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The oldest old in England and Wales: a descriptive analysis based on the MRC Cognitive Function and Ageing Study

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Abstract

Objective: to describe the characteristics and survival of the oldest old in England and Wales.
Design: retrospective analysis of the oldest old from a population-based cohort study.
Setting: population-based study in England and Wales: two rural and three urban sites.
Methods: two types of analyses were conducted: (i) a descriptive analysis of those individuals who were aged 90 years or more, and 100 years or more, and (ii) a survival analysis of those who reached their 90th, 95th, or 100th birthday during the study. Median survival time was calculated by the Kaplan–Meier method. Effects of socio-demographic characteristics on survival were evaluated using the Cox proportional-hazards regression model.
Results: in total, 958 individuals aged 90 years or more, and 24 individuals aged 100 years or more, had been interviewed at least once during the study. Twenty-seven per cent were living in residential or nursing homes. Women aged 90 years or more were more likely to be living in residential and nursing homes, be widowed, have any disability or have lower MMSE scores. The centenarians were mostly cognitively and functionally impaired. The median survival times for those reaching their 90th ($n = 2{,}336$), 95th ($n = 638$), or 100th birthday ($n = 92$) during the study were 3.7 years (95% CI: 3.5–4.0), 2.3 (2.1–2.6) and 2.1 (1.7–2.6) years for women, and 2.9 (95% CI: 2.6–3.1), 2.0 (1.2–3.1) and 2.2 (0.5–2.3) for men, respectively. Those living in residential and nursing homes had a shorter survival when aged 90 years, with similar non-significant effects for those aged 95 and 100 years. After the age of 100 years, the high mortality rate and small sample size limited the ability to detect any differences between the different groups.
Conclusion: even at the very oldest ages, the majority live in non-institutionalised settings. Among the oldest old, women were frailer than men. Being male and living in residential nursing homes shortened survival in those aged 90 years or more.

Keywords: *centenarians, nonagenarians, characteristics, survival, risk factors*

Introduction

People are today living longer, but relatively few studies concentrate on the oldest old. Life expectancy is increasing steadily in the United Kingdom and the current average life expectancy at birth is 81 years for women and 76 years for men [1]. The fastest growing section of the population is the oldest old. The number of centenarians is increasing by 7% per annum [2]. In 2003, almost 400,000 people in the United Kingdom were aged 90 years or more (0.7% of the total population). Projections show that there are expected to be 984,000 people aged 90 years or more in 2031, representing 1.6% of the whole population [3, 4].

The oldest old are more likely to experience frailty, illness and dependence in comparison with younger old people (those aged 65–84). A large body of research has described the demographic characteristics, physical health, cognitive impairment, disability and self-perceived health of the oldest

old [3, 5]. The oldest old have significantly worse physical function, cognition and social functioning than younger old people. Among the oldest old, women outnumber men with a sex ratio of more than 3:1 [6]. The oldest old are less likely to live with a spouse or partner, more likely to be widowed and to be in worse physical function, cognition and social functioning than younger old people [3, 5].

Some risk factors for mortality are similar to those in younger old people, including age, sex, marital status, cognitive impairment, disability, self-rated health, cancer, social support and health status [7, 8]. Though some of these studies have been population-based [9, 10], others examined specific population groups such as those living in the community or as in-patients, [11] and most have been conducted in developed countries [12, 13].

Nonagenarians are old enough to reflect exceptional longevity, but at the same time represent a less selected group than centenarians. Some surveys have indicated that the relationship between risk factors and mortality is different in the oldest old [14, 15]. In the old old, predictors (age, sex, disability, self-reported health) of mortality have changed over time, and their predictive effects have eventually diminished [7]. It has been reported that the exponential relationship of age with morbidity and mortality for people aged 65–84 years does not persist in those aged 90 years or more [15]. Age and gender were unrelated with survival in centenarians [16].

Given the ageing population, information on characteristics and estimates of survival of the oldest old are useful for policy planners. However, limited information on the health status and mortality of nonagenarians and centenarians is available in the United Kingdom. We have previously reported cognitive and functional results for the whole population from the Medical Research Council Cognitive Function and Ageing Study (MRC CFAS) [17]. This analysis draws on the full 10-year dataset to capture as much information as possible on individuals aged 90 or more and 100 years or more. The aim is to provide a description of the health status and survival of a population-based cohort aged 90 years and more.

Methods

Study population

MRC CFAS is a population-based cohort study of individuals aged 65 years and over living in the community and in institutions. The study design and methodology have been described elsewhere ([18], www.cfas.ac.uk). Informed consent was obtained at entry to the study and at each follow-up interview. The screening interviews were undertaken between 1991 and 1994 with a response rate of 80%. Individuals numbering 13,004 were recruited from Family Health Services Authority lists gathered from five geographical areas. A 20% stratified sub-sample of those screened was selected for assessment, and a similar two-phase interview procedure was repeated 2 years later. All the interview waves were used in this analysis (years 0, 1, 2, 3, 6, 8, and 10).

Descriptive study of nonagenarians and centenarians

Nonagenarians and centenarians during the study follow-up

Individuals who were in their 90s at screening interview (S0) and those who reached their 90s during the study follow-up were selected for the descriptive analysis of nonagenarians. A total of 958 individuals had been interviewed after their 90th birthday (See Flowchart 1 in the supplementary data on the Journal's website http://www.ageing.oxfordjournals.org.).

Likewise, individuals who were already aged 100 years or more, or who reached 100 years of age during follow-up and had interview data available were selected for the descriptive analysis of centenarians. Twenty-four centenarians had been interviewed after their 100th birthday (See Flowchart 1 in the supplementary data on the Journal's website http://www.ageing.oxfordjournals.org.).

Instruments and procedures

All individuals were interviewed by trained interviewers with a structured questionnaire including accommodation type, social status, cognitive function and functional disability—Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) [19]. The Townsend deprivation score was chosen as a measure of area level deprivation which has shown to be highly reliable (Cronbach's $\alpha = 0.875$) in the United Kingdom [20, 21]. Based on the 1991 census data, a Townsend deprivation score has been calculated from the respondent's postcode, from which tertiles were constructed.

Cognitive function was measured using the MMSE [22] and Automated Geriatric Examination for Computer-Assisted Taxonomy (AGECAT) organicity items [23]. If a non-physical item was missing a person's MMSE score was set to 'missing'. Dementia cases were derived as AGECAT organicity O3 or above at assessment interview.

Self-reported health was measured using a 4-point scale, based on the question 'Would you say that for someone of your age, your health is excellent, good, fair, or poor?'.

Disability is measured using hierarchy of need, previously developed, based on a set of IADL and ADL [19]. This index had good internal consistency (Cronbach's $\alpha = 0.837$). Participants have ADL-IADL disability if they need help with washing, hot meals, shoes and socks, or if they cannot get around outside their homes. Participants have IADL disability if they need help with heavy housework or shopping and carrying heavy bags.

Survival analysis of those who reached their 90th, 95th, and 100th birthday during the study follow-up

Individuals were flagged in the Office of National Statistics National Health Service Central Register, resulting in automatic notification of death. Date of death was collected for all individuals who died on or before 31 December 2005. All individuals alive on 31 December 2005 were censored as at that date.

A total of 307, 53, and 5 individuals were excluded from the survival analyses as they were already aged more than 90, 95 or 100, respectively, at baseline interview.

Two thousand three hundred and thirty-six individuals reached their 90th birthday, 638 reached their 95th birthday and 92 reached their 100th birthday during the study period. Two individuals reaching their 95th birthday on the censoring date (31 December 2005) were excluded. Survival time was defined as the time to death or censoring date from their 90th, 95th and 100th birthdays, respectively.

Statistical methods

Version 8.1 of the MRC CFAS dataset was used for the analysis. The variables included were age, gender (women versus men), educational level (<9 or 9 (statutory), 10–12, and >12 years of full-time education), social class (social class I denotes professionals; II is managerial and technical workers; III is non-manual and manual skilled workers; IV is partly skilled workers; and V is unskilled manual workers), accommodation type (community accommodation versus residential and nursing home), dementia status (yes versus no), disability status (no disability, IADL disability only, and IADL/ADL disability), and self-reported health status (excellent, good, fair and poor). Demographic characteristics and health status between women and men for nonagenarians and centenarians were compared using the Mann–Whitney U test for continuous variables, and with the chi-square test for categorical variables. Differences between nonagenarians and centenarians were not compared due to the small numbers available.

For the survival analysis, median survival time from 90th, 95th and 100th birthday by gender, social class, educational level, accommodation type and marital status were calculated using the Kaplan–Meier method. Log-rank tests were used for testing the equality of survival among groups. Relative risk of death from gender, educational level, accommodation type, marital status, and social class were derived from Cox proportional-hazards regression models, using univariate and multi-variable models. The Schoenfeld residual test was used to evaluate the proportional hazards assumptions.

Analyses were undertaken using Stata 9.2 statistical software (Stata Corp, College Station, Texas).

Results

Descriptive study

Characteristics of nonagenarians

Individuals numbering 13,004 aged 65 years or more who participated in the MRC CFAS baseline interview formed the sample frame. By the end of the last interview period (September 2003), a total of 958 nonagenarians had been interviewed. Among those nonagenarians, women outnumbered men by 3:1. Women were more likely to be living in residential and nursing homes, being widowed, having some disability, with lower MMSE scores and more likely to have dementia (Table 1).

Characteristics of centenarians

Among the 24 centenarians who were interviewed before the censored date, 7 centenarians did not have a diagnosis of dementia. Forty-four per cent (7/16) of centenarians had dementia. Twelve (50%) centenarians scored 21 or less on the MMSE. Nine (38%) centenarians could not report their health status. Of those who could report their health status, nine (60%) felt in good or excellent health. All centenarians, where disability could be measured, had IADL or ADL disability (all but one at the more severe level).

Missing data

Due to the frailty of the oldest old, many variables (MMSE score, disability and self-reported health) have missing data (Table 1). Further analyses shows that those with missing values were frailer than those with complete data (data not shown). Fifteen per cent of subjects (145) were missing in the MMSE scores (female: 123, male: 22), more than half of them were living in institutions and had a higher proportion of disability.

Survival analysis of the oldest old

Table 2 provides a comparison of the median survival time in people who reached their 90th, 95th, or 100th birthday during the study by gender, social class, educational level, accommodation type, and marital status. There were 1,564 (86%), 456 (72%) and 68 (74%) deaths in people who reached their 90th, 95th, or 100th birthday during the study follow-up, respectively, and the total mortality rate was 22, 32 and 39 per 100 person-years, respectively (Table 2).

The univariate model shows that gender, social class and accommodation type were predictors of mortality in nonagenarians, while educational level, Townsend deprivation at baseline and marital status had less impact (Table 3). Men had a significantly shorter survival than women (Log-rank test: $P<0.001$). The median survival time after their 90th birthday was 3.7 years for women and 2.9 years for men (unadjusted HR: 1.2; adjusted HR: 1.3). Those living in the community had significantly longer survival (3.6 years) than those living in residential and nursing homes (2.1 years) (unadjusted HR: 1.5, adjusted HR: 1.3).

In the multi-variable model, after adjusting for the same set of confounders, educational level and social class did not independently influence mortality, while the association with gender and accommodation type remained (Table 3).

For individuals aged 95 or more and 100 years or more, there were consistent patterns or effects with regard to gender, social class and education. With the oldest old, the factors no longer reach conventional significance, but the gender effect and residential status are consistent with the pattern seen in those aged 90 and above.

Discussion

People aged 90 or more and 100 years or more in this population-based study are detailed. The sex ratio (FM) of

Table 1. Socio-demographic characteristics and health status of nonagenarians and centenarians by gender

Variables	Nonagenarians All ($n = 958$)	Women ($n = 719$)	Men ($n = 239$)	P[a]	Centenarians ($n = 24$)
Age at first interview	91.1	91.2	91.0	0.07	100.6
(median (25th, 75th percentile))	(90.4, 92.6)	(91.2, 93.0)	(90.3, 92.2)		(100.3, 101.1)
Age at death	94.6	95.0	93.7		102.2
(median (25th, 75th percentile))	(92.9, 97.1)	(93.1, 97.6)	(92.4, 95.5)	0.001	(101.6, 103.3)
	($n = 825$)	($n = 617$)	($n = 208$)		($n = 23$)
Education (years)[b] *n* (%)					
≤9	566 (65)	433 (67)	133 (59)		14 (74)
10–11	167 (19)	115 (18)	52 (23)	0.08	3 (16)
≥12	135 (16)	95 (15)	40 (18)		2 (10)
Social class[b] *n* (%)					
I/II	151 (20)	100 (18)	51 (26)		6 (25)
III	383 (51)	295 (54)	88 (44)	0.04	9 (38)
IV/V	179 (24)	125 (23)	54 (27)		4 (17)
Armed forces/unclassified	34 (5)	27 (5)	7 (3)		5 (21)
Accommodation type *n* (%)					
Community[c]	685 (73)	496 (70)	189 (80)	0.003	13 (54)
Residential and nursing home	259 (27)	211 (30)	48 (20)		11 (46)
Marital status[d] *n* (%)					
Married/cohabiting	106 (12)	32 (5)	74 (33)		1 (5)
Single	88 (10)	74 (12)	14 (6)	0.001	6 (27)
Widowed	669 (78)	532 (83)	137 (61)		15 (68)
Townsend deprivation index[b] *n* (%)					
Least deprivation	296 (33)	212 (31)	84 (37)		7 (30)
Middle tertile	354 (39)	271 (40)	83 (37)	0.261	9 (40)
Most deprivation	254 (28)	195 (29)	59 (26)		7 (30)
Disability[d] *n* (%)					
No disability	121 (14)	69 (11)	52 (25)		0 (0)
IADL disability only	171 (20)	134 (21)	37 (18)	0.001	1 (6)
ADL-IADL disability	567 (66)	445 (68)	122 (57)		17 (94)
Missing	99	71	28		6
Self-perceived health[d] *n* (%)					
Excellent	151 (20)	100 (18)	51 (26)		5 (33)
Good	383 (51)	295 (54)	88 (44)	0.040	4 (27)
Fair	179 (24)	125 (23)	54 (27)		4 (27)
Poor	34 (5)	27 (5)	7 (3)		2 (13)
Missing	211	172	39		9
Dementia[d] *n* (%)					
No	647 (70)	472 (68)	175 (77)	0.006	9 (56)
Yes	276 (30)	225 (32)	51 (23)		7 (44)
Missing	35	22	13		8
MMSE[d] *n* (%)					
0–17	182 (23)	152 (27)	30 (14)		4 (24)
18–21	191 (24)	143 (25)	48 (23)		8 (50)
22–25	207 (27)	154 (27)	53 (25)	0.001	2 (13)
26–30	202 (26)	123 (21)	79 (38)		2 (13)
Missing	145	123	22		8

[a] P: for comparison of women versus men.
[b] Status at baseline screening (S0).
[c] Community accommodation (own home, granny flat or warden-controlled accommodation).
[d] Health status of individuals in their 90s or 100s or more.

3:1 in nonagenarians reflects the UK national figures [3]. As at younger ages, women were more likely to be in worse health than men, based on physical and cognitive function, as well as being more likely to live in residential and nursing homes, and to be widowed [17]. Median survival time was 3.5, 2.3, and 2.1 years for those aged 90, 95 and 100 years of age during the study follow-up, respectively.

The limitations of the analyses need to be taken into consideration. Of those who reached their 90s during the time of the study or further follow-up, interview information

Table 2. Median survival times of those who reached their 90th, 95th and 100th birthday during the study follow-up[a]

	Those reached 90th birthday (2,336)					Those reached 95th birthday (638)					Those reached 100th birthday (92)				
			IQR					IQR					IQR		
Variables	*n*	Median (95% CI)	25th	75th	*P*	*n*	Median (95% CI)	25th	75th	*P*	*n*	Median (95% CI)	25th	75th	*P*
Gender															
Women	1,722	3.7 (3.5–4.0)	1.7	6.4	0.001	512	2.3 (2.1–2.6)	1.0	4.1	0.4	80	2.1 (1.7–2.6)	1.0	3.4	0.3
Men	614	2.9 (2.6–3.1)	1.4	5.3		124	2.0 (1.2–3.1)	0.6	4.2		12	2.2 (0.5–2.3)	0.6	2.3	
Education (years)															
≤9	1,430	3.5 (3.2–3.7)	1.6	5.9	0.024	382	2.4 (2.1–2.7)	0.9	4.1	0.4	52	2.1 (1.7–2.3)	1.4	2.9	0.3
10–11	454	3.8 (3.2–4.4)	1.6	6.4		124	2.1 (1.7–2.5)	1.1	3.7		15	2.3 (0.6–2.6)	0.7	2.6	
≥12	378	3.8 (3.3–4.3)	1.8	6.9		101	2.9 (1.9–3.6)	0.8	4.4		17	2.7 (0.8–4.1)	0.8	4.1	
Social class															
I/II	758	3.9 (3.5–4.2)	1.6	6.8	0.042[b]	197	2.7 (2.1–3.1)	1.0	4.4	0.8	29	2.1 (0.8–2.5)	0.5	2.6	0.4
III	1,027	3.4 (3.1–3.7)	1.6	6.0		275	2.4 (2.1–2.7)	1.0	4.0		36	2.0 (1.4–1.9)	1.0	3.2	
IV/V	432	3.5 (3.1–3.8)	1.6	6.0		113	2.0 (1.7–2.6)	1.0	3.9		13	2.3 (1.1–2.9)	1.2	2.9	
Armed forces/unclassified	119	2.5 (2.1–3.3)	1.2	4.8		51	1.9 (0.9–1.9)	0.7	4.3		14	2.2 (0.5–4.4)	0.7	4.4	
Townsend deprivation index															
Least deprivation	762	3.8 (3.4–4.1)	1.6	6.5	0.2	201	2.6 (2.1–3.0)	1.1	4.7	0.2	31	2.1 (1.7–2.7)	1.4	3.2	0.7
Middle tertile	803	3.6 (3.3–3.9)	1.7	6.0		223	2.3 (2.0–2.8)	0.9	4.1		35	2.3 (1.0–2.9)	0.8	3.4	
Most deprivation	681	3.2 (2.9–3.5)	1.5	5.9		181	1.9 (1.4–2.5)	0.9	3.6		21	1.7 (0.9–2.1)	0.9	2.2	
Accommodation type															
Community	2,192	3.6 (3.4–3.8)	1.6	6.2	0.001	567	2.3 (2.1–2.6)	1.0	4.1	0.2	71	2.2 (1.9–2.6)	1.0	3.2	0.03
Residential or nursing home	318	2.1 (1.8–2.8)	0.8	4.5		62	1.7 (1.3–2.8)	0.8	4.2		20	1.2 (0.5–2.6)	0.5	2.6	
Marital status															
Married/cohabiting	717	3.3 (2.8–3.7)	1.4	5.7	0.2	117	2.5 (1.7–2.8)	0.7	4.9	0.8	10	2.3 (0.4–3.0)	1.0	2.9	0.7
Single	235	3.5 (2.9–4.3)	1.6	6.0		76	2.0 (1.3–2.9)	0.8	4.5		16	1.8 (0.9–2.7)	0.8	3.7	
Widowed	1,343	3.7 (3.4–4.0)	1.7	6.3		417	2.4 (2.1–2.7)	1.1	4.0		59	2.1 (1.7–2.5)	0.9	2.7	

[a] Individuals for this survival analysis are those who reached their 90th, 95th and 100th birthday during the study follow-up. All variables were from baseline screen.

[b] Comparison among the I/II, III, and IV/V groups.

was only available on 45%, which limited analysing the effect of disability and self-reported health on survival. At baseline, the response rate was good for all ages (80% in all age groups). Most other studies which report response rates are lower for this age group. Only 15% (273/1,800) participated in the Tokyo Centenarian Study [24], and 58% in the Heidelberg study [6]. Attrition analyses from our cohort showed that dropout not due to death was higher in the older age groups [25]. Mortality information is from the national registration system, and can therefore, be considered relatively complete. Individuals in our analysis of median survival time reached the required birthday after the start of the study, hence, the attrition effects will not affect the survival data. This study, therefore, provides accurate estimates of median survival time of the oldest old for specific age groups. There are very little data with which to compare these findings [12].

Consistent with previous studies [5, 9], gender differences in old-age health are quite pronounced in our study. Older women are much more likely to be living in residential and nursing homes, be widowed, have some disability, have lower MMSE scores and more likely to have dementia than older men.Twenty-seven per cent of female nonagenarians and 14% of male nonagenarians scored 17 or below on the MMSE. This rate was higher than the Leiden 85-plus [5] study which showed that 17% of individuals aged 85 years and above had a MMSE score of 18 or less [5], but almost 15% of individuals could not complete the MMSE which indicates a very high level of cognitive impairment in the oldest old. Further analysis shows that those with missing values in MMSE were frailer (worse disability, poorer self-reported health, demented) than those with complete data. None of those with missing values in MMSE had a history of stroke, and 57 reported having hearing problems.

Disabilities are extremely common in the very old. A high prevalence of disability was found in nonagenarians and centenarians. About 89% of nonagenarian women and 75% of nonagenarian men reported having IADL or ADL disability, similar to results of Leiden 85-plus study [5]. All centenarians had IADL or ADL disability. The sample of men was too small to make gender-specific observations in centenarians. The validity of self-reported health and

Table 3. Hazard ratio for death of those who reached 90th, 95th, and 100th birthday during the study[b]

Variables	Those reached 90th birthday $n = 2258$ Adjusted HR[a] (95% CI)	Those reached 95th birthday $n = 603$ Adjusted HR[a] (95% CI)	Those reached 100th birthday $n = 84$ Adjusted HR[a] (95% CI)
Gender			
Women	1	1	1
Men	1.3 (1.1–1.5)	1.2 (0.9–1.5)	1.3 (0.6–2.9)
Education (years)			
≤9	1	1	1
10–11	1.0 (0.8–1.1)	1.1 (0.8–1.4)	1.2 (0.6–2.4)
≥12	0.8 (0.8–1.1)	0.9 (0.7–1.2)	0.6 (0.3–1.3)
Social class			
I/II	1	1	1
III	1.1 (1.0–1.3)	1.1 (0.8–1.4)	0.8 (0.4–1.6)
IV/V	1.1 (0.9–1.3)	1.1 (0.8–1.5)	0.8 (0.3–1.9)
Armed forces/unclassified	1.2 (0.9–1.6)	1.2 (0.8–2.0)	0.8 (0.3–1.9)
Accommodation type			
Community	1	1	1
Residential/nursing home	1.3 (1.1–1.6)	1.2 (0.8–1.6)	1.5 (0.8–2.8)

[a] Adjusted for the same variables in the table.
[b] Some subjects were excluded from multi-variable analysis due to being missing in one or more variables.

symptoms has been widely discussed [26]. Around 71% of people aged 90 years or more rated their overall health as excellent or good compared with others of the same age. Women rated their health much better than men [27].

Gender is one of the best predictors of mortality known in the literature [7]. In this study, on average, women aged 90 years live longer than men, while at age 100, survival is largely similar for both men and women. Educational level has been found to predict mortality in younger old [12]. Our results showed that individuals aged 90 years or more, with less than 9 years' education, had a median survival time of 3.5 years compared with 3.8 years for those with higher education, and a difference is seen at all ages. However, after adjusting for other covariates, this effect is attenuated, which differs from the result of the Danish 1905 Cohort Survey [12].

Our results showed that marital status was not associated with shorter survival in contrast to results in the younger old, which showed that unmarried men and women have higher mortality from all causes [28], and married individuals showed lower total covariate-adjusted death rates [12, 26]. Some other studies have found gender differences in mortality by marital status and/or accommodation types [29, 30]. Our analyses indicate that any protective effect of marriage on mortality is limited or weak in the oldest old.

In conclusion, even in the very oldest age groups, most people are living in non-institutionalised settings, and gender difference in survival persists into the 90s. After age 100, the mortality is very high in all groups with small numbers of individuals, hence, limiting the ability to detect any differences between different groups. The pattern of mortality prediction showed that being male and living in residential and nursing homes predicted mortality in those aged 90 years or more. Some factors including marital status, accommodation type and low education do not persist to influence mortality in the oldest old.

Key points

- Large UK-based multi-centre study describing the characteristics of the oldest old in representative population. Even at the very oldest ages, the majority live in non-institutionalised settings.
- Being male and living in institutionalised settings shortens survival in those aged 90 years and more. After age 100 the mortality rate is so high that no difference can be detected between different groups.

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Conflict of interest

None.

Ethical approval

MRC CFAS has Multi-centre Research Ethics Committee approval and ethical approval from the relevant Local Research Ethics Committees. All participant gave their informed consent.

Supplementary data

Supplementary data for this article are available online at http://ageing.oxfordjournals.org.

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