Original article

Scand J Work Environ Health. 2017;43(1):15–23. doi:10.5271/sjweh.3589

Physical and cognitive capability in mid-adulthood as determinants of retirement and extended working life in a British cohort study

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Stafford M, Cooper R, Cadar D, Carr E, Murray E, Richards M, Stansfeld S, Zaninotto P, Head J, Kuh D. Physical and cognitive capability in mid-adulthood as determinants of retirement and extended working life in a British cohort study. *Scand J Work Environ Health.* 2017;43(1):15–23. doi:10.5271/sjweh.3589

Objective Policy in many industrialized countries increasingly emphasizes extended working life. We examined associations between physical and cognitive capability in mid-adulthood and work in late adulthood.

Methods Using self-reported physical limitations and performance-based physical and cognitive capability at age 53, assessed by trained nurses from the Medical Research Council (MRC) National Survey of Health and Development, we examined prospective associations with extended working (captured by age at and reason for retirement from main occupation, bridge employment in paid work after retirement from the main occupation, and voluntary work participation) up to age 68 among >2000 men and women.

Results Number of reported physical limitations at age 53 was associated with higher likelihood of retiring for negative reasons and lower likelihood of participating in bridge employment, adjusted for occupational class, education, partner's employment, work disability at age 53, and gender. Better performance on physical and cognitive tests was associated with greater likelihood of participating in bridge or voluntary work. Cognitive capability in the top 10% compared with the middle 80% of the distribution was associated with an odds ratio of bridge employment of 1.71 [95% confidence interval (95% CI) 1.21–2.42].

Conclusions The possibility for an extending working life is less likely to be realized by those with poorer midlife physical or cognitive capability, independently of education, and social class. Interventions to promote capability, starting in mid-adulthood or earlier, could have long-term consequences for extending working.

Key terms ageing; bridge employment; Britain; cognitive performance; early retirement; older worker; physical performance; self-reported health; United Kingdom.

In many industrialized countries with an ageing population, public policy seeks to extend working lives. This can be achieved through increasing the state pension age (SPA) as many European countries have done. In the UK, just over ten per cent of people work beyond SPA though around one quarter of those aged between 50 years and the SPA do not participate in the labor market. A broad understanding of factors related to older people's work considers extended work to include bridge employment (that is, participation in paid work after retirement from the main occupation) and voluntary work as well as postponement of retirement. In middle and early older age, people leave the work force for many reasons, notably health-related reasons (1). Earlier retirement and lower rates of bridge employment are associated with poor self-rated health (2–6) and chronic disease/symptoms (1, 7–10) but exploration of associations with physical and cognitive capability is warranted since these capture the capacity to undertake the physical and mental tasks of daily living, are influenced by ageing in multiple biological systems, and can be quantified along a continuum using performance-based tests as well as reported functional limitations (11). Longitudinal evidence shows difficulty walking,

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limitations in instrumental daily activities (6) and steep cognitive decline (12) predict work exit among workers ≥50 years. Extant studies of performance-based measures of physical capability as determinants of retirement are cross-sectional (5, 7).

Education and occupational status may confound (7, 8, 13) or modify the association between physical or cognitive capability and retirement. Lower status jobs confer lower job control (14), greater physical work demands, and fewer opportunities to adapt the physical and psychosocial environment and workload to facilitate work participation given declining capability. Conversely, higher status jobs are more intellectually demanding so even minor cognitive impairments may negatively affect managing the tasks of work. Findings on modification by socioeconomic position are inconsistent. Coronary heart disease patients in manual but not non-manual occupations were at increased risk of labor market withdrawal one year after the cardiovascular event (15). However, a large representative study in Italy found that number of chronic diseases was more strongly related to early retirement in higher status occupations (16).

Older people participate in unpaid as well as paid socially productive activities and recent public policy decisions have aimed to increase volunteerism in later life (17). Voluntary work participation is also patterned by self-reported health and socioeconomic position (18) though the literature is limited, as above, in not having considered multiple measures of capability.

This study examined longitudinal associations between self-reported and performance-based measures of physical and cognitive capability in mid-adulthood with retirement age and participation in bridge employment and voluntary work. Because push and pull factors – such as poor health and financially beneficial incentives to retire – drive early retirement, we considered reasons for retirement as well as timing. We also tested whether associations were independent of or modified by socioeconomic circumstances.

Methods

Data

The Medical Research Council (MRC) National Survey of Health and Development (NSHD) is a socially stratified sample of all births that occurred during one week in March 1946 across England, Scotland, and Wales. This cohort of 5362 men and women has been followed prospectively >20 times across life from birth onwards with the main adult sweeps at ages 26, 36, 43, 53, 60–64 and 68 years. Information on retirement and work was collected in postal questionnaires administered in 2006–2010 (when study members were 60–64 years) and 2014 (68 years). Information on capability used in these analyses was collected in 1999 (53 years). Ethical approval for the study was obtained from the Greater Manchester Local Research Ethics Committee and the Scotland A Research Ethics Committee. Written, informed consent was obtained from study participants for each component of data collection.

Retirement and work participation

At ages 60–64 and 68 years, study members reported whether they had retired from their main occupation and, if so, at what age and their single main reason for retirement. Retirement reason was grouped as: (i) usual age for the job; (ii) positive reason (financially able, left early with good bonus, early retirement or voluntary redundancy package, lifestyle change, retired with partner); (iii) negative reason (own health, partner's health, becoming a carer, bereavement, made redundant, unhappy with job or with working, work problems); (iv) neutral or other reason (relocation to support spouse, business stopped or sold, homemaker, other). SPA was 65 and 60 years for men and women, respectively, in this cohort. For those who reported that they retired at the usual age for the job, this was SPA for 51.9% of men and 59.5% of women, before SPA for 37.7% of men and 7.4% of women, and after SPA for 10.3% of men and 33.1% of women. At each adult data collection sweep, they also reported their current employment status and participation in paid work since the previous sweep. Frequency of participation in voluntary work was collected at age 60–64 and hours of participation in voluntary work at age 68. Based on these questions, we derived three outcomes of interest. The first outcome combined retirement reason and timing because previous UK studies have identified distinct groups of early retirees (those in better financial circumstances and those in poorer health) that render simple analysis of retirement age misleading (2). Study members were grouped into seven categories: usual retirement age for the job; retirement at or before SPA for negative reason, later retirement (that is, after SPA) for negative reason; retirement at or before SPA for positive reason; later retirement for positive reason; other reason for retirement; not yet retired. The second outcome was participation in bridge employment defined as any paid employment after retirement from the main occupation. The third outcome was participation in voluntary work at least weekly at age 60–64 and/or ≥1 hour per week at age 68.

Physical and cognitive capability at age 53

Difficulties with a range of physical tasks due to long term health problems were reported at age 53. These capture lower body (difficulty walking for quarter of a

mile, difficulty walking up and down a flight of stairs [12 steps]) and upper body (difficulty using arms to reach above head or behind, difficulty holding something heavy or removing a stiff lid) limitations. A reported physical limitations score based on the presence or absence of each limitation was derived [ranging from 0 (no difficulty with any of the tasks) to 4 (difficulty with all 4 tasks)]. Performance-based physical capability was recorded by trained nurses using standardized protocols (19). Briefly, grip strength was measured twice in each hand using an electronic handgrip dynamometer and the maximum value achieved used in analyses. Chair rise time was based on the time taken to rise from a sitting to standing position and back to sitting ten times as fast as possible and calculated as reciprocal so that higher values indicate better physical capability. Standing balance time was based on the longest time that the study member was able to stand on one leg with his or her eyes closed, up to a maximum of 30 seconds. Those who could not complete a test for health reasons were assigned a value at the 99th (ie, the lowest) sex-specific centile. Grip strength was height adjusted and scores on the three tests were rescaled from 0 (indicating lowest physical capability) to 1 and summed to create a performance-based physical capability composite score. Study members were grouped into high, medium and low performance on the basis of sex-specific cut-offs (top 10%, middle 80% and bottom 10% of scores respectively) (20).

Performance-based cognitive tests were completed under standardized conditions (21). Verbal memory was based on a word learning task, measured as the number of correct words recalled from a list of 15 over three learning trials with a maximum score of 45. Processing speed was based on a score representing the total number of target letters searched within one minute. The National Adult Reading Test was also administered with scores calculated as number of words out of 50 pronounced correctly. Standardized scores on these three tests were summed and study members were grouped into high, medium, and low performance on the basis of sex-specific cut-offs (top 10%, middle 80%, and bottom 10% of scores respectively). Study members were not asked to self-report cognitive problems at this age.

Covariates

Socioeconomic position was captured by education and occupational class. Highest qualification by age 26 was grouped into "no qualifications", "lower secondary" (O levels or equivalent, usually attained at 16 years), "advanced secondary" (A levels or equivalent, usually attained at 18 years), and "degree level or equivalent". Occupation at age 53 years (or ages 43 or 36 if this was missing; N=764), was coded according to the Registrar General's classification. Study members not in or seeking paid work at age 53 were asked the main reason for non-employment and those who indicated that this was due to long-term sickness or disability were classified as work-disabled. Since couples often seek to retire together (22), we also considered partner's employment status at age 69, grouped as "partner not in paid work", "partner in paid work", and "no partner".

Statistical analysis

Using multinomial logit models and comparing with usual retirement age for the job as the base outcome, we estimated the association between each mid-adulthood capability measure and the relative probabilities of: (i) retiring at or before SPA for negative reason, (ii) retiring late for negative reason, (iii)) retiring at or before SPA for positive reason, or (iv) retiring late for positive reason. The tables show exponentiated multinomial logit estimates [that is, relative risk ratios (RRR)] interpreted as odds ratios (OR) (23). Results are not presented for those who retired for other reasons or were not yet retired. We used logistic regression models to estimate the associations between mid-adulthood capability and participation in bridge employment as well as voluntary work and present OR for these analyses. We present coefficients comparing categories of capability, but we also tested for linear associations between outcomes and continuous version of the capability measures (shown as P for trend in the tables and with estimates in the supplementary table S2, www.sjweh.fi/index.php?page=data-repository). In preliminary analyses, we tested for gender interactions and found no evidence that the associations between outcomes and exposures of interest were modified by gender hence we report findings for men and women combined. Adjustment was made for gender, educational attainment, occupational class, partner's employment status and work-disability at age 53. Models for bridge employment participation were also adjusted for retirement age. Next, we included the three capability indicators together to assess whether physical and cognitive capabilities were independently related to extended working, and whether performance-based tests provided additional information that was not captured by self-reported data on limitations. In these analyses, we collapsed the retirement reason and timing variable into retiring for a negative reason (irrespective of timing), retirement for a positive reason, and usual retirement age due to small numbers in some cells. Finally, we tested whether the association between each capability measure and outcome differed for people in manual occupations compared with those in non-manual occupations and those with lower educational attainment (O-level or below) compared with those with higher attainment (A-level or above). All analyses were undertaken using Stata 14 (Stata Corp LP, College Station, TX, USA).

Analytical sample

A total of 2661 study members participated at age 60–64 (84% of those eligible) and 2452 at age 68; 2610 provided data on ≥1 outcome of interest. Non-responders were over-represented in groups with low educational attainment, more disadvantaged occupational social class, unemployed or long-term sick- or work-disabled, poorer cognitive performance and fewer health-promoting behaviors (24). Analyses of retirement reason and timing excluded those who retired at ≤53 years (N=490) or who had not been in paid work from age ≥36 (N=20). Independent variables were missing for 861 study members who had at least one outcome of interest and these data were multiply imputed using chained equations and incorporating additional data on childhood social class and spouse's social class throughout adulthood. The estimates presented are based on ten imputed datasets combined using Rubin's rules.

Results

By age 53, 18% of men and 22% of women had retired. Approximately 20% retired for positive reasons and just over 30% for negative reasons. A greater percentage of men participated in bridge employment after they retired from their main occupation (40% verus 24%) though participation in voluntary work was a little higher for women (table 1). Respectively, 2% and 6% of men and women reported 3–4 physical limitations at age 53. As expected, higher performance-based physical capability scores were associated with fewer reported functional limitations (Spearman's correlation coefficient -0.38) and weakly positively correlated with cognitive capability (0.19).

Those with 3–4 physical limitations at age 53 were 3.15 (95% CI 1.07–9.26) times as likely to retire at or before SPA for a negative reason and 3.98 (95% CI 1.34–11.88) times as likely to retire after SPA for a negative reason compared with those with no limitations, with usual retirement age as the base outcome (table 2). These results are adjusted for gender, education, occupational social class, partner's employment and work disability at age 53. (Associations between these covariates and outcome are summarized in supplementary table S1, www.sjweh.fi/index.php?page=data-repository). P-values based on number of limitations as a continuous variable (P for trend in the tables; regression estimates in supplementary table S2) show a statistically significant dose response association with retiring for a negative reason. Performance-based physical and cognitive capabilities were not related to retirement reason and timing.

A dose–response association between increasing number of physical limitations and lower likelihood of

Table 1. Description of retirement, work participation and capability among members of the MRC National Survey of Health and Development, based on N=2610 with outcome data. [SPA=state pension age.]

	Men	Women
	%	%
Age retired from main occupation [a]		
<50 years	8	11
51–55 years	17	18
56–60 years	26	40
61–65 years	37	24
66–68 years	9	5
Not yet retired	3	1
Retirement reason and timing [b]		
Usual age for job	24	27
Retired >SPA negative reason	4	13
Retired >SPA positive reason	2	7
Retired ≤SPA negative reason	28	21
Retired ≤SPA positive reason	18	16
Other reason	8	8
Not yet retired	15	8
Participated in bridge employment [a]		
No	60	76
Yes	40	24
Participated in voluntary work		
No	75	70
Yes	25	30
Educational attainment at age 26		
None/sub GCE	39	41
O level	15	27
A level	29	26
Degree/higher	17	6
Occupational social class midlife		
Professional/managerial & technical	56	38
Skilled non-manual	11	35
Skilled manual	23	8
Partly-skilled and unskilled	10	19
Partner's employment status		
Not in paid work	41	40
In paid work	39	35
No partner	19	25
Reported physical limitations age 53 [c]		
0 limitations	86	68
1 limitations	9	19
2 limitations	3	7
3–4 limitations	2	6
Work-disabled age 53		
No	96	94
Yes	4	6

[a] Among those who were in any paid work from age 36 onwards.
[b] Among those who were in any paid work from age 36 onwards and retired at age ≥54; negative reasons include own health, partner's health, becoming a carer, bereavement, made redundant, unhappy with job or with working, work problems; positive reasons include being financially able, left early with good bonus, early retirement or voluntary redundancy package, life style change, retired with partner.
[c] 5 % of men and 11% of women had 1–2 lower body limitation and 11% of men and 28% of women had 1–2 upper body limitations.

Table 2. Midlife capability (each indicator considered separately) and retirement reason and timing, based on N=2093 study members.[a] [RRR=relative risk ratio interpreted as OR (odds ratio); SPA=state pension age; 95% CI=95% confidence interval]

	Likelihood of retiring at or before SPA for negative reason			Likelihood of retiring late for negative reason			Likelihood of retiring at or before SPA for positive reason			Likelihood of retiring late for positive reason		
	RRR	P trend	95% CI	RRR	P trend	95% CI	RRR	P trend	95% CI	RRR	P trend	95% CI
Reported physical limitations age 53												
No limitations	1			1			1			1		
1 limitation	1.35		0.91–2.00	1.52		0.90–2.56	1.19		0.77–1.84	1.95		1.11–3.44
2 limitations	1.41		0.71–2.78	2.22		1.07–4.61	1.16		0.53–2.56	1.03		0.29–3.63
3–4 limitations	3.15		1.07–9.26	3.98		1.34–11.88	0.87		0.16–4.82	1.53		0.14–16.66
		0.01			0.001			0.6			0.2	
Performance-based physical capability score age 53												
Top 10%	0.76		0.44–1.30	1.30		0.67–2.51	1.16		0.72–1.88	1.71		0.84–3.46
Middle 80%	1			1			1			1		
Bottom 10%	1.01		0.63–1.62	1.45		0.80–2.60	0.64		0.33-–.24	0.97		0.39–2.45
		0.3			0.4			0.3			0.5	
Performance-based cognitive capability score age 53												
Top 10%	1.05		0.64–1.71	1.15		0.56–2.36	1.11		0.63–1.96	1.30		0.56–3.05
Middle 80%	1			1			1			1		
Bottom 10%	0.96		0.60–1.53	0.96		0.50–1.83	0.83		0.46–1.52	1.35		0.65–2.81
		0.3			0.8			0.07			0.9	

[a] Adjusted for gender, education, occupational social class, partner's employment, and work disability at age 53.

participating in bridge employment was seen (table 3). Physical and cognitive performances were positively associated with likelihood of participation in bridge or voluntary work (table 3). There was a suggestion of non-linearity in these associations such that physical performance in the bottom 10% of the distribution was associated with lower likelihood of bridge employment and physical performance in the top 10% of the distribution was associated with greater likelihood of voluntary employment. High cognitive capability was associated with greater likelihood of participation in bridge employment whereas low cognitive capability was related to lower likelihood of voluntary work.

When considering the three capability indicators in mutually adjusted models, number of reported limitations but not performance-based physical capability was positively related to retirement for a negative reason (table 4). Physical and cognitive capabilities were independently related to both bridge employment and voluntary work. Reported physical limitations and cognitive capability but not performance-based physical capability was associated with likelihood of participation in bridge employment. Performance-based physical and cognitive capability was related to voluntary work but reported limitations were not.

We found no evidence that associations between the capability indicators and the three outcomes were modified by occupational class or by educational attainment (data available on request).

Discussion

Both physical and cognitive capabilities were related to participation in bridge employment and voluntary work in older age. Independently of socioeconomic characteristics, those with poorer physical or cognitive capabilities were less likely to participate in bridge employment or voluntary work. Those who reported physical limitations at age 53 were more likely to retire for negative reasons both before and after SPA. It appears that physical limitations may have implications which extend beyond retiring early on health grounds. Our findings demonstrate that it is possible to identify groups of people in middle age who are less likely to extend their working life because of reduced capability.

Ours is the first longitudinal study to consider complementary self-reports and performance-based physical capability measures in relation to retirement. Self-reports encapsulate health anxiety and an assessment of one's ability to undertake physical and mental tasks at work and so may capture person–work environment fit given current or anticipated health. Poorer physical performance predicts mortality and may be indicative of disease, poor general health status, and underlying ageing processes (25). At age 53, it is unlikely to reflect only manifest disease and physical limitations and may therefore capture information that is additional to self-reported limitations. Performance-based physi-

Table 3. Midlife capability (each indicator considered separately) and i) bridge employment, ii) voluntary work. [OR=odds ratio; 95% CI=95% confidence interval.]

	Likelihood of participating in bridge employment [a] (N=2040)			Likelihood of participating in voluntary work [b] (N=2167)		
	OR	P trend	95% CI	OR	P trend	95% CI
Reported physical limitations age 53						
No limitations	1			1		
1 limitation	0.84		0.60–1.16	0.91		0.67–1.22
2 limitations	0.58		0.32–1.04	0.99		0.58–1.69
3–4 limitations	0.31		0.12–0.82	0.90		0.44–1.82
		0.003			0.6	
Performance-based physical capability score age 53						
Top 10%	0.98		0.69–1.37	1.65		1.21–2.24
Middle 80%	1			1		
Bottom 10%	0.56		0.36–0.88	1.00		0.67–1.50
		0.03			0.002	
Performance-based cognitive capability score age 53						
Top 10%	1.71		1.21–2.42	1.19		0.87–1.62
Middle 80%	1			1		
Bottom 10%	1.06		0.72–1.54	0.59		0.36–0.96
		0.001			<0.001	

[a] Adjusted for gender, education, occupational social class, partner's employment, work disability at age 53, and retirement age.
[b] Adjusted for gender, education, occupational social class, partner's employment, and work disability at age 53.

Table 4. Midlife capability (mutually adjusted) and i) negative reason for retiring, ii) bridge employment, iii) voluntary work. [RRR=relative risk ratio interpreted as OR (odds ratio); 95% CI=95% confidence interval.]

	Likelihood of retiring for negative reason [a, b] (N=2093)			Likelihood of participating in bridge employment [b] (N=2040)			Likelihood of participating in voluntary work [c] (N=2167)		
	RRR	P trend	95% CI	OR	P trend	95% CI	OR	P trend	95% CI
Reported physical limitations age 53									
No limitations	1			1			1		
1 limitation	1.32		0.91–1.90	0.83		0.60–1.16	0.92		0.68–1.25
2 limitations	1.79		0.96–3.33	0.61		0.34–1.10	1.04		0.60–1.78
3–4 limitations	3.24		1.21–8.69	0.39		0.14–1.06	0.92		0.45–1.89
		0.002			0.007			0.9	
Performance-based physical capability score age 53									
Top 10%	0.92		0.57–1.51	0.94		0.67–1.33	1.63		1.20–2.22
Middle 80%	1			1			1		
Bottom 10%	0.96		0.61–1.50	0.65		0.40–1.04	1.05		0.69–1.59
		0.6			0.3			0.006	
Performance-based cognitive capability score age 53									
Top 10%	1.01		0.63–1.59	1.71		1.20–2.43	1.17		0.85–1.60
Middle 80%	1			1			1		
Bottom 10%	0.98		0.63–1.54	1.07		0.73–1.57	0.59		0.36–0.97
		0.7			0.002			0.001	

[a] Estimates are from a multinomial model with usual retirement age for the job as the base outcome. Results for retiring for positive reason are not shown.
[b] Model includes gender, education, occupational social class, partner's employment, work disability at age 53, retirement age, reported limitations, performance-based physical and cognitive capability.
[c] Model includes gender, education, occupational social class, partner's employment, work disability at age 53, reported limitations, performance-based physical and cognitive capability.

cal capability is also positively correlated with earlier cognitive capability (26) and negatively correlated with subsequent cognitive decline (27) and, as demonstrated here, cognitive capability is strongly related to work participation. Poor capability on both self-reported and performance-based measures, when they were considered singly, was related to lower likelihood of bridge and voluntary work participation. This indicates that self-justification alone (that is, exaggeration of poor health among those with lower job satisfaction) is unlikely to explain previous findings of a link between self-reported health status and older people's work exit. When considered in models together, reported limitations and physical performance did not show independent associations with outcomes. Given the moderate correlation between reported and performance-based physical capability measures, this is not unexpected but it is in contrast to the only previous study to have considered both

reported and performance-based measures, which was cross-sectional in design and found that both higher grip strength and reporting no daily activity limitations were related to a greater likelihood of paid work participation (7). However, in the mutually adjusted models it was reported limitations which showed a positive association with retirement for a negative reason and an inverse association with participation in bridge employment. In contrast, physical performance showed an independent association with voluntary work. This suggests that these two kinds of measures provide complementary information when considered across multiple kinds of extended work.

Associations between cognitive capability and bridge or voluntary work participation were not explained by education and occupational class. Participation in bridge and voluntary work requires effort and motivation to find suitable opportunities. The findings may reflect avoidance caused by difficulty with learning specific new skills, lower confidence in securing new employment and also broader limitations in planning and structuring goals for later life (28).

There was no evidence that associations were modified by socioeconomic position though we were unable to investigate multiple mechanisms that may cancel out an overall effect. Those with less education or lower status jobs may be less able to make adaptations at work whereas the tasks involved in higher status jobs, which tend to require higher educational attainment, may demand a higher level of cognitive capability.

Strengths and limitations

This study is based on a representative sample, not confounded by age or cohort effects, and the first to examine performance-based and self-reported capability in relation to extended working in the British context. It used capability measures in middle age whereas previous studies have only been able to consider capability at ages closer to retirement.

Eligible non-responders were more likely to be out of work, in poor cognitive health, and more socioeconomically disadvantaged than responders so we may have underestimated the contribution of poor health to extended working life. The literature has identified other determinants of retirement behaviors that we have not considered here including caring responsibilities, pension entitlements, and workplace and organizational characteristics. Informal caring may have a detrimental effect on health and the ability to participate in paid work but few (N=36) study members were not in paid work because of caring responsibilities at age 53 and few (N=109) were providing ≥10 hours of care per week at age 60–64. Investigation of pension characteristics was beyond the scope of the current data though these, and work and organizational characteristics, are likely to be correlated with occupational social class and education, which were included in our regression models. Work characteristics such as physical job strain, low job control, effort–reward imbalance and increasing job insecurity, rather than being confounders, may be considered as upstream factors that lead to poor health (29–31) and lower likelihood of extended working life and could be the focus of interventions to improve midlife capability.

Concluding remarks

In addition to the immediate benefits of having a healthy workforce, interventions to promote worker's physical and cognitive capability, which start in midlife or earlier, could have long-term consequences by increasing work participation in later life (in the form of bridge employment and voluntary work) as well as promoting a more positive experience of retirement (32, 33). Long-term intervention studies, if feasible, could provide more robust evidence on this but the current findings highlight that the potential health and financial wellbeing benefits in older age afforded by extended working life are less likely to be realized by those with poorer midlife physical and cognitive capability. Extended working initiatives could exacerbate social and health inequalities in older age if they are not complemented by interventions targeted at those experiencing or at risk of experiencing poor capability by midlife.

Acknowledgements

This work was supported by the Medical Research Council and the Economic and Social Research Council under the Lifelong Health and Wellbeing Cross-Council Programme initiative (ES/L002892/1). MS, DK, RC and MR are supported by the Medical Research Council (MC_UU_12019/5, MC_UU_12019/4, MC_UU_12019/3). The financial sponsors played no role in the preparation of this paper.

Data used in this publication are available to bona fide researchers upon request to the NSHD Data Sharing Committee via a standard application procedure. Further details can be found at www.nshd.mrc.ac.uk/data. doi: 10.5522/NSHD/Q101; doi: 10.5522/NSHD/Q102; doi: 10.5522/NSHD/S103.

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Received for publication: 15 March 2016