 1). There was a strong gradient in functional limitations across the high, intermediate and low adversity groups: 44%, 30% and 23% in men, respectively ($p < 0.001$), and 61%, 55% and 49% in women, respectively ($p < 0.05$; percentages not shown in the table).

Based on their high level of adversity but absence of functional limitations, 196 respondents were defined as resilient (table 2).

Bivariate results

Compared with the resilient, respondents with high adversity/limitations more often reported childhood illness, had lower adolescent self-management and higher neuroticism, less often did voluntary work at any age or specifically at age 43, were more likely to smoke at age 43, more likely to be obese at ages 43 and 60–64, and throughout ages 43–64, and were less likely to be physically active at age 60–64 (table 3). Additionally, those with 'Intermediate Adversity/Limitations' and 'Low Adversity/Limitations' were more likely to be obese across ages 43–64 than the resilient. Moreover, despite less adversity, those with 'Intermediate Adversity/No Limitations' (all waves) and 'Low Adversity/No Limitations' (age 53) were no less likely to be obese than the resilient.

Multiply adjusted results

Based on the bivariate results, we selected childhood illness, self-management, neuroticism, voluntary work (at age 43 and/or 60–64), smoking (age 43), obesity throughout ages 43 to 60–64, and physical activity (age 60–64) for multiply adjusted models. The percentage without childhood illness and obesity remained significantly lower in the resilient, while differences with the high adversity/limitations group in self-management, neuroticism, smoking and physical activity became marginally significant ($0.05 \geq p < 0.10$; table 4).

Additional analyses

The prevalence of two or more functional limitations was 17% in men and 33% in women. Prevalence estimates in the high, intermediate and low adversity groups were 26%, 18% and 9% in men, respectively, and 41%, 33% and 26% in women, respectively. Using this cut-off, we found no differences in the factors associated with resilience (details in online supplementary material).

Repeating analyses with the intermediate adversity/no limitations as the reference group, we found that at an intermediate level of adversity, more regularly meeting friends at age 60–64, and not smoking and avoiding obesity across ages 43 to 60–64, distinguished those with and without functional limitations.

When we repeated the bivariate analyses in the sample with complete data on all covariates, the same factors were selected for the multiply adjusted analysis. In the multiply adjusted analysis ($n = 1516$), the finding on all factors except childhood illness (no longer significant; $p = 0.12$) appeared robust.

Table 3 Bivariate comparison of psychosocial and health-related factors between resilient and other groups (N=1973), adjusted for sex

Variable (measured at age)	Adjusted means/proportions for group					
	Resilient (reference)	High adversity/ limitations	Medium adversity/no limitations	Medium adversity/ limitations	Low adversity/no limitations	Low adversity/ limitations
Childhood						
% No child illness (0–15)	88.0	79.2*†	86.4	85.1	90.5	84.7
Parental interest primary education	28.8	26.9	31.2*†	30.6	38.8***‡	37.0***‡
Parental interest secondary education	21.8	20.0	23.8	23.6	30.5***‡	29.9***‡
Self-management (15)	-0.05	-0.24*†	0.18***‡	0.06	0.40***‡	0.15***‡
Adulthood						
Neuroticism (26)	6.6	7.4*†	6.1	6.3	5.6***‡	6.0
Any education (26)	40.3	35.4	66.8***‡	65.4***‡	93.1***‡	84.5***‡
% Social contact (age 43–64)	48.8	55.0	53.6	48.0	51.6	55.4
At age 43	75.9	73.9	78.4	76.4	79.0	74.4
At age 53	77.3	82.5	79.7	77.5	77.4	76.7
At age 60–64	74.2	75.7	78.9	69.8	72.8	80.5
% Voluntary work (43 and/or 60–64)	22.3	14.1*†	25.0	21.9	41.3***‡	35.6***‡
At age 43	10.3	4.3*†	9.6	9.4	12.7	15.5
At age 60–64	21.7	18.4	24.2	22.1	37.3*‡	32.0*‡
% Married (age 43–64)	64.4	60.7	74.5*‡	70.0	73.5	71.6
At age 43	80.9	76.0	86.6	85.9	86.3	85.7
At age 53	78.9	75.3	86.0*‡	82.2	85.4	82.6
At age 60–64	72.6	67.6	85.0**‡	79.3	84.1**‡	80.0
% Not smoking (age 43–64)	58.4	50.5	78.1***‡	67.7	81.9***‡	75.6***‡
At age 43	65.2	52.4***†	82.9***‡	69.4	87.0***‡	82.9***‡
At age 53	69.6	61.3	88.2***‡	78.3*‡	90.9***‡	86.8***‡
At age 60–64	77.2	77.6	91.1***‡	87.5***‡	94.3***‡	93.3***‡
% No obesity (age 43–64)	69.1	52.6**†	71.8	51.3***†	78.6*‡	61.5
At age 43	91.3	79.4**†	91.2	83.4*†	96.4*‡	90.1
At age 53	79.5	71.0	80.7	68.0**†	86.3*‡	74.5
At age 60–64	73.3	57.5**‡	76.5	56.6***†	83.6**‡	64.2*†
% Active (age 43–64)	16.6	10.4	23.7	17.9	31.7**‡	29.1**‡
At age 43	38.7	30.2	53.7***‡	46.4	65.6***‡	57.9***‡
At age 53	42.2	34.8	59.6***‡	50.0	68.9***‡	65.2***‡
At age 60–64	27.8	17.1*†	38.9**‡	33.0	49.6***‡	40.1**‡

*P<0.05, **P<0.01, ***P<0.001.

†Less favourable (meaning associated with less functional limitations) than in the resilient.

‡More favourable than in the resilient.

DISCUSSION

This study investigated, in a nationally representative birth cohort, what psychosocial and health-behavioural factors across the life course characterised individuals who remained free from functional limitations at age 60–64 despite being exposed to socioeconomic adversity across life. Among those with a high level of lifetime adversity, remaining free from childhood illness and not being obese at any age between ages 43 and 60–64 appeared to be the strongest of several factors distinguishing those without functional limitations (ie, the resilient) from those with limitations. Relatively high self-management, low neuroticism, not smoking, and engaging in volunteer work and physical activity were also associated with resilience, although these associations were only marginally significant after adjusting for other protective factors. We found no evidence that parental interest in

education, contact frequency and marital status were associated with resilience as defined in this study.

The factors found to be associated with resilience operated at multiple stages of the life course, and involved health-related, psychological and behavioural aspects. First, as housing conditions have been argued to affect childhood health,^{36 37} our finding that remaining free from childhood illness was associated with resilience may suggest that there was a gradient in socioeconomic conditions within those with high adversity, and that even small improvements in housing conditions may have made a large difference in health within this group.

Second, the absence of obesity seemed the most important health-related factor contributing to resilience. Obesity was no more prevalent in the resilient than in any group with lower adversity, which we consider exceptional given the much higher

Table 4 Multiply adjusted comparison of psychosocial and health-related factors between resilient and other groups (N=1973), adjusted for sex and all other included protective factors

Variable (measured at age)	Adjusted means/proportions for group					
	Resilient (reference)	High adversity/limitations	Medium adversity/no limitations	Medium adversity/limitations	Low adversity/no limitations	Low adversity/limitations
Childhood						
% No child illness (0–15)	88.5	80.8*†	86.6	85.4	90.1	84.4
Self-management (15)	−0.02	−0.15	0.17***‡	0.10	0.34***‡	0.13
Adulthood						
Neuroticism (26)	6.6	7.3	6.2	6.3	5.7**‡	6.0
% Voluntary work (43 and/or 60–64)	24.2	18.0	23.2	22.0	36.3***‡	33.5**‡
% Not smoking (43)	68.9	59.7	83.6***‡	71.9	85.3***‡	82.9**‡
% Not obese (43–64)	70.3	55.0***†	71.7	51.7***†	77.6	61.4
% Physically active (60–64)	28.9	20.2	37.8*‡	34.6	45.4***‡	38.4*‡

*P<0.05, **P<0.01, ***P<0.001.

†Less favourable (meaning associated with less functional limitations) than in the resilient.

‡More favourable than in the resilient.

FL, functional limitation.

average risk of obesity associated with lower SEP, at least in higher income countries.³⁸ Furthermore, our results on the timing of health-behavioural factors suggest that resilience may be fostered by stimulating healthy lifestyles earlier and later in life. For instance, while the resilient were no more physically active than those with high adversity and functional limitations at ages 43 and 53, engaging in physical activity more often at age 60–64 eventually contributed to their resilience, although reverse causality might partly explain this difference.

Third, in line with previous studies, we found some evidence that personality characteristics contributed to resilience in the face of socioeconomic adversity.^{25 26} Compared with those with high adversity and functional limitations, the resilient showed a lower tendency to react with distress to situations and events (neuroticism),³⁹ and better abilities to cope with stressors (self-management)⁴⁰; this might explain the importance of self-management for resilience. As such characteristics are also linked to health behaviours, these characteristics may partly explain the present findings on health-behavioural factors.

The finding that social factors played a minor role for resilience in our study seems at odds with the previous literature.^{23 24 26} This might be because the social measures that were available to us reflected structural rather than qualitative features of the social network, and resilience may emerge from actual support gained from contacts rather than the fact of having them. However, many studies that found social factors to be associated with resilience focused on psychological and social outcomes, whereas our study focused on functional limitations. It might be that social factors are less important for resilience in relation to physical capability. At the same time, we were not able to measure factors such as the use of social security arrangements, which may be crucial for the resilience of persons with a low SEP. Therefore, a challenge for future studies is to identify and analyse data on factors that may have particular importance within the context of high adversity.

Planned additional analyses showed that the combination of factors found to distinguish those with and without functional limitations at a high level of adversity was only partly the same as at an intermediate level of adversity. Still, as most factors included in this study appear to be important for physical functioning at all levels of adversity, future studies on resilience should theorise

and empirically examine additional psychological, behavioural and social factors that are important specifically for those living with adversity. Moreover, compared with those with intermediate and low adversity, many characteristics of the resilient were less favourable. This also implies that despite avoiding functional limitations at age 60–64, the resilient are still at higher risk of (future) health problems than those with less socioeconomic disadvantage. Nevertheless, our results pinpoint factors that may be the basis for effective interventions to improve physical capability in low SEP groups.

Strengths and limitations

Using prospective data on multiple indicators of SEP and psychosocial factors from birth to early old age is a strength of this study. Moreover, we reported findings from several additional analyses that demonstrated robustness of the results.

One limitation of our study was sample attrition by 60–64 years of follow-up, which has been somewhat selective in favouring those with a higher SEP and with better health.²⁸ Therefore, differences between those with high and low adversity may have been underestimated. Nevertheless, it is unlikely that comparisons of those with and without functional limitations *within* socioeconomic groups—which was the primary focus of this study—are biased through selective attrition.

Another limitation is that we had to combine socioeconomic trajectories because our study had insufficient statistical power to perform analyses on each of the seven socioeconomic trajectories identified previously (see online supplement material). Additionally, limitations of the available statistical methods to obtain pooled differences and significance tests in means and percentages between multiple categories while using multiple imputed data sets led us to dichotomise several variables. This may have reduced statistical power to detect group differences. Additionally, our dichotomisation of functional limitations did not capture a gradient in severity of experienced limitations. Nevertheless, our findings were similar with a higher cut-off point, and our measure of functional limitations was accurate in defining the main group of interest, that is, those without functional limitations despite high adversity.

What is already known on this subject

- ▶ Those with lower childhood and adulthood socioeconomic position are at greater risk of developing functional limitations in old age.
- ▶ Less favourable psychosocial and behavioural risk factors in older adults with a lower socioeconomic position partly explain these associations.

What this study adds

- ▶ Rather than focusing on average differences in functional limitations between groups with and without socioeconomic adversity, this study uses the concept of resilience to guide analyses on differences in functional limitations within the group exposed to socioeconomic adversity.
- ▶ The resilient group was characterised by a relatively low prevalence of childhood illness, and obesity throughout ages 43–60–64.
- ▶ Several other factors were associated with resilience in partially adjusted models: high adolescent self-management and low neuroticism, volunteer work, not smoking (particularly at age 43), and being physically active (particularly at age 60–64).
- ▶ Marital status and contact frequency were not associated with resilience as defined in this study.

CONCLUSION

Remaining free from functional limitations in early old age despite socioeconomic adversity requires the presence of multiple resources that may have additive protective effects from birth onwards. Our study has pinpointed specific psychological and health-behavioural factors that may offset some of the health risks associated with socioeconomic adversity, and may be amenable to prevention and intervention efforts in different life stages.

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REFERENCES

- 1 Minkler M, Fuller-Thomson E, Guralnik JM. Gradient of disability across the socioeconomic spectrum in the United States. *N Engl J Med* 2006;355:695–703.
- 2 Kok AAL, Aartsen MJ, Deeg DJH, et al. Socioeconomic inequalities in a 16-year longitudinal measurement of successful ageing. *J Epidemiol Community Health* 2016;70:1106–13.
- 3 Melchior M, Lert F, Martin M, et al. Socioeconomic position in childhood and in adulthood and functional limitations in midlife: data from a nationally-representative survey of French men and women. *Soc Sci Med* 2006;63:2813–24.
- 4 Luo Y, Waite LJ. The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. *J Gerontol B Psychol Sci Soc Sci* 2005;60:S93–S101.
- 5 Haas S. Trajectories of functional health: the 'long arm' of childhood health and socioeconomic factors. *Soc Sci Med* 2008;66:849–61.
- 6 Nilsson CJ, Avlund K, Lund R. Social inequality in onset of mobility limitations in midlife: a longitudinal study in Denmark. *Eur J Ageing* 2011;8:255–69.
- 7 Murray ET, Hardy R, Strand BH, et al. Gender and life course occupational social class differences in trajectories of functional limitations in midlife: findings from the 1946 British birth cohort. *J Gerontol A Biol Sci Med Sci* 2011;66:1350–9.
- 8 Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med* 1994;38:1–14.
- 9 Chan L, Beaver S, Maclellan RF, et al. Disability and health care costs in the Medicare population. *Arch Phys Med Rehabil* 2002;83:1196–201.
- 10 Guralnik JM, Fried LP, Salive ME. Disability as a public health outcome in the aging population. *Annu Rev Public Health* 1996;17:25–46.
- 11 Groffan DAL, Bosma H, Tan FES, et al. Material vs. psychosocial explanations of old-age educational differences in physical and mental functioning. *Eur J Public Health* 2012;22:587–92.
- 12 van Lenthe FJ, Schrijvers CTM, Droomers M, et al. Investigating explanations of socio-economic inequalities in health: the Dutch globe study. *Eur J Public Health* 2004;14:63–70.
- 13 Van De Mheen H, Stronks K, Van Den Bos J, et al. The contribution of childhood environment to the explanation of socio-economic inequalities in health in adult life: a retrospective study. *Soc Sci Med* 1997;44:13–24.
- 14 Sawyer SM, Afifi RA, Bearinger LH, et al. Adolescence: a foundation for future health. *Lancet* 2012;379:1630–40.
- 15 Moffitt TE, Arseneault L, Belsky D, et al. A gradient of childhood self-control predicts health, wealth, and public safety. *Proc Natl Acad Sci U S A* 2011;108:2693–8.
- 16 Suchy Y, Williams PG, Kraybill ML, et al. Instrumental activities of daily living among community-dwelling older adults: personality associations with self-report, performance, and awareness of functional difficulties. *J Gerontol B Psychol Sci Soc Sci* 2010;65:542–50.
- 17 Wahl H-W, Schmitt M, Danner D, et al. Is the emergence of functional ability decline in early old age related to change in speed of cognitive processing and also to change in personality? *J Aging Health* 2010;22:691–712.
- 18 Kanamori S, Kai Y, Aida J, et al. Social participation and the prevention of functional disability in older Japanese: the JAGES cohort study. *PLoS One* 2014;9:e99638–10.
- 19 Stuck AE, Walther JM, Nikolaus T, et al. Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Soc Sci Med* 1999;48:445–69.
- 20 Deeg DJH. Longitudinal characterization of course types of functional limitations. *Disabil Rehabil* 2005;27:253–61.
- 21 Paterson DH, Warburton DE. Physical activity and functional limitations in older adults: a systematic review related to Canada's physical activity guidelines. *Int J Behav Nutr Phys Act* 2010;7.
- 22 Ferrer RL, Palmer R. Variations in health status within and between socioeconomic strata. *J Epidemiol Community Health* 2004;58:381–7.
- 23 Masten AS. Ordinary magic. resilience processes in development. *Am Psychol* 2001;56:227–38.
- 24 Almqvist YB, Landstedt E, Jackisch J, et al. Prevailing over adversity: factors counteracting the long-term negative health influences of social and material disadvantages in youth. *Int J Environ Res Public Health* 1842;2018.
- 25 Chen E, Miller GE. "Shift-and-Persist" Strategies: Why Low Socioeconomic Status Isn't Always Bad for Health. *Perspect Psychol Sci* 2012;7:135–58.
- 26 Lerner RM. Resilience as an attribute of the developmental system: comments on the papers of Professors Masten & Wachs. *Ann NY Acad Sci* 2006;1094:40–51.
- 27 Kuh D, Wong A, Shah I, et al. The MRC national survey of health and development reaches age 70: maintaining participation at older ages in a birth cohort study. *Eur J Epidemiol* 2016;31:1135–47.
- 28 Stafford M, Black S, Shah I, et al. Using a birth cohort to study ageing: representativeness and response rates in the National survey of health and development. *Eur J Ageing* 2013;10:145–57.
- 29 Wadsworth MEJ, Butterworth SL, Hardy RJ, et al. The life course prospective design: an example of benefits and problems associated with study longevity. *Soc Sci Med* 2003;57:2193–205.
- 30 Wloch EG, Kuh D, Cooper R. Is the hierarchy of loss in functional ability evident in midlife? Findings from a British birth cohort. *PLoS One* 2016;11:1–13.

- 31 Douglas JWB. *The home and the school: A study of ability and attainment in the primary school*. London: MacGibbon and Kee, 1964.
- 32 Xu MK, Jones PB, Barnett JH, *et al*. Adolescent self-organization predicts midlife memory in a prospective birth cohort study. *Psychol Aging* 2013;28:958–68.
- 33 Eysenck HJ. A short questionnaire for the measurement of two dimensions of personality. *J Appl Psychol* 1958;42:14–17.
- 34 Sterne JAC, White IR, Carlin JB, *et al*. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ* 2009;338.
- 35 Rubin DB. *Multiple Imputation for Nonresponse in Surveys*. Hoboken, New Jersey: John Wiley & Sons, Inc, 1987.
- 36 Hopton J, Hunt S. The health effects of improvements to housing: a longitudinal study. *Hous Stud* 1996;11:271–86.
- 37 Reading R. Social disadvantage and infection in childhood. *Social Health Illn* 1997;19:395–414.
- 38 Kinge JM, Strand BH, Vollset SE, *et al*. Educational inequalities in obesity and gross domestic product: evidence from 70 countries. *J Epidemiol Community Health* 2015;69:1141–6.
- 39 Gunthert KC, Cohen LH, Armeli S. The role of neuroticism in daily stress and coping. *J Pers Soc Psychol* 1999;77:1087–100.
- 40 Aneshensel CS. Social stress: theory and research. *Annu Rev Sociol* 1992;18:15–38.