Journal of Public Health | pp. 1–9 | doi:10.1093/pubmed/fdz018

# Is it possible to overcome the 'long arm' of childhood socioeconomic disadvantage through upward socioeconomic mobility?

**Anusha M. Vable[1,2], Paola Gilsanz[3], Ichiro Kawachi[4]**

[1]Department of Family and Community Medicine, University of California, San Francisco, 550 16th Street, San Francisco CA 94158, USA
[2]Department of Epidemiology and Biostatistics, University of California, San Francisco, 550 16th Street, San Francisco CA 94158, USA
[3]Kaiser Permanente Division of Research, 2000 Broadway, Oakland CA 94612, USA
[4]Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston MA 02115, USA
Address correspondence to Anusha M. Vable, E-mail: anusha.vable@ucsf.edu

## ABSTRACT

**Objectives** Socioeconomically disadvantaged children have worse adult health; we test if this 'long arm' of childhood disadvantage can be overcome through upward socioeconomic mobility in adulthood.

**Methods** Four SES trajectories (stable low, upwardly mobile, downwardly mobile and stable high) were created from median dichotomized childhood socioeconomic status (SES; childhood human and financial capital) and adult SES (wealth at age 67) from Health and Retirement Study respondents ($N = 6669$). Healthy ageing markers, in tertiles, were walking speed, peak expiratory flow (PEF), and grip strength measured in 2008 and 2010. Multinomial logistic regression models, weighted to be nationally representative, controlled for age, gender, race, birthplace, outcome year and childhood health and social capital.

**Results** Upwardly mobile individuals were as likely as the stable high SES group to be in the best health tertile for walking speed (OR = 0.81; 95% CI: 0.63, 1.05; $P = 0.114$), PEF (OR = 0.97; 95% CI: 0.78, 1.21; $P = 0.810$) and grip strength (OR = 0.97; 95%CI: 0.74, 1.27; $P = 0.980$).

**Discussion** Findings suggest the 'long arm' of childhood socioeconomic disadvantage can be overcome for these markers of healthy ageing through upward socioeconomic mobility.

**Keywords** health disparities, health inequalities, lifecourse, SES, social mobility

## Introduction

Health among older adults is patterned by socioeconomic status (SES) throughout the lifecourse. This relationship begins early in the lifecourse such that low childhood SES (cSES) predicts poorer health in diverse health markers in older adulthood, such as functional health,[1] cognitive health[2] and mortality .[3] There is additional evidence that the relationship with low cSES and worse health persists even after adjusting for adult SES (aSES).[1,4–9] The relationship between childhood disadvantage and adult health is well-documented and is known as the 'long arm' of childhood socioeconomic disadvantage.[1,3,7,10] However, it is unclear if it is possible to fully overcome this 'long arm' of childhood disadvantage through upward social mobility later in life, or if childhood socioeconomic adversity sets people on a trajectory to have measurably worse health in adulthood, even if they are upwardly mobile.

There are a few hypothesized pathways through which upward socioeconomic mobility may impact health in later life. The 'health constraint' hypothesis posits that socially mobile individuals have health characteristics from both the group they leave and the group they join,[11] suggesting that socially mobile groups experience health in-between individuals who experienced consistently high or consistently low

**Anusha M. Vable,** Assistant Adjunct Professor
**Paola Gilsanz,** Staff Scientist
**Ichiro Kawachi,** Professor of Social Epidemiology; Chair, Department of Social and Behavioral Sciences

SES. This hypothesis, which has similarities to some accumulation[12] and cumulative risk[13] hypotheses, postulates that childhood disadvantage gets 'under the skin', increasing later illness even if the disadvantage is removed in adulthood. For example, in an analysis using the same dataset we use, the US Health and Retirement Study, Luo & Waite (2005) found upward socioeconomic mobility can partially, but not fully, ameliorate the negative effects of childhood socioeconomic disadvantage on self-reported markers of physical, cognitive and mental health.[14] If the health constraint hypothesis similarly applies to objective markers of healthy ageing, we would expect that upwardly mobile individuals have better health than individuals with low SES throughout the lifecourse, and worse health than individuals who have high SES throughout the lifecourse. The 'health constraint' hypothesis suggests it is not possible to fully overcome the 'long arm' of childhood disadvantage through upward socioeconomic mobility.

Other work examining mammography finds the upwardly mobile have equivalent health to those with consistently high SES, suggesting it is possible to overcome the 'long arm' of childhood disadvantage through upward social mobility. However, it is unclear if these findings are isolated to health behaviors, or if equivalent health for the upwardly mobile generalizes to other health outcomes. Ability to overcome the 'long arm' of childhood disadvantage through upward social mobility seems to vary by both population and health outcome, suggesting more work is needed to understand these heterogeneities.

We investigate if it is possible to attain health equity through upward social mobility in objectively measured markers of functional health (measured walking speed, grip strength and lung function) in a nationally representative sample of older Americans. We focus on markers of functional health that are objectively measured because self-reported measures may miss health declines that are not yet noticed and therefore cannot be reported. Additionally, these measures are unlikely to be effected by medications, unlike other objectively measured outcomes such as blood pressure or hemoglobin A1c. Walking speed, grip strength, and lung function predict fractures, cognitive decline,[15] worse functional health[16,17] and mortality,[18–21] indicating their importance as markers of healthy ageing among older adults.

## Methods

### Sample

Data for this analysis come from the Health and Retirement Study (HRS), a nationally representative, longitudinal sample of Americans 50 years of age and older and their spouses that began in 1992; every 6 years a new cohort of individuals who have aged into HRS eligibility is added to the sample. These analyses were restricted to individuals who were 65 years of age or older, alive and community-dwelling through 2010 ($N = 7179$). We excluded 468 individuals with missing outcome data and 42 with missing covariate data, yielding an analytic sample of 6669 (93.0%).

### Exposure

Lifecourse socioeconomic mobility was determined based on SES in childhood (cSES) and adulthood (aSES); cSES was operationalized using previously validated measures[22] incorporating retrospective reports of childhood human capital (educational attainment of the respondent's parents) and childhood financial capital (measures of financial resources and financial instability of the respondents parents) before age 16. The two measures were $z$-scored and averaged. For respondents missing data on one measure ($N = 3$), cSES was operationalized as the other measure. Childhood SES was median dichotomized to create high and low cSES categories. These validated cSES measures offer several advantages over alternative operationalizations, including comprehensive measurement of the construct (thereby reducing residual confounding), and inclusion of the most socially vulnerable (who are often excluded from analysis due to missing data).[22]

Adult SES was operationalized as wealth per capita (wealth divided by the square root of the number of household members) at age 67. Wealth has two main advantages over operationalizations of SES using education and income among older adults. First, wealth may continue to change following retirement while income can be zero following retirement and educational attainment does not change after age 30 for most individuals. Second, wealth is a more comprehensive measure of SES, reflecting both accumulated savings and debt through the lifecourse as well as intergenerational transfers.[23] We used wealth at age 67 because that is the average age when the wealth per capita of participants in the HRS stops increasing and starts decreasing (Appendix Figure A1). We calculated wealth per capita at age 67 using a random intercepts and random slopes model (using linear and quadratic terms for age, centered at age 67). Wealth per capita at age 67 was median dichotomized to create high and low aSES categories.

From the cSES and aSES measures, indicators were created for stable low lifecourse SES (low SES at both timepoints) downward mobility (high cSES, low aSES), upward mobility (low cSES, high aSES) and stable high SES (high SES at both timepoints).

### Outcomes

We use three measures of healthy ageing in this analysis: walking speed, lung function and grip strength. HRS measures physical functioning data on half of the sample at each wave. For approximately half the sample (51%) outcome data were collected in 2008, and the other half (49%) were collected in 2010; we used outcome data from 2008 and 2010 to have outcome data on the whole sample (i.e. 2008 and 2010 outcome data were collected on different individuals). We separated these outcome measures into tertiles with the low tertile representing below average functioning, the middle tertile reflecting average functioning and the highest tertile reflecting above average functioning. We adopted this approach to improve interpretability and to avoid transformation of skewed outcome data.

Walking speed was measured as the length of time to walk 98.5 inches (~12 feet), and was assessed twice for each individual.[24] Values less than one second were considered implausibly low and set to missing. Mean walking speed was calculated and reverse coded so higher values reflect better functioning (for consistency with lung function and grip strength) then separated into tertiles.

Lung function was measured as peak expiratory flow (PEF), a measure of obstructive lung disease that is assessed more accurately among older adults with cognitive impairment than forced expiratory volume.[25–28] PEF was measured three times, 30 s apart, with a Mini-Wright Peak Flow Meter, with higher measures reflecting better lung function. Validity of PEF depends on participant's effort[24]; the two highest PEF measures were averaged, as this operationalization was most predictive of death by 2014, and then separated into tertiles.

Dominant and non-dominant hand grip strength was assessed two times on each hand with a Smedly spring-type hand dyanometer.[24] Grip strength was operationalized as the average of the two measures and separated into tertiles for analysis.

### Covariates

Socioeconomic mobility spans childhood and adulthood, therefore only childhood measures were considered possible confounders (with the exception of age at the time of outcome measurement). We did not include variables following childhood as they are mediators of the effect of interest; adjusting for mediators can bias estimates.[29] The following demographic or childhood variables were included: age at outcome measurement (centered at 67, the age at which wealth was calculated; linear, quadratic and cubic terms included), gender, self-reported race/ethnicity (White, Black, Latino and Other Race), birthplace (indicators for birth in the South or abroad), outcome year and childhood self-rated health (response options: excellent, very good, good, fair and poor) and childhood social capital. Childhood social capital (validated previously[22]) was the following continuous measures, $z$-scored: maternal investment (indicating the strength of the respondent's relationship with their mother during childhood) and family structure (i.e. did not grow up with mother, lived with grandparents, etc.; higher numbers predicted better health).

### Analysis

We ran multinomial logistic regression models for each outcome with the worst health tertile as the outcome reference group. We considered stable high SES as the exposure reference group in our primary analysis, and conducted supplemental analyses with stable low SES as the reference group. All models were adjusted for the covariates previously specified. We performed three robustness checks: (1) we examined mobility patterns when cSES and aSES were divided into tertiles rather than dichotomized to see if our results were robust to different mobility specifications; (2) we examined the outcome measures continuously rather than in tertiles to see if socioeconomic mobility had different effects on mean outcomes and (3) we examined interactions of mobility groups by gender to check if it was appropriate to combine men and women.[30] Effect estimates, 95% confidence intervals (CI), and $P$-values for two-tailed $t$-statistics are presented for all models. Results were weighted to reflect the complex, clustered sampling design of HRS and represent the community-dwelling US population 65 years of age and older in 2010. Analyses were performed using proc surveyreg in SAS, version 9.3 (SAS Institute Inc, Cary, NC, USA).

## Results

### Sample demographics

There were $N = 2002$ (30.0%) individuals in the stable low lifecourse SES group, $N = 1332$ (20.0%) in the downward mobility group, $N = 1332$ (20.0%) in the upward mobility group and $N = 2003$ (30.0%) in the stable high SES group (Table 1). Outcomes were assessed at age 75 on average across groups. The stable low and downwardly mobile groups had a higher proportion of females and minorities than the upwardly mobile or stable high SES groups. A higher proportion of those in the stable low SES group were born in the South, and they reported worse health in childhood than the other groups.

**Table 1** Distribution of confounding variables across social mobility categories

| | *Stable low SES* | | *Downwardly mobile* | | *Upwardly mobile* | | *Stable high SES* | |
|---|---|---|---|---|---|---|---|---|
| | N = N *(weighted mean)* | *2002 weighted % (weighted SD)* | N = N *(weighted mean)* | *1332 weighted % (weighted SD)* | N = N *(weighted mean)* | *1332 weighted % (weighted SD)* | N = N *(weighted mean)* | *2003 weighted % (weighted SD)* |
| Age at outcome measurement | (75.9) | (0.3) | (73.6) | (0.3) | (75.6) | (0.3) | (73.5) | (0.2) |
| Female | 1159 | 57.6 | 840 | 61.2 | 707 | 54.1 | 1096 | 54.7 |
| Non-Hispanic White | 1201 | 72.6 | 1038 | 87.1 | 1184 | 92.8 | 1888 | 96.4 |
| Non-Hispanic Black | 421 | 13.3 | 206 | 8.1 | 68 | 2.7 | 62 | 1.3 |
| Hispanic | 330 | 11.5 | 62 | 2.9 | 56 | 2.6 | 24 | 0.8 |
| Other Race | 47 | 2.6 | 26 | 1.9 | 24 | 1.9 | 29 | 1.5 |
| Maternal investment | (−0.1) | (0.0) | (0.1) | (0.0) | (−0.1) | (0.0) | (0.1) | (0.0) |
| Family structure | (−0.1) | (0.0) | (0.0) | (0.0) | (0.0) | (0.0) | (0.1) | (0.0) |
| Southern born | 885 | 39.4 | 424 | 26.3 | 414 | 28.6 | 432 | 19.7 |
| Foreign born | 267 | 10.5 | 97 | 5.3 | 119 | 9.8 | 149 | 7.2 |
| Outcome year | 1007 | 52.6 | 676 | 54.0 | 702 | 53.8 | 1088 | 56.9 |
| *Childhood health* | | | | | | | | |
| Excellent | 881 | 45.3 | 661 | 51.3 | 690 | 51.3 | 1231 | 63.1 |
| Very good | 500 | 25.8 | 381 | 27.4 | 332 | 24.8 | 461 | 22.2 |
| Good | 450 | 20.4 | 218 | 16.2 | 220 | 16.8 | 247 | 11.9 |
| Fair | 128 | 6.2 | 55 | 3.9 | 73 | 5.5 | 49 | 2.1 |
| Poor | 43 | 2.3 | 17 | 1.1 | 17 | 1.6 | 15 | 0.7 |
| *Exposures* | | | | | | | | |
| cSES | (−0.8) | (0.0) | (0.7) | (0.0) | (−0.7) | (0.0) | (0.9) | (0.0) |
| aSES | ($94 967) | ($7253) | ($99 034) | ($4579) | ($669,419) | ($22 558) | ($885 132) | ($36 496) |

Since cSES and aSES were both median dichotomized, there are similar numbers of number of upwardly and downwardly mobile individuals, and those with stable high and stable low SES.

## Mobility trajectories

The upwardly mobile were as likely as the stable high SES group to be in the above average or average health tertile for all outcomes (that is, 95% CI for odds ratio estimates included the null value of one), although CI just barely included the null for walking speed (Table 2). For walking speed, the upwardly mobile were as likely as the stable high SES group to be in the above average (OR = 0.81; 95%CI: 0.63, 1.05), and average (OR = 0.90; 95%CI: 0.74, 1.09) health tertiles. For lung function, the upwardly mobile were as likely as the stable high SES group to be in the above average (OR = 0.97; 95%CI: 0.78, 1.21) and average (OR = 0.91; 95%CI: 0.75, 1.11) health tertiles. For dominant hand grip strength, the upwardly mobile were as likely as the stable high SES group to be in the above average (OR = 0.97; 95% CI: 0.74, 1.27) and average (OR = 0.94; 95%CI: 0.76, 1.16) health tertiles For non-dominant hand grip strength, the upwardly mobile were as likely as the stable high SES group to be in the above average (OR = 0.90; 95%CI: 0.68, 1.18) and average (OR = 0.96; 95%CI: 0.74, 1.24) health tertiles.

Those who experienced stable low SES or were downwardly mobile were less likely to be in the above average health tertile for all outcomes (Table 2). In analyses with stable low SES as the reference group (Appendix Table A1), downwardly mobile individuals were as likely as the stable low SES group to be in the above average or average health tertile for most outcomes (exception: downwardly mobile more likely to be in the average health tertile for lung function than the stable low SES group), while those who were upwardly mobile or experienced stable high SES were more

**Table 2** The relationship between lifecourse social mobility and markers of healthy ageing (reference group = stable high SES)

| | *ORs for being in the above average health tertile compared to the below average health tertile* | | | *ORs for being in the average health tertile compared to the below average health tertile* | | |
|---|---|---|---|---|---|---|
| | *OR* | *95% CI* | P | *OR* | *95% CI* | P |
| *Walking speed* | | | | | | |
| Stable low SES | 0.35 | 0.27, 0.46 | <0.0001 | 0.56 | 0.46, 0.69 | <0.0001 |
| Downwardly mobile | 0.42 | 0.33, 0.53 | <0.0001 | 0.66 | 0.51, 0.86 | 0.003 |
| Upwardly mobile | 0.81 | 0.63, 1.05 | 0.114 | 0.90 | 0.74, 1.09 | 0.268 |
| Stable high SES | Ref | | | Ref | | |
| *Lung function* | | | | | | |
| Stable low SES | 0.42 | 0.32, 0.55 | <0.0001 | 0.51 | 0.41, 0.62 | <0.0001 |
| Downwardly mobile | 0.40 | 0.32, 0.51 | <0.0001 | 0.63 | 0.51, 0.78 | <0.0001 |
| Upwardly mobile | 0.97 | 0.78, 1.21 | 0.810 | 0.91 | 0.75, 1.11 | 0.358 |
| Stable high SES | Ref | | | Ref | | |
| *Dominant hand grip strength* | | | | | | |
| Stable low SES | 0.67 | 0.47, 0.94 | 0.020 | 0.78 | 0.66, 0.92 | 0.005 |
| Downwardly mobile | 0.58 | 0.41, 0.82 | 0.003 | 0.73 | 0.59, 0.91 | 0.005 |
| Upwardly mobile | 0.97 | 0.74, 1.27 | 0.802 | 0.94 | 0.76, 1.16 | 0.564 |
| Stable high SES | Ref | | | Ref | | |
| *Non-dominant hand grip strength* | | | | | | |
| Stable low SES | 0.64 | 0.45, 0.91 | 0.015 | 0.84 | 0.67, 1.04 | 0.102 |
| Downwardly mobile | 0.56 | 0.44, 0.73 | <0.0001 | 0.82 | 0.66, 1.03 | 0.083 |
| Upwardly mobile | 0.90 | 0.68, 1.18 | 0.436 | 0.96 | 0.74, 1.24 | 0.745 |
| Stable high SES | Ref | | | Ref | | |

The upwardly mobile were as likely as those with consistently high SES to be in the best and middle health tertiles for walking speed, lung function, dominant hand grip strength and non-dominant hand grip strength at the conventional $\alpha$ level of 0.05. However, for walking speed, the confidence intervals for the upwardly mobile just barely include the null value of 1 for both the best and middle health tertiles, suggesting there may be a true difference in walking speed between the upwardly mobile and those with consistently high SES that we did not detect in these data. For this reason, these analyses should be repeated in other data sets.

likely to be in the above average or average health tertiles for walking speed, and lung function.

### Robustness checks

Findings were substantively similar in three sensitivity analyses: first, examining the exposure, socioeconomic mobility, in tertiles, we found socially mobile groups generally had similar health to the socioeconomic group they joined (Appendix Table A2); one notable exception was upwardly mobile individuals were less likely than those with consistently high SES to be the in above average or average health tertile for walking speed, with CI either just below or barely including the null value of one. Second, we examined the outcomes continuously rather than in tertiles, and again found socially mobile groups had similar health to the socioeconomic group they joined (Appendix Table A3). Third, we found it was appropriate to combine men and women for all outcomes except lung function, where results for downwardly mobile men and women were different ($F_{(2,51)} = 6.95$; $P = 0.002$), such that downward mobility was more deleterious for men than women (Appendix Table A4); our main conclusions that socially mobile groups had similar health to the socioeconomic group they joined were unchanged.

## Discussion

### Main findings of this study

In this nationally representative sample of US older adults, we found that upwardly mobile individuals were able to

overcome the 'long arm' of childhood socioeconomic disadvantage and achieve health equity with individuals who had life-long socioeconomic advantage for the makers of healthy ageing examined (walking speed, lung function and grip strength). Results were largely robust to different specifications of the exposure, the outcome and the analytic models, although there is some evidence to support the health constraint hypothesis for the upwardly mobile with respect to walking speed. Overall, our findings suggest the 'long arm' of childhood socioeconomic disadvantage can be partially or fully overcome for these markers of healthy ageing through upward socioeconomic mobility.

Upward socioeconomic mobility in the USA, however, is increasingly rare,[31] with substantial variability within the USA. Some regions have similar upward mobility to the highest mobility countries, while other regions have the lowest mobility in the developed world.[32] Factors correlated with upward social mobility are less residential segregation, less income inequality, better primary schools, more social capital and greater family stability.[32] Programs or polices[33] to facilitate improvements in these areas and facilitate upward socioeconomic mobility, may improve health equity. For example, research on the Korean War GI Bill, which subsidized college education for qualifying US military veterans, found that low cSES groups particularly benefited from such policies such that GI Bill eligibility predicted smaller socioeconomic inequalities in markers of mental,[34] physical[35] and cognitive[36] health. More research lever ageing quasi-experimental approaches is needed to determine if policies to improve upward social mobility will results in improvements in health equity.

## What is already known on this topic

Substantial work provides empirical evidence of a 'long arm' of childhood socioeconomic disadvantage in examining adult health outcomes,[2,3,37–39] including markers of functional health[1,4,5,40,41] similar to the markers examined in our study. Consistent with health constraint/accumulation hypotheses, prior work examining birth outcomes,[42] cognition[2], leisure time physical activity,[43] and markers of mental and physical health[14] found that upward socioeconomic mobility may partially, but not fully, offset the 'long arm' of childhood socioeconomic disadvantage. Work examining mammography finds socially mobile individuals have similar health behaviors to the socioeconomic group they join,[44] suggesting it is possible to overcome the 'long arm' of childhood socioeconomic disadvantage for some outcomes. However, health behaviors such as getting recommended screenings may be more mutable than objective measures of physical health. The prior literature suggests ability to overcome the 'long arm' of childhood disadvantage varies by operationalization of lifecourse SES, outcome examined and population under study. Our study substantially advances this literature by using comprehensive measures of childhood and adult SES and evaluating objective measures of healthy ageing in a nationally representative sample of older US adults.

## What this study adds

We found it is possible to overcome the 'long arm' of childhood socioeconomic disadvantage through upward socioeconomic mobility for objective measures of walking speed, lung function and grip strength. We know of no prior work that has examined the effect of social mobility on these objective measures of healthy ageing. Our work suggests that health disparities that arise early in life are mutable and interventions that improve socioeconomic conditions may improve health outcomes for individuals who experienced childhood socioeconomic disadvantage.

It is important to note that individuals who experienced downward social mobility experienced similar health to those who had consistently low SES. In supplemental analyses, examining nine SES mobility groups rather than four, results yielded similar conclusions such that socioeconomically mobile groups had similar health to the mobility group they joined. Our results suggest for these outcomes an individual's health status closely reflects their achieved SES. The findings for downward social mobility may also reflect some degree of reverse causality, i.e. poor health preceded their downward socioeconomic trajectory. The implications of our findings for health inequalities at the population level depends upon the balance of people who are upwardly versus downwardly mobile over the lifecourse. An evaluation of population-level health inequalities requires estimation of population-weighted indices of health inequality—such as the Slope Index of Inequality (SII)—which is beyond the scope of the present analysis. Future analyses evaluating the SII or using external benchmarks for cSES and aSES are important avenues for further study to better understand how to reduce population-level disparities. Our findings are consistent with prior work suggesting that social policies that provide economic transfers to the poor are associated with better health.[45–48]

## Limitations

Although HRS is uniquely suited to investigate lifecourse social mobility, important limitations should be acknowledged. We modeled wealth at age 67, but outcome data come from individuals 65 and older, introducing some minor temporal ambiguity. Bias due to selective survival is a possibility in this observational study, particularly for the low cSES group; selective survival would result in an overestimation of the health

benefits of upward mobility making the upwardly mobile more likely to attain health equity with those who experienced life-long high SES. Health selection is a possibility, whereby individuals who are healthy are more likely to be upwardly mobile and unhealthy individuals may be downwardly mobile.[49] This may be particularly true for the downwardly mobile, such that individuals who experienced poor health in early or middle life are unable to work fulltime, resulting in lower adult SES[50]; we adjusted for self-reported childhood health to reduce the likelihood that health selection is the explanation for our results. There is the possibility of unmeasured or unmeasureable confounding in this observational analysis, for example due to personality traits such as grit and resilience. We operationalized childhood SES as childhood human and financial capital, and adulthood SES as wealth at age 67; while these measures of lifecourse SES have several advantages (detailed in the methods), they reflect slightly different, though related, constructs.[51,52] Finally, because our research question of whether it is possible to overcome the 'long arm' of childhood disadvantage, rather than the more academic question of which lifecourse model best fits the data, we did not test all possible lifecourse models to see which best fit our data; using the wrong lifecourse model may bias estimates.[30,53] Despite these limitations, this is the first study, to our knowledge, to examine whether it is possible to overcome the 'long arm' of childhood disadvantage through upward socioeconomic mobility using these objective markers of healthy ageing, and therefore represents an important contribution to the field.

Using data from a nationally representative sample of American older adults, we found that upwardly mobile individuals were able to overcome the 'long arm' of childhood socioeconomic disadvantage and achieve health equity with individuals who had life-long socioeconomic advantage for the makers of walking speed, lung function and grip strength. Although upward socioeconomic mobility is increasingly rare in the USA, programs and policies to facilitate upward mobility may help those from low cSES backgrounds overcome the 'long arm' of childhood socioeconomic disadvantage.

## Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

## References


1 Haas S. Trajectories of functional health: the 'long arm' of childhood health and socioeconomic factors. *Soc Sci Med* 2008;**66**(**4**):849–61. doi:10.1016/j.socscimed.2007.11.004.

2 Marden JR, Tchetgen Tchetgen EJ, Kawachi I *et al.* Contribution of socioeconomic status at 3 life-course periods to late-life memory function and decline: early and late predictors of dementia risk. *Am J Epidemiol* 2017;**186**(**7**):1–10. doi:10.1093/aje/kwx155.

3 Hayward MD, Gorman BK. The long arm of childhood: the influence of early-life social conditions on men's mortality. *Demography* 2004;**41**(**1**):87–107. doi:10.1353/dem.2004.0005.

4 Haas S, Rohlfsen L. Life course determinants of racial and ethnic disparities in functional health trajectories. *Soc Sci Med* 2010;**70**(**2**):240–50. doi:10.1016/j.socscimed.2009.10.003.

5 Haas SA, Krueger PM, Rohlfsen L. Race/ethnic and nativity disparities in later life physical performance: the role of health and socioeconomic status over the life course. *J Gerontol B Psychol Sci Soc Sci* 2012;**67**:238–48. doi:10.1093/geronb/gbr155.

6 Bowen ME. Childhood socioeconomic status and racial differences in disability: evidence from the Health and Retirement Study (1998–2006). *Soc Sci Med* 2009;**69**(**3**):433–41. doi:10.1016/j.socscimed.2009.06.006.

7 Tampubolon G. Growing up in poverty, growing old in infirmity: the long arm of childhood conditions in Great Britain. *PLoS One* 2015;**10**(**12**):1–16. doi:10.1371/journal.pone.0144722.

8 Ramsay SE, Whincup PH, Lennon LT *et al.* Longitudinal associations of socioeconomic position in childhood and adulthood with decline in lung function over 20 years: results from a population-based cohort of British men. *Thorax* 2011;**66**(**12**):1058–64. doi:10.1136/thoraxjnl-2011-200621.

9 Agahi N, Shaw BA, Fors S. Social and economic conditions in childhood and the progression of functional health problems from midlife into old age. *J Epidemiol Community Health* 2014;**68**(**8**):734–40. doi:10.1136/jech-2013-203698.

10 Masters RK, Hayward MD. Is the 'Long Arm of Childhood' Growing Shorter? Race, Socioeconomic Status, and Changes in US Adult Mortality. 2001:915-8.

11 Pollitt RA, Rose KM, Kaufman JS. Evaluating the evidence for models of life course socioeconomic factors and cardiovascular outcomes: a systematic review. *BMC Public Health* 2005;**5**:7. doi:10.1186/1471-2458-5-7.

12 Kuh D, Lynch J, Hallqvist J *et al.* Life course epidemiology. *J Epidemiol Community Health* 2003:778–83. doi:10.1136/jech.57.10.778.

13 Liu SY, Jones RN, Glymour MM. Implications of lifecourse epidemiology for research on determinants of adult disease. *Public Health Rev* 2010;**32**(**4**):489–511. doi:10.1007/BF03391613.

14 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**(**2**):S93–S101. doi:10.1093/geronb/60.2.S93.

15 Cooper R, Kuh D, Cooper C *et al.* Objective measures of physical capability and subsequent health: a systematic review. *Age Ageing* 2011;**40**(**1**):14–23. doi:10.1093/ageing/afq117.

16 Eisner MD, Iribarren C, Yelin EH *et al.* Pulmonary function and the risk of functional limitation in chronic obstructive pulmonary disease. *Am J Epidemiol* 2008;**167**(**9**):1090–1101. doi:10.1093/aje/kwn025.Pulmonary.

17 Coultas DB, Mapel D, Gagnon R *et al.* The health impact of undiagnosed airflow obstruction in a national sample of United States adults. *Am J Respir Crit Care Med* 2001;**164**(**3**):372–7. doi:10.1164/ajrccm.164.3.2004029.

18 Cooper R, Kuh D, Hardy R. Mortality Review Group. Objectively measured physical capability levels and mortality: systematic review

and meta-analysis. *BMJ* 2010;**341**(**sep09 1**):c4467–67. doi:10.1136/bmj.c4467.

19 Miller MR, Pedersen OF, Lange P *et al*. Improved survival prediction from lung function data in a large population sample. *Respir Med* 2009;**103**(**3**):442–8. doi:10.1016/j.rmed.2008.09.016.

20 Vaz Fragoso CA, Gahbauer EA, Van Ness PH *et al*. Peak expiratory flow as a predictor of subsequent disability and death in community-living older persons. *J Am Geriatr Soc* 2008;**56**(**6**):1014–20. doi:10.1111/j.1532-5415.2008.01687.x.

21 Young RP, Hopkins R, Eaton TE. Forced expiratory volume in one second: not just a lung function test but a marker of premature death from all causes. *Eur Respir J* 2007;**30**(**4**):616–22. doi:10.1183/09031936.00021707.

22 Vable AM, Gilsanz P, Nguyen TT *et al*. Validation of a theoretically motivated approach to measuring childhood socioeconomic circumstances in the Health and Retirement Study. *PLoS One* 2017;**12**(**10**):e0185898. doi:10.1371/journal.pone.0185898.

23 Gale WG, Scholz JK. Intergenerational transfers and the accumulation of wealth. *J Econ Perspect* 1994;**8**(**4**):145–60. doi:10.1257/jep.8.4.145.

24 Crimmins EM, Guyer H, Langa KM *et al*. Documentation of physical measures, anthropometrics and blood pressure in the health and retirement study. *Hrs* 2008. (February) https://hrs.isr.umich.edu/sites/default/files/biblio/dr-011.pdf (accessed October 20, 2015).

25 Carvalhaes-Neto N, Lorino H, Gallinari C *et al*. Cognitive function and assessment of lung function in the elderly. *Am J Respir Crit Care Med* 1995;**152**(**5 I**):1611–5. doi:10.1164/ajrccm.152.5.7582303.

26 Bellia V, Pistelli R, Catalano F *et al*. Quality control of spirometry in the elderly: the SA.R.A. study. *Am J Respir Crit Care Med* 2000;**161**(**4 I**):1094–1100. doi:10.1164/ajrccm.161.4.9810093.

27 Licia P, Gianluca G, Silvia C *et al*. Quality of spirometric performance in older people y. *Age Ageing* 2003;**32**(**February 1996**):43–6.

28 Allen S, Yeung P, Janczewski M *et al*. Predicting inadequate spirometry technique and the use of FEV1/FEV3 as an alternative to FEV1/FVC for patients with mild cognitive impairment. *Clin Respir J* 2008;**2**(**4**):208–13. doi:10.1111/j.1752-699X.2008.00063.x.

29 Victora C, Huttly S, Fuchs S *et al*. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. *Int J Epidemiol* 1997;**26**(**1**):224–7. doi:10.1093/ije/26.1.224.

30 Murray ET, Mishra GD, Kuh D *et al*. Life course models of socioeconomic position and cardiovascular risk factors: 1946 Birth Cohort. *Ann Epidemiol* 2011;**21**(**8**):589–97. doi:10.1016/j.annepidem.2011.04.005.

31 Chetty R, Grusky D, Hell M *et al*, Jimmy Narang. The Fading American Dream: Trends in Absolute Incoe Mobillity Since 1940. Natl Bur Econ Res Work Pap. 2016;(December). http://www.nber.org/papers/w22910.

32 Chetty R, Hendren N, Kline P *et al*. Where is the Land of Opportunity? The geopgraphy of intergenerational mobility in the United States. *Q J Econ* 2014;**129**(**4**):1553–1623. doi:10.1093/qje/qju022.Advance.

33 Corna LM. A life course perspective on socioeconomic inequalities in health: a critical review of conceptual frameworks. *Adv Life Course Res* 2013;**18**(**2**):150–9. doi:10.1016/j.alcr.2013.01.002.

34 Vable AM, Canning D, Glymour MM *et al*. Can social policy influence socioeconomic disparities? Korean War GI Bill eligibility and markers of depression. *Ann Epidemiol* 2016;**26**(**2**):129–35.e3. doi:10.1016/j.annepidem.2015.12.003.

35 Vable AM, Kiang MV, Basu S *et al*. Military service, childhood socio-economic status, and late-life lung function: Korean War Era Military Service Associated with Smaller Disparities. *Mil Med* 2018;**183**(**9-10**):e576–82. doi:10.1093/milmed/usx196.

36 Vable AM, Eng CW, Mayeda ER *et al*. Mother's education and late-life disparities in memory and dementia risk among US military veterans and non-veterans. *J Epidemiol Community Health* 2018;**72**:1162–7. doi:10.1136/jech-2018-210771.

37 Nandi A, Glymour MM, Kawachi I *et al*. Using marginal structural models to estimate the direct effect of adverse childhood social conditions on onset of heart disease, diabetes, and stroke. *Epidemiology* 2012;**23**(**2**):223–32. doi:10.1097/EDE.0b013e31824570bd.

38 Glymour MM, Avendano M, Haas S *et al*. Lifecourse social conditions and racial disparities in incidence of first stroke. *Ann Epidemiol* 2008;**18**(**12**):904–12. doi:10.1016/j.annepidem.2008.09.010.

39 Tiffin PA. Social mobility over the lifecourse and self reported mental health at age 50: prospective cohort study. *J Epidemiol Community Health* 2005;**59**(**10**):870–2. doi:10.1136/jech.2005.035246.

40 Laditka JN, Laditka SB. Adverse childhood circumstances and functional status throughout adult life. *J Aging Health* 2017. doi:10.1177/0898264317715976.

41 Henretta JC, McCrory C. Childhood circumstances and mid-life functional mobility. *J Aging Health* 2016;**28**(**3**):440–59. doi:10.1177/0898264315594135.

42 Osypuk TL, Slaughter-Acey JC, Kehm RD *et al*. Life-course social mobility and reduced risk of adverse birth outcomes. *Am J Prev Med* 2016;**51**(**6**):975–82. doi:10.1016/j.amepre.2016.09.008.

43 Elhakeem A, Hardy R, Bann D *et al*. Intergenerational social mobility and leisure-time physical activity in adulthood: A systematic review. *J Epidemiol Community Health* 2017;**71**(**7**):673–80. doi:10.1136/jech-2016-208052.

44 Missinne S, Daenekindt S, Bracke P. The social gradient in preventive healthcare use: what can we learn from socially mobile individuals? *Sociol Health Illn* 2015;**37**(**6**):823–38. doi:10.1111/1467-9566.12225.

45 Rehkopf DH, Strully KW, Dow WH. The short-term impacts of earned income tax credit disbursement on health. *Int J Epidemiol* 2014;**43**(**6**):1884–94. doi:10.1093/ije/dyu172.

46 Strully KW, Rehkopf DH, Xuan Z. Effects of prenatal poverty on infant health: state earned income tax credits and birth weight. *Am Sociol Rev* 2010;**75**(**4**):534–62. doi:10.1177/0003122410374086.

47 Pega F, Carter K, Kawachi I *et al*. The impact of an unconditional tax credit for families on self-rated health in adults: Further evidence from the cohort study of 6900 New Zealanders. *Soc Sci Med* 2014;**108**:115–9. doi:10.1016/j.socscimed.2014.03.002.

48 Hamad R, Rehkopf DH. Poverty, pregnancy, and birth outcomes: a study of the earned income tax credit. *Paediatr Perinat Epidemiol* 2015;**29**(**5**):444–52. doi:10.1111/ppe.12211.

49 Dahl E. Social mobility and health: cause or effect? *BMJ* 1996;**313**(**7055**):435–6. doi:10.1136/bmj.313.7055.435.

50 Chandola T, Bartley M, Sacker A *et al*. Health selection in the Whitehall II study, UK. *Soc Sci Med* 2003;**56**(**10**):2059–72. doi:10.1016/S0277-9536(02)00201-0.

51 Galobardes B, Shaw M, Lawlor DA *et al*. Indicators of socioeconomic position (part 1). *J Epidemiol Community Health* 2006;**60**(**1**):7–12. doi:10.1136/jech.2004.023531.

52 Galobardes B, Shaw M, Lawlor DA *et al*. Indicators of socioeconomic position (part 2). *J Epidemiol Community Health* 2006;**60**(**1**):7–12. doi:10.1136/jech.2004.023531.

53 Mishra GD, Nitsch D, Black S *et al*. A structured approach to modelling the effects of binary exposure variables over the life course. *Int J Epidemiol* 2009;**38**(**2**):528–37. doi:10.1093/ije/dyn229.