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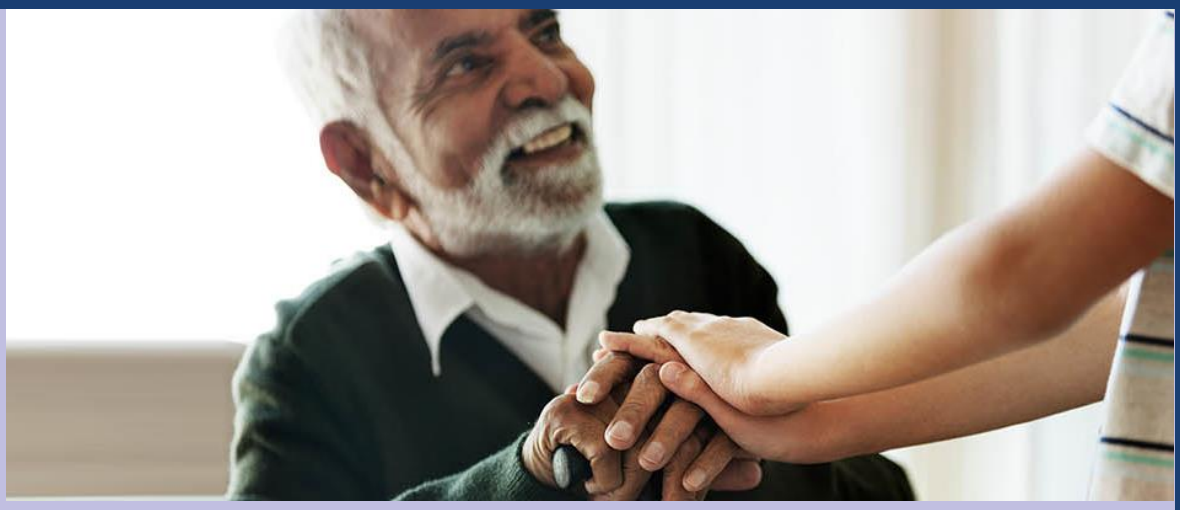

Using individual and neighbourhood profiles and trends to understand frailty with nationally representative population data

Part 5: Care receipt, unmet need for care and frailty: a longitudinal analysis with multistate models

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Full Report

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Abstract

Frailty is a well-established measure of the decline in physical, cognitive, energy, and health reserves among older individuals. It is strongly associated with adverse clinical outcomes. The relationship between receiving care, or receiving insufficient care, and changes in a person's level of frailty remains unclear. This study used multistate models to investigate the associations between care receipt, unmet care needs, frailty status, and mortality over 18 years in a sample of 15,003 individuals aged 50 and above from the English Longitudinal Study of Ageing (ELSA). Covariates included age, gender, care status, wealth, area deprivation, education, and marital status. Care status was assessed through received care and self-reported unmet care needs, while frailty status was determined using a frailty index. The findings show that individuals who receive care (paid or unpaid) are more susceptible to frailty and are less likely to recover from frailty to a less frail state. Additionally, wealth emerges as an equally influential predictor of changes in frailty status, with individuals in the lowest wealth quintile who do not receive care being as likely to become frail as those in the highest wealth quintile who do receive care. Gender differences were observed, as unmet care needs were associated with changes in frailty status for males but not females. Individuals starting to receive care (paid or unpaid) and people with the least wealth are potential target groups for interventions aimed at delaying the onset of frailty.

Background

As populations age, older people will account for an increasing proportion of health and social care services [1]. Frailty is a valuable measure of the health of older people, characterised by a decline in physiologic and cognitive reserves and function, which leads to an increased vulnerability to stressors [2]. Frailty is associated with adverse outcomes, including higher mortality rates, number of falls, and use of health and social care services [3-5].

There are several measures of frailty [2, 6, 7]. One measure, the frailty index (based on the cumulative deficit model) is widely used for health records and survey data [7]. A frailty index records a large range of 'deficits', which typically accumulate over time. These deficits often cover mobility, cognitive function, sensory ability, and chronic illnesses, although the precise components vary between frailty indexes [8]. Estimates of frailty prevalence in England vary by metric and age groups, but recent estimates range from 3-14% of older people [9-11], with a further 10-12% being prefrail [9, 10].

Many older people with frailty receive some social care. In the UK, this is provided by both public and private expenditure, as well as by unpaid care from family and friends. Despite this, an estimated 1.5 million people over 65 have unmet care needs [12]. Our previous work shows that the receipt of local authority-funded care (0.5 million) in England is lower than would be expected from estimates of the prevalence of frailty (0.7 million) and pre-frailty (1.6 million) [13]. Unmet needs for care exist where care provision does not meet the requirements of the care recipient, whether it is paid or unpaid care. Inequalities in unmet needs for care may result from social policies, family relations and societal structures [14].

Providing care for people with frailty is estimated to be between 4 and 9 times as expensive as caring for people without frailty [15]. Frailty is also associated with increased numbers of hospital admissions, longer hospital lengths of stay, higher numbers of ambulance calls that do not require conveyance to a hospital and greater health care costs [16-18].

This study aims to understand how care receipt, unmet need for care and socio-economic characteristics are associated with longitudinal health outcomes, as measured by frailty. Longitudinal health and care data from the English Longitudinal Study of Ageing are modelled using multistate models to investigate the relationship between frailty and social care.

Methods

Study Population:
We used data from the English Longitudinal Study of Ageing (ELSA), a nationally representative prospective cohort study of people aged 50 and over in England [19]. ELSA surveys approximately 10,000 people every two years, collecting information on demographic, socio-economic, health and lifestyle characteristics. So far, ELSA has conducted 9 waves from 2002-2019. New participants are periodically added to account for ageing and attrition. ELSA does not sample care home residents at baseline but participants who move into a care home remain eligible for subsequent

waves.

Frailty:
We constructed a frailty index using participants' responses in ELSA with sixty deficits covering mobility, chronic diseases, cognitive ability, and sensory impairment (Appendix A1). This frailty index was previously described by Maharani et al [13]. We stratified frailty index scores into three categories: robust (frailty index ≤ 0.08), prefrail (frailty index >0.08 and <0.25) and frail (frailty index ≥ 0.25) [20].

Care:
We used two primary definitions of care, the first measuring receipt of care and the second recording unmet need for care.

Receipt of care was defined as receiving any help for a range of tasks, including Activities of Daily Living (ADLs), Instrumental Activities of Daily Living (IADLs) and climbing stairs without rest (Appendix A2). Questions on receiving care associated with these activities have been included in each ELSA wave, although the questions were modified slightly after wave 6. Since wave 6, participants have been asked to only consider help received in the past month. No time period was specified in earlier waves, instead, participants were asked not to include difficulties they expected to last less than three months.

Unmet need for care is more difficult to measure. Two approaches are commonly used: self-reporting of inadequate care provision and asking older people if care is provided for each reported ADL or IADL disability [21]. Both methods have weaknesses: the former is vulnerable to self-reporting bias, while the latter may underestimate unmet care, as it does not measure the sufficiency of care provided [22, 23]. Here, we use the self-reported method, recording unmet need for care when participants said the care they received 'sometimes' or 'hardly ever' met their needs (versus 'always' or 'usually' met their needs).

Both receipt of care and unmet need for care were recorded as binary variables.

Mortality:
Participants' date of death data were obtained from three sources. A subset (21%) of ELSA participants known to have died before wave 6 is linked to end-of-life interviews which include their year of death [24]. Year of death is not provided for the remaining participants known to have died before wave 6, however, the wave of death is provided, allowing the year of death range for each participant to be narrowed down to 2-3 years. We used a uniform random distribution to assign a date of death (day and month) to each of these participants, bounded by the beginning and end of their year of death range. Year of death for participants known to have died in waves 6-9 was obtained by linking Office for National Statistics mortality data to ELSA participants. Again, the exact date of death (within the known year) was drawn from a uniform random distribution. We also used a uniform random distribution to generate dates of birth, as only the year of birth of ELSA participants is provided.

Covariates:

Frailty is not solely distributed by age and gender in the older population, with studies finding associations with socio-economic and demographic factors [9, 13, 25-27]. Four socio-economic covariates were analysed in our models: wealth, educational attainment, marital status (self-reported measures) and area deprivation (derived from participant postcode). Wealth was defined as the net total wealth of the respondent's 'benefit unit' and split into quintiles, where a benefit unit is a single adult or a married/cohabiting couple, and any dependent children. Area deprivation was categorised using the English Index of Multiple Deprivation [28] and divided into quintiles. Educational attainment was stratified into lower than secondary school, secondary school, and college or higher. Marital status was divided into married and not married.

Statistical Analysis:
The relationship between frailty and care receipt was modelled using multistate models with longitudinal data from ELSA waves 1-9. A state transition model was defined allowing individuals to move between robust, prefrail, frail and death states (Figure 1). Bidirectional transitions were possible between adjacent frailty states: robust and prefrail, and prefrail and frail. All states could unidirectionally transition to the (absorbing) death state. Individuals could also remain in the same state. Time was measured by individuals' age.

The risk of a person with a given covariate (e.g. receiving care) moving from one state to another in a given time period, compared to a person without the given covariate (e.g. does not receive care) is measured by its Hazard Ratio (HR). A hazard ratio greater than 1 indicates an increased risk of the transition occurring, whereas a hazard ratio less than 1 indicates a reduced risk of the transition occurring.

Transitions were possible during each model time step (Δt=1 month). Some participants transition from robust-to-frail or frail-to-robust in consecutive ELSA waves; the model assumes they have transitioned through the prefrail state during the time steps between waves. Although data may not be available to identify participants who transition back and forth between states multiple times between consecutive ELSA waves, the multistate model assumes these are possible when optimising the model fit.

The relationship between frailty and care receipt was investigated using age, wealth, area deprivation, and educational attainment as continuous covariates, as well as marital status as a binary covariate. For each model, one of these socio-economic covariates was univariately adjusted alongside age and one measure of care status. Separate analyses were conducted for men and women due to the well-established difference in frailty prevalence between genders and the different mortality rates [29-32]. Participants with no longitudinal data were not included. We included 15,003 unique participants over 9 waves, with 9,491 at baseline (ELSA has recruited new participants in most waves to maintain population representativeness). Model selection was conducted with the Bayesian Information Criterion (BIC). Models were fitted using the *msm* package (version 1.6.9) in R (version 4.2.1) [33, 34].

Alternative, broader definitions of receipt of care and unmet need for care were included as a sensitivity analysis. The broader definition of received care added the

use of meals on wheels and the use of a day centre in the past month. Care activities were also categorised as high or low-level care. Care for activities of daily living and meals on wheels were categorised as high-level care and help with instrumental activities of daily living, help climbing stairs without resting and use of a day centre were recorded as low-level care (Appendix A2). This was treated as an ordinal variable, with high-level care assigned a value of 2, low-level care 1, and no care 0. Questions on the use of meals on wheels and day centres were introduced to ELSA in wave 6, restricting this sensitivity analysis to waves 6-9 (2012-2019).

The broader definition of unmet need for care included participants who reported that their care 'usually', 'sometimes' or 'hardly ever' meets their needs (versus 'always' meets their needs). In the primary definition of unmet care, 'usually' was considered to mean the participant does not have an unmet need for care.

Ethics statement:
Ethical approval for all ELSA waves was obtained from the National Research and Ethics Committee. Participants gave full informed written consent to participate in the study. Separate ethical approval for the current analysis was not required.

Results

Table 1 shows the characteristics of the ELSA wave 1 (i.e., baseline) population. There was a greater proportion of women than men (55.0% vs 45.0%), with 69.6% of the baseline population aged 50-70 years. Participants were more likely to come from the least deprived area quintiles (47% in the upper two quintiles) and be married (67.6%). Educational attainment was split: 40.0% had less than a secondary school education while 43.4% had college or higher education. One in five (21.1%) received care, with 2.6% reporting unmet need for care.

Wealth was the most important covariate, providing the best fit for both the care receipt (Table 2) and unmet need for care models (Table 3), as measured by BIC. The transition hazard ratios of the care receipt and unmet need for care models, with each socio-economic covariate, are included in the Appendix (A3 and A4, respectively).

Care receipt (Table 2a) was associated with an increased risk of transitioning from robust-to-prefrail states (hazard ratio, HR, males: 2.1 [1.7-2.6], females: 1.8 [1.5-2.0]) and decreased risk of the reverse transition (males: 0.5 [0.4-0.6], females: 0.5 [0.4-0.5]). Similarly, receiving care was associated with an increased risk of transitioning from prefrail-to-frail (males: 2.6 [2.3-2.9], females: 2.3: [2.1-2.5]) and decreased risk of frail-to-prefrail (males: 0.7 [0.6-0.8], females: 0.6 [0.6-0.7]).

Unmet need for care (Table 3) was not associated with any risk of transition for females, but for males was associated with a higher risk of transitioning from prefrail-to-frail (1.7 [1.2-2.4]).

Greater wealth was associated with a lower risk of transition to greater frailty states (i.e. robust-to-prefrail and prefrail-to-frail) and with increased recovery to less frail states (i.e. frail-to-prefrail and prefrail-to-robust) in both models. The only exception

was that wealthy males with frailty were *not* more likely to recover to pre-frailty than less wealthy males in the unmet care model.

Unlike transitions to greater frailty, the risk of death is only clear in a subset of the transitions. Wealth is associated with mortality, however, care receipt and unmet need for care are not. The risk of death is reduced with increased wealth for robust males and prefrail females in the received care model. In the unmet need for care model, increased wealth is associated with reduced risk of death for robust and prefrail females, but increased risk of death for males and females with frailty.

Both receipt of care and low wealth are strongly associated with changes in frailty status (Figure 2 and Appendix A5). In nearly every instance, the risk of frailty for someone with low wealth (vs high wealth) matches the risk for someone receiving care (vs no care). The risk of increasing frailty state (or dying) is similar for individuals in the lowest wealth quintile who do not receive care, as it is for individuals in the highest wealth quintile who do receive care (Appendix A5). The single difference in frailty risk for receiving care vs not receiving care, compared to high wealth vs low wealth, is that prefrail females who receive care are less likely to recover to the robust state (Appendix A5).

The results for models with the other covariates (educational attainment, area deprivation and marital status) using the care receipt model are included in Appendix A3 (a-e). As with the wealth model, care receipt increased the risk of greater frailty and reduced the risk of decreasing frailty when the other socioeconomic covariates were considered.

After adjusting for receipt of care and age, higher educational attainment was associated with lower hazard ratios for increasing frailty and higher hazard ratios for prefrail-to-robust. It also increased the likelihood of recovery from frail-to-prefrail for females. The same associations existed for lower area deprivation and marriage. Marriage was additionally associated with a lower risk of death for robust and prefrail males, but not females.

The unmet need for care models with each socio-economic covariate are shown in Appendix A4 (a-e). Unlike receipt of care, unmet need for care is not significantly associated with many transitions in any of the models. It is associated with an increased risk of transitioning from prefrail to frail for males, an association consistent across models with the four socio-economic covariates: wealth, deprivation, education, and marriage. In the deprivation model alone, unmet need for care is also associated with reduced risk of robust-to-prefrail and prefrail-to-robust.

Focusing on the socio-economic covariates in the unmet need for care models: higher educational attainment is associated with reduced risk of frailty and increased recovery from prefrail-to-robust for males and females. It is also associated with recovery from frail-to-prefrail for females and reduced risk of death for robust and prefrail females. Lower deprivation is similarly associated with reduced risk of increased frailty and increased recovery to lower frailty states for males and females. Lower deprivation is further associated with a reduced risk of death for robust females and an increased risk of death for frail males and females. Marriage follows

the same pattern as lower deprivation, except it is not associated with recovery to lower frailty states for females, nor increased risk of death for frail males.

Sensitivity analysis

Results of multistate models with the broader definition of care receipt and unmet need for care are presented in Appendix A6 and A7. The broader definitions of care receipt (ELSA wave 6) and unmet need for care (ELSA wave 1) are shown in Appendix A9. Low-level care is required by 10.8% of ELSA wave 6 participants, and high-level care by 7.8% (Appendix A9) (these sum to a lower value than 21.1% which receive care reported in Table 1, as Table 1 reports data from ELSA wave 1). Using the broader definition of unmet need for care, 8.2% of ELSA wave 1 have unmet need for care, compared to 2.6% in the primary definition (Table 1 and Appendix A9).

The hazard ratios follow similar patterns with both definitions of received care (Appendix A6). Increased care is associated with a greater risk of increasing level of frailty and decreased risk of reducing frailty.

Comparable hazard ratios are also present with the broader definition of unmet need for care (Appendix A7). The only significant changes between the broader definition and the narrower, main definition of unmet need for care are a greater hazard ratio for frail-to-prefrail for wealthier males and a greater hazard ratio for prefrail-to-frail for females with unmet need for care.

ELSA limits the precision of participants' dates of birth and death. Precise dates of birth were randomly assigned, within the boundaries of the data provided (e.g., randomly selecting one day during a given year of birth). We confirmed that our results were not sensitive to the generated dates by regenerating the dates for five additional model fits of the best-fitting care receipt model (covariates: age, wealth, care receipt).

Year of birth was included as an additional covariate in the best-fitting care receipt model (covariates: age, wealth, care receipt, Table 2) to see whether including demographic change in populations improved model fit (Appendix A8). These models did not improve the fit (as measured by BIC), hence simpler models without birth year are favoured.

An interaction between wealth and care receipt was tested and found to be not significant.

Further models that relaxed the Markov assumption were investigated. In these models, the probability of transitioning from the current state additionally depended on whether the person had ever previously been frail or prefrail. However, the model fit did not improve.

Discussion

This longitudinal analysis, spanning 18 years of data, suggests individuals who receive care (paid or unpaid) are more susceptible to frailty and are less likely to

recover from frailty to a less frail state. Furthermore, it reveals that individuals with higher household wealth are less likely to develop frailty and have a greater likelihood of recovering to a less frail state than those with lower household wealth. Notably, household wealth outperforms other socio-economic factors such as area deprivation, education level, and marital status in predicting frailty.

The extra annual cost to the healthcare system for each older person living with frailty is estimated to be £1200-2100 (UK, 2013/14 reference costs) [16]. Furthermore, it has been estimated that the total at-home formal social care costs for England could be reduced by £4.4 million per annum (2021 costs) for every 1% of robust people who are prevented from becoming frail [15]. This study highlights two specific groups that provide an opportunity for targeted interventions to reduce the occurrence and progression of frailty: individuals with lower wealth and those who are receiving any type of care. Such interventions might, for example, include implementing physical activity interventions, either alone or in combination with nutritional interventions [35, 36]. Identifying those who start receiving care could generate the most success, as these people are least likely to have increased their level of frailty and so may benefit most from a proactive intervention. Although identifying people who receive unpaid care may be more complex than using registers of formal home care provision, identifying only those who receive paid-for care risks exacerbating health inequalities, as wealthier households may be more likely to have paid-for care.

Receiving care appears to be a greater indicator of a person's change in frailty state than having unmet need for care. Unmet need for care was not associated with any transitions for females, although it was associated with an increased risk of prefrail males progressing to frailty. It is unclear whether the few associations of unmet need for care with changing frailty state is a limitation of the survey data. The smaller number of ELSA participants reporting unmet need for care (wave 1: n=245, 2.6%) compared to receiving care (wave 1: n=1997, 21.1%) may have led to larger confidence intervals in the model output. The subjective nature of whether care needs are 'always', 'usually', 'sometimes' or 'hardly ever' met may also make it difficult to identify an underlying relationship.

Our results suggest low wealth is a significant predictor of frailty and of those less likely to recover from frailty. This is consistent with previous studies, which have found frailty prevalence is lower for those with greater wealth [13, 26] or other socio-economic advantages [5, 9, 27].

The strength of the association between wealth and changes in frailty is similar to that of receiving care (as shown in Figure 2). The associations between wealth and frailty are present for both the received care and unmet care models and are consistent between males and females.

Low wealth is also a predictor for mortality, unlike receipt of care or unmet need for care. Counter-intuitively, greater wealth was associated with greater mortality for people with frailty in the unmet need for care model. Wealth may allow people to live a greater proportion of their lives in the robust and prefrail state, which may explain the decreased time spent in the frail state.

When we considered alternative socio-economic covariates, we found a consistent pattern where greater socio-economic advantages are beneficial to frailty-free health. Lower deprivation, more education and being married are all associated with reduced risk of frailty and increased recovery to lower frailty states.

The sensitivity analysis found that using a broader definition of unmet need for care produces greater hazard ratios for the prefrail-to-frail transition for females with unmet need for care. With the broader definition, care must ‘always’ meet a person’s need for them to have no unmet need for care. This threshold may disproportionately be met for those with few needs, a set of people who may be able to remain prefrail for a longer period than those with many care needs. The absence of this distinction among males may imply a variation in how 'usually' and 'always' are interpreted by males and females.

Limitations

We drew on a large, nationally representative data set, which has recorded participant data over 18 years with detailed information about their care receipt, socio-economic and demographic factors and frailty status, however, there are limitations to the analysis. Unmet need for care is non-trivial to measure; we used a subjective measure which is vulnerable to self-reporting bias. We also do not distinguish between paid and unpaid care receipt.

Despite the size of ELSA, there are a limited number of transitions between some combinations of states, such as people who die when they are not frail. The number of ELSA participants reporting unmet need for care is also low in our main definition (2.6%). These small numbers result in large confidence intervals for some hazard ratios.

Conclusion

Our findings demonstrate that receiving care indicates increased susceptibility to frailty and identifies individuals who are less likely to experience a reduction in their level of frailty. Household wealth emerges as an equally influential factor in predicting these transitions, highlighting that the risk of frailty for low-wealth individuals who *do not* receive any care is the same as the risk for high-wealth individuals who *do* receive care. This care encompasses both unpaid and paid care. Interventions aimed at preventing frailty may be of greatest benefit to individuals who start to receive care and to those with lower levels of wealth. Unmet need for care does not appear to be strongly associated with changes in frailty, although this may be due to the small number of people reporting unmet needs.

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Table 1: Characteristics of ELSA wave 1 population			
Characteristic		**n**	**(%)**
All		9491	
Gender			
	Male	4268	45.0
	Female	5223	55.0
Age			
	50-54	1801	19.0
	55-59	1880	19.8
	60-64	1466	15.4
	65-69	1460	15.4
	70-74	1209	12.7
	75-79	859	9.1
	80-84	593	6.2
	85-89	209	2.2
	90+	14	0.1
Deprivation quintile			
	1 (Most)	1362	14.4
	2	1735	18.3
	3	1935	20.4
	4	2227	23.5
	5 (Least)	2232	23.5
Marital status			
	Not married	3071	32.4
	Married	6418	67.6
Education			
	Lower than secondary school	3797	40.0
	Secondary school	1574	16.6
	College or higher	4120	43.4
Wealth quintile			
	1 (Least)	1749	18.7
	2	1772	19.0
	3	1851	19.8
	4	1950	20.9
	5 (Most)	2009	21.5
Receipt of care			
	No	7488	78.9
	Yes	1997	21.1
Unmet need for care			
	No	9,241	97.4
	Yes	245	2.6

Table 2: State transition hazard ratios and 95% confidence intervals [CI] for receipt of care, wealth and age covariates. Results are split by gender. Wealth is categorised into quintiles, with quintile 1 being the least wealthy. It was not possible to accurately constrain the robust-death transition for males in receipt of care due to the small number of recorded transitions.

Male	**Age [CI]**	**Receive care [CI]**	**Wealth [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	2.09 [1.70-2.58]	0.87 [0.85-0.90]
Robust–Death	1.007 [1.005-1.009]	0.17 [-]	0.81 [0.70-0.94]
Prefrail–Robust	0.997 [0.996-0.997]	0.47 [0.39-0.55]	1.16 [1.13-1.20]
Prefrail–Frail	1.003 [1.003-1.004]	2.56 [2.27-2.90]	0.82 [0.78-0.85]
Prefrail–Death	1.007 [1.006-1.008]	1.10 [0.84-1.45]	0.95 [0.88-1.04]
Frail–Prefrail	0.999 [0.999-1.000]	0.65 [0.55-0.77]	1.08 [1.01-1.16]
Frail–Death	1.005 [1.005-1.006]	1.04 [0.86-1.26]	1.02 [0.96-1.09]
Female			
Robust–Prefrail	1.003 [1.003-1.004]	1.75 [1.50-2.04]	0.88 [0.86-0.90]
Robust–Death	1.008 [1.006-1.010]	0.88 [0.14-5.59]	0.97 [0.81-1.16]
Prefrail–Robust	0.996 [0.996-0.996]	0.48 [0.42-0.54]	1.12 [1.09-1.15]
Prefrail–Frail	1.003 [1.003-1.004]	2.26 [2.05-2.48]	0.83 [0.80-0.86]
Prefrail–Death	1.009 [1.008-1.010]	1.17 [0.87-1.57]	0.84 [0.76-0.94]
Frail–Prefrail	0.999 [0.998-0.999]	0.64 [0.56-0.74]	1.18 [1.12-1.24]
Frail–Death	1.006 [1.005-1.006]	1.13 [0.92-1.40]	1.01 [0.95-1.07]

Table 3: State transition hazard ratios and 95% confidence intervals [CI] for unmet need for care, wealth and age covariates. Results are split by gender. Wealth is categorised into quintiles, with quintile 1 being the least wealthy.

Male	**Age [CI]**	**Unmet care [CI]**	**Wealth [CI]**
Robust–Prefrail	1.005 [1.004-1.005]	0.76 0.45-1.29	0.87 0.85-0.90
Robust–Death	1.005 [0.998-1.012]	1.01 0.12-8.74	0.43 0.14-1.35
Prefrail–Robust	0.997 [0.996-0.997]	0.78 0.46-1.32	1.18 1.14-1.22
Prefrail–Frail	1.004 [1.004-1.005]	1.71 1.21-2.42	0.83 0.80-0.87
Prefrail–Death	1.002 [0.999-1.004]	1.03 0.85-1.24	1.01 0.80-1.27
Frail–Prefrail	0.998 [0.998-0.999]	1.02 0.94-1.10	1.05 0.98-1.12
Frail–Death	1.004 [1.003-1.004]	1.00 0.96-1.03	1.10 1.04-1.17
Female			
Robust–Prefrail	1.003 [1.003-1.004]	0.78 0.58-1.06	0.88 0.86-0.90
Robust–Death	1.004 [1.001-1.007]	1.03 0.05-20.4	0.76 0.62-0.93
Prefrail–Robust	0.996 [0.995-0.996]	0.78 0.58-1.06	1.13 1.10-1.16
Prefrail–Frail	1.004 [1.004-1.004]	1.00 0.97-1.03	0.84 0.82-0.87
Prefrail–Death	1.007 [1.003-1.011]	1.05 0.06-17.0	0.37 0.16-0.88
Frail–Prefrail	0.998 [0.998-0.999]	1.01 0.97-1.05	1.15 1.10-1.21
Frail–Death	1.004 [1.004-1.005]	0.99 0.98-1.01	1.13 1.08-1.18

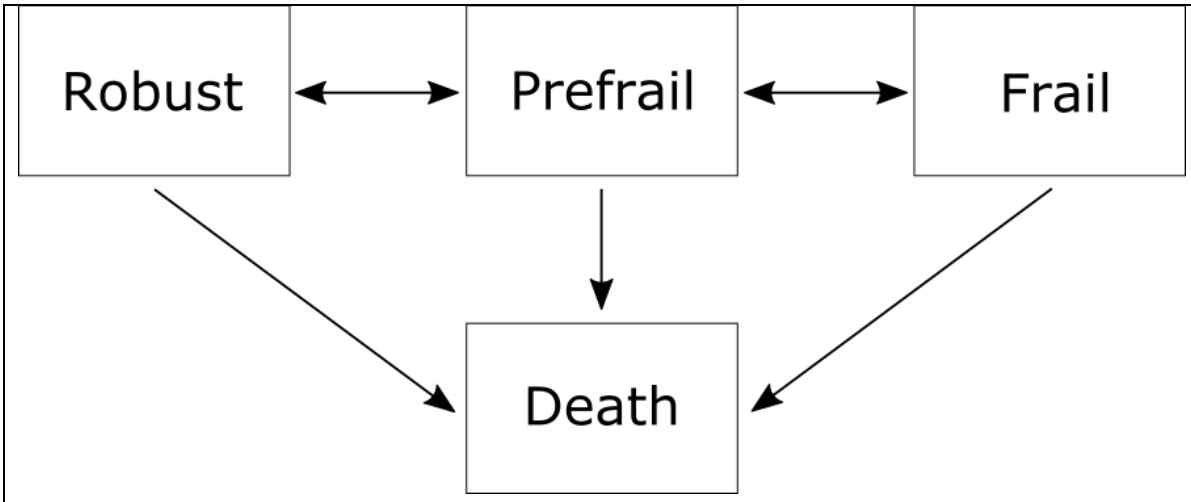

Figure 1: State transition diagram for all models. ELSA participants are tracked transitioning between the frailty states and death to determine the risk of each state transition. Socio-economic and demographic covariates adjusted the risk of transitioning between states.

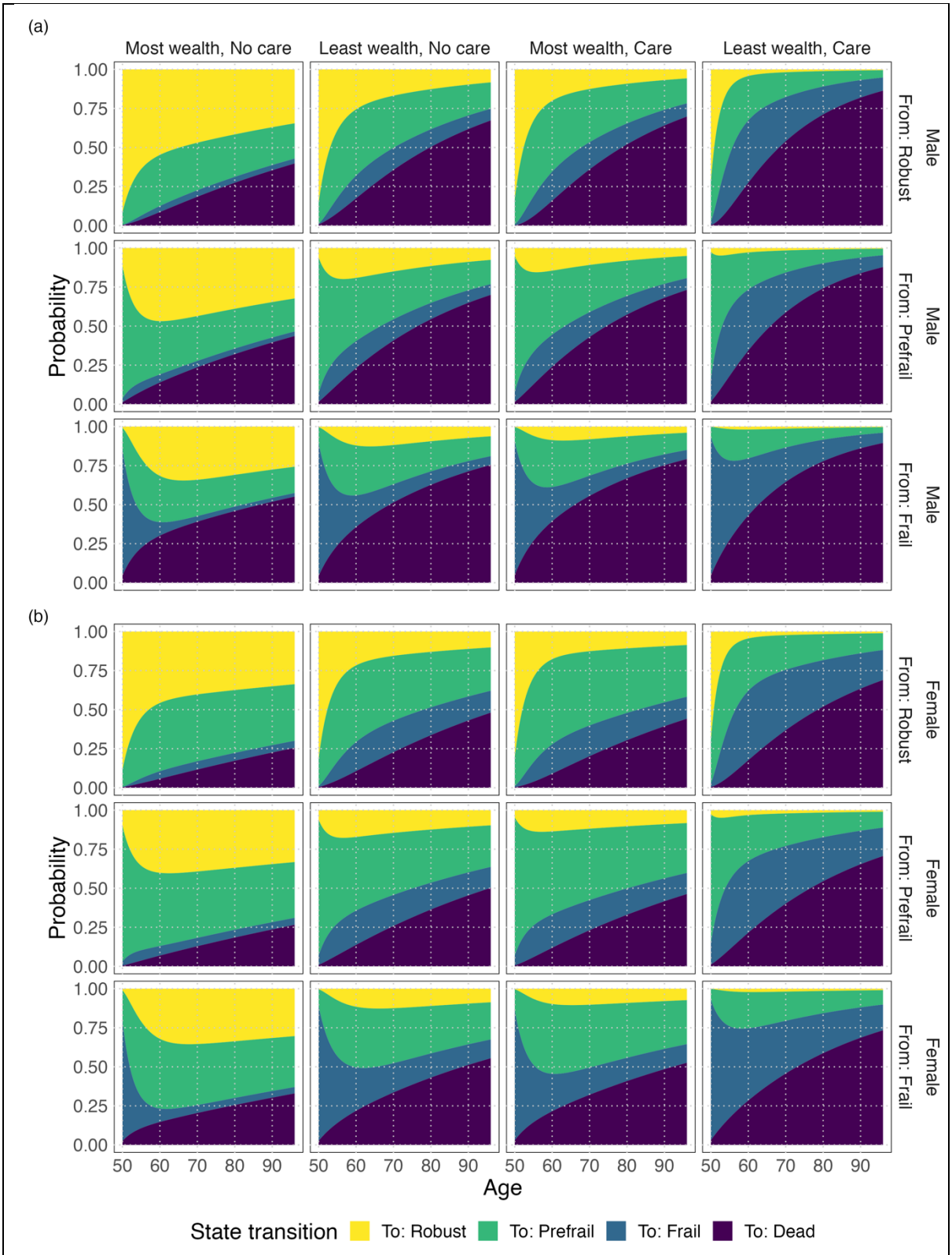

Figure 2: Transition probabilities from each frailty state to each frailty state and death from age 50-100 for (a) males and (b) females. Probabilities are categorised by wealth quintile and whether a person receives care. Plot created with the msm.stacked R package [37].

Appendix

A1 Frailty index deficits

Deficits correspond to those in Supplementary Table 1 of Maharani et al [38].

Description
1. Difficulty with walking 100 yards
2. Difficulty sitting for about two hours
3. Difficulty getting up from a chair after sitting for long periods
4. Difficulty climbing several flights of stairs without resting
5. Difficulty climbing one flight of stairs without resting
6. Difficulty stooping, kneeling, or crouching
7. Difficulty reaching or extending arms above shoulder level
8. Difficulty pulling or pushing large objects like a living room chair
9. Difficulty lifting or carrying weights over 10 pounds, like a heavy bag
10. Difficulty picking up a 5p coin from a table
11. Difficulty dressing, including putting on shoes and socks
12. Difficulty walking across a room
13. Difficulty bathing or showering
14. Difficulty eating, such as cutting up your food
15. Difficulty getting in or out of bed
16. Difficulty using the toilet, including getting up or down
17. Difficulty using a map to figure out how to get around in a strange place
18. Difficulty preparing a hot meal
19. Difficulty shopping for groceries
20. Difficulty making telephone calls
21. Difficulty taking medications
22. Difficulty managing money, (e.g. paying bills and keeping track of expenses)
23. Difficulty doing work around the house or garden
24. Self-reported general health
25. Whether respondent has felt depressed much of the time during the past week
26. Whether respondent felt everything they did during the past week was an effort
27. Whether respondent felt their sleep was restless much of the time during the past week
28. Whether respondent was happy much of the time during the past week
29. Whether respondent felt lonely much of the time during the past week
30. Whether the respondent enjoyed life much of the time during the past week
31. Whether respondent felt sad much of the time during the past week
32. Whether respondent could not get going much of the time during the past week
33. High blood pressure or hypertension (self-reported)
34. Angina (self-reported)
35. Heart attack (including MI or coronary thrombosis) (self-reported)
36. Congestive heart failure (self-reported)
37. An abnormal heart rhythm (self-reported)
38. Diabetes or high blood sugar (self-reported)
39. A stroke (cerebral vascular disease) (self-reported)
40. Chronic lung disease such as chronic bronchitis or emphysema (self-reported)
41. Asthma (self-reported)
42. Arthritis (including osteoarthritis, or rheumatism) (self-reported)
43. Osteoporosis, sometimes called thin or brittle bones (self-reported)
44. Cancer or a malignant tumour (excluding minor skin cancers) (self-reported)
45. Parkinson's disease (self-reported)
46. Any emotional, nervous or psychiatric problems (self-reported)
47. Alzheimer's disease (self-reported)

48. Dementia, organic brain syndrome, senility or any other serious memory impairment (self-reported)
49. Self-reported eyesight function (while using lenses, if appropriate)
50. Self-reported hearing function (while using hearing aid if appropriate)
51. Whether respondent has fallen down at all /last year /last 2 years
52. Whether respondent has fractured hip ever /in last 2 years
53. Whether respondent has had joint replacement ever
54. Whether respondent has had any pain whilst walking
55. Identify today's date: day of month
56. Identify today's date: month
57. Identify today's date: year
58. Identify the day of the week
59. Immediate word recall (sample organized into quartiles)
60. Delayed word recall (sample organized into quintiles)

A2 Variables used in the definition of Received Care

Variables used in the definition of received care for the main analysis and sensitivity analysis. The main analysis treats received care as a binary variable, while the sensitivity analysis models it as a continuous variable with values 0-2. The value of the sensitivity analysis column relates to the level of care (no care = 0; low-level = 1; high-level = 2). ADL: Activity of Daily Living, IADL: Instrumental Activity of Daily Living. Meals on wheels and the use of a day centre are not considered ADLs or IADLs.

Care type	**ADL/IADL**	**Main analysis**	**Sensitivity analysis**
Using the toilet, including getting up or down	ADL	Yes	2
Getting in and out of bed	ADL	Yes	2
Eating, such as cutting up food	ADL	Yes	2
Bathing or shower	ADL	Yes	2
Walking across a room	ADL	Yes	2
Dressing, including putting on shoes and socks	ADL	Yes	2
Shopping for groceries	IADL	Yes	1
Doing work around the house or garden	IADL	Yes	1
Managing money, such as paying bills and keeping track of expenses	IADL	Yes	1
Climbing several flights of stairs without resting	IADL	Yes	1
Climbing one flight of stairs without resting	IADL	Yes	1
Taking medication	IADL	Yes	1
Walking 100 yards	IADL	Yes	1
Meals on wheels	-	No	2
Day centre	-	No	1
Did not receive care	-	No	0

A3 Results of care receipt models with each set of covariates

Table A3a: Transition hazard ratios of the receipt of care model, covariates: age and receipt of care. Bayesian Information Criterion (BIC): 51 550 (Male), 63 226 (Female). CI: 95% Confidence interval.

Male	**Age [CI]**	**Receive care [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	2.09 [1.70-2.57]
Robust–Death	1.007 [1.005-1.009]	0.36 [0.00-50.3]
Prefrail–Robust	0.997 [0.997-0.998]	0.44 [0.37-0.52]
Prefrail–Frail	1.003 [1.003-1.004]	2.66 [2.36-3.00]
Prefrail–Death	1.007 [1.006-1.008]	1.12 [0.84-1.50]
Frail–Prefrail	0.999 [0.999-1.000]	0.67 [0.57-0.80]
Frail–Death	1.005 [1.005-1.006]	0.91 [0.76-1.08]
Female		
Robust–Prefrail	1.003 [1.003-1.004]	1.79 [1.53-2.08]
Robust–Death	1.008 [1.006-1.010]	0.69 [0.07-6.29]
Prefrail–Robust	0.996 [0.996-0.997]	0.48 [0.43-0.54]
Prefrail–Frail	1.003 [1.003-1.004]	2.24 [2.05-2.46]
Prefrail–Death	1.009 [1.007-1.010]	1.38 [1.02-1.86]
Frail–Prefrail	0.999 [0.998-0.999]	0.69 [0.61-0.79]
Frail–Death	1.006 [1.005-1.006]	0.86 [0.73-1.01]

Table A3b: Transition hazard ratios of the receipt of care model, covariates: age, receipt of care, wealth. Wealth is categorised into quintiles, with quintile 1 being the least wealthy. It was not possible to accurately constrain the 95% confidence interval of robust-death for males due to a low number of transitions. Bayesian Information Criterion: 50 164 (Male) 61 117 (Female). CI: 95% Confidence interval.

Male	**Age [CI]**	**Receive care [CI]**	**Wealth [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	2.09 [1.70-2.58]	0.87 [0.85-0.90]
Robust–Death	1.007 [1.005-1.009]	0.17 [-]	0.81 [0.70-0.94]
Prefrail–Robust	0.997 [0.996-0.997]	0.47 [0.39-0.55]	1.16 [1.13-1.20]
Prefrail–Frail	1.003 [1.003-1.004]	2.56 [2.27-2.90]	0.82 [0.78-0.85]
Prefrail–Death	1.007 [1.006-1.008]	1.10 [0.84-1.45]	0.95 [0.88-1.04]
Frail–Prefrail	0.999 [0.999-1.000]	0.65 [0.55-0.77]	1.08 [1.01-1.16]
Frail–Death	1.005 [1.005-1.006]	1.04 [0.86-1.26]	1.02 [0.96-1.09]
Female			
Robust–Prefrail	1.003 [1.003-1.004]	1.75 [1.50-2.04]	0.88 [0.86-0.90]
Robust–Death	1.008 [1.006-1.010]	0.88 [0.14-5.59]	0.97 [0.81-1.16]
Prefrail–Robust	0.996 [0.996-0.996]	0.48 [0.42-0.54]	1.12 [1.09-1.15]
Prefrail–Frail	1.003 [1.003-1.004]	2.26 [2.05-2.48]	0.83 [0.80-0.86]
Prefrail–Death	1.009 [1.008-1.010]	1.17 [0.87-1.57]	0.84 [0.76-0.94]
Frail–Prefrail	0.999 [0.998-0.999]	0.64 [0.56-0.74]	1.18 [1.12-1.24]
Frail–Death	1.006 [1.005-1.006]	1.13 [0.92-1.40]	1.01 [0.95-1.07]

Table A3c: Transition hazard ratios of the receipt of care model, covariates: age, receipt of care, education. Education is split into three ordered categories: lower than secondary school (0), secondary school (1), and college or higher (2). BIC: 51 493 (Male), 63 151 (Female). CI: 95% Confidence interval. It was not possible to accurately constrain the robust-death transition for males in receipt of care due to the small number of recorded transitions.

Male	**Age [CI]**	**Receive care [CI]**	**Education [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	2.08 [1.69-2.56]	0.89 [0.86-0.93]
Robust–Death	1.007 [1.005-1.009]	0.26 [-]	1.07 [0.82-1.38]
Prefrail–Robust	0.997 [0.997-0.998]	0.46 [0.38-0.54]	1.18 [1.12-1.24]
Prefrail–Frail	1.003 [1.003-1.004]	2.62 [2.32-2.95]	0.86 [0.81-0.92]
Prefrail–Death	1.007 [1.006-1.008]	1.14 [0.86-1.51]	0.89 [0.79-1.01]
Frail–Prefrail	0.999 [0.999-1.000]	0.67 [0.57-0.79]	1.00 [0.92-1.09]
Frail–Death	1.005 [1.005-1.006]	0.91 [0.77-1.09]	0.99 [0.91-1.07]
Female			
Robust–Prefrail	1.003 [1.003-1.003]	1.77 [1.52-2.06]	0.89 [0.86-0.93]
Robust–Death	1.008 [1.005-1.010]	0.72 [0.08-6.11]	0.76 [0.58-1.00]
Prefrail–Robust	0.996 [0.996-0.997]	0.48 [0.43-0.55]	1.09 [1.04-1.14]
Prefrail–Frail	1.003 [1.003-1.004]	2.23 [2.03-2.44]	0.85 [0.81-0.90]
Prefrail–Death	1.009 [1.007-1.010]	1.40 [1.04-1.90]	0.89 [0.76-1.05]
Frail–Prefrail	0.999 [0.998-0.999]	0.70 [0.61-0.80]	1.09 [1.02-1.17]
Frail–Death	1.006 [1.005-1.006]	0.85 [0.73-1.01]	0.95 [0.88-1.03]

Table A3d: Transition hazard ratios of the receipt of care model, covariates: age, receipt of care, area deprivation. Area deprivation is categorised as quintiles, with quintile 1 being the most deprived. BIC: 51 237 (Male), 62 926 (Female). CI (95% Confidence interval).

Male	**Age [CI]**	**Receive care [CI]**	**Deprivation [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	2.10 [1.70-2.58]	0.91 [0.89-0.94]
Robust–Death	1.007 [1.005-1.009]	0.59 [0.03-12.03]	0.74 [0.63-0.87]
Prefrail–Robust	0.997 [0.997-0.997]	0.45 0.38-0.54]	1.15 [1.11-1.19]
Prefrail–Frail	1.003 [1.003-1.004]	2.61 [2.31-2.94]	0.87 [0.83-0.90]
Prefrail–Death	1.007 [1.006-1.008]	1.13 [0.85-1.50]	0.97 [0.90-1.06]
Frail–Prefrail	0.999 [0.999-1.000]	0.67 [0.56-0.79]	1.05 [0.99-1.11]

Frail–Death	1.005 [1.005-1.006]	0.91 [0.77-1.09]	1.00 [0.95-1.06]
Female			
Robust–Prefrail	1.003 [1.003-1.004]	1.76 1.51-2.05	0.92 0.89-0.94
Robust–Death	1.008 [1.006-1.010	0.73 0.10-5.28	0.84 0.71-1.01
Prefrail–Robust	0.996 [0.996-0.996]	0.48 0.43-0.55	1.10 1.07-1.14
Prefrail–Frail	1.003 [1.003-1.004	2.21 2.02-2.43	0.89 0.86-0.92
Prefrail–Death	1.009 [1.008-1.010]	1.35 1.01-1.81	0.97 0.88-1.08
Frail–Prefrail	0.998 [0.998-0.999]	0.69 0.60-0.79	1.11 1.06-1.16
Frail–Death	1.006 [1.005-1.006]	0.88 0.75-1.03	0.96 0.91-1.01

Table A3e: Transition hazard ratios of the receipt of care model, covariates: age, receipt of care, marital status. Marital status is categorised as married (=1) or not married (=0). BIC: 51 501 (Male), 63 188 (Female). CI (95% Confidence interval). It was not possible to accurately constrain the robust-death transition for males in receipt of care due to the small number of recorded transitions.

Male	**Age [CI]**	**Receive care [CI]**	**Marital status [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	2.13 [1.73-2.62]	0.84 [0.77-0.91]
Robust–Death	1.007 [1.005-1.009]	0.41 [-]	0.57 [0.37-0.88]
Prefrail–Robust	0.997 [0.997-0.998]	0.44 [0.37-0.52]	1.29 [1.16-1.44]
Prefrail–Frail	1.003 [1.003-1.004]	2.69 [2.39-3.04]	0.75 [0.66-0.84]
Prefrail–Death	1.007 [1.006-1.008]	1.14 [0.85-1.52]	0.74 [0.58-0.94]
Frail–Prefrail	0.999 [0.999-1.000]	0.67 [0.56-0.79]	1.03 [0.87-1.23]
Frail–Death	1.005 [1.005-1.006]	0.91 [0.77-1.09]	0.93 [0.80-1.08]
Female			
Robust–Prefrail	1.003 [1.003-1.003]	1.81 [1.56-2.11]	0.85 0.79-0.91
Robust–Death	1.008 [1.005-1.010]	0.71 [0.08-6.58]	0.68 0.42-1.09
Prefrail–Robust	0.996 [0.996-0.997]	0.48 [0.42-0.54]	1.13 1.03-1.23
Prefrail–Frail	1.003 [1.003-1.003]	2.26 [2.06-2.48]	0.77 0.70-0.84
Prefrail–Death	1.008 [1.007-1.010]	1.40 [1.03-1.90]	0.76 0.55-1.05
Frail–Prefrail	0.999 [0.998-0.999]	0.68 [0.59-0.77]	1.15 1.01-1.31
Frail–Death	1.006 [1.005-1.007]	0.84 [0.72-1.00]	1.13 0.97-1.33

A4 Results of unmet need for care models with each set covariates

Table A4a: Transition hazard ratios of the unmet need for care model, covariates: age, unmet need for care. It was not possible to accurately constrain the 95% confidence interval of robust-death for females due to a low number of transitions. BIC: 45 140 (Male), 57 079 (Female). CI (95% Confidence interval).

Male	**Age [CI]**	**Unmet care [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	0.94 [0.58-1.51]
Robust–Death	1.007 [1.006-1.009]	1.01 [0.66-1.55]
Prefrail–Robust	0.997 [0.997-0.998]	0.96 [0.60-1.54]
Prefrail–Frail	1.004 [1.004-1.005]	1.14 [0.72-1.81]
Prefrail–Death	1.003 [1.001-1.004]	1.03 [0.88-1.20]
Frail–Prefrail	0.999 [0.998-0.999]	1.01 [0.96-1.07]
Frail–Death	1.005 [1.004-1.005]	1.00 [0.96-1.05]
Female		

Robust–Prefrail	1.003 [1.003-1.004]	0.75 [0.56-1.00]
Robust–Death	1.006 [1.003-1.009]	1.04 [-]
Prefrail–Robust	0.996 [0.996-0.996]	0.75 [0.56-1.00]
Prefrail–Frail	1.004 [1.004-1.005]	0.99 [0.97-1.01]
Prefrail–Death	1.003 [1.001-1.006]	1.09 [0.20-6.02]
Frail–Prefrail	0.998 [0.998-0.999]	1.00 [0.97-1.04]
Frail–Death	1.005 [1.004-1.005]	1.00 [0.98-1.01]

Table A4b: Transition hazard ratios of the unmet care model, covariates: age, unmet need for care, wealth. Wealth is split into five quintiles, with quintile 1 being the least wealthy. BIC: 43 818 (Male), 55 392 (Female). CI (95% Confidence interval).

Male	**Age [CI]**	**Unmet care [CI]**	**Wealth [CI]**
Robust–Prefrail	1.005 [1.004-1.005]	0.76 [0.45-1.29]	0.87 [0.85-0.90]
Robust–Death	1.005 [0.998-1.012]	1.01 [0.12-8.74]	0.43 [0.14-1.35]
Prefrail–Robust	0.997 [0.996-0.997]	0.78 [0.46-1.32]	1.18 [1.14-1.22]
Prefrail–Frail	1.004 [1.004-1.005]	1.71 [1.21-2.42]	0.83 [0.80-0.87]
Prefrail–Death	1.002 [0.999-1.004]	1.03 [0.85-1.24]	1.01 [0.80-1.27]
Frail–Prefrail	0.998 [0.998-0.999]	1.02 [0.94-1.10]	1.05 [0.98-1.12]
Frail–Death	1.004 [1.003-1.004]	1.00 [0.96-1.03]	1.10 [1.04-1.17]
Female			
Robust–Prefrail	1.003 [1.003-1.004]	0.78 [0.58-1.06]	0.88 [0.86-0.90]
Robust–Death	1.004 [1.001-1.007]	1.03 [0.05-20.4]	0.76 [0.62-0.93]
Prefrail–Robust	0.996 [0.995-0.996]	0.78 [0.58-1.06]	1.13 [1.10-1.16]
Prefrail–Frail	1.004 [1.004-1.004]	1.00 [0.97-1.03]	0.84 [0.82-0.87]
Prefrail–Death	1.007 [1.003-1.011]	1.05 [0.06-17.0]	0.37 [0.16-0.88]
Frail–Prefrail	0.998 [0.998-0.999]	1.01 [0.97-1.05]	1.15 [1.10-1.21]
Frail–Death	1.004 [1.004-1.005]	0.99 [0.98-1.01]	1.13 [1.08-1.18]

Table A4c: Transition hazard ratios of the unmet need for care model, other covariates: age, education. Education is split into lower than secondary school, secondary school and college or higher. BIC: 44 917 (Male), 56 980 (Female). CI (95% Confidence interval). It was not possible to accurately constrain the robust-death transition for females with unmet need for care due to the small number of recorded transitions.

Male	**Age [CI]**	**Unmet care [CI]**	**Education [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	0.75 [0.46-1.24]	0.90 [0.86-0.94]
Robust–Death	1.005 [1.001-1.009]	1.02 [0.25-4.21]	0.54 [0.09-3.10]
Prefrail–Robust	0.997 [0.997-0.998]	0.77 [0.47-1.26]	1.21 [1.15-1.28]
Prefrail–Frail	1.004 [1.003-1.004]	1.80 [1.28-2.52]	0.84 [0.78-0.91]
Prefrail–Death	1.001 [0.998-1.004]	1.03 [0.82-1.28]	0.96 [0.38-2.41]
Frail–Prefrail	0.999 [0.998-0.999]	1.02 [0.94-1.10]	1.00 [0.91-1.10]

Frail–Death	1.004	[1.003-1.004]	1.01	[0.95-1.08]	1.02	[0.92-1.13]
Female						
Robust–Prefrail	1.003	[1.003-1.004]	0.76	[0.57-1.02]	0.89	[0.86-0.92]
Robust–Death	1.004	[1.001-1.007]	1.04	[-]	0.61	[0.43-0.88]
Prefrail–Robust	0.996	[0.996-0.996]	0.77	[0.58-1.02]	1.10	[1.05-1.15]
Prefrail–Frail	1.004	[1.004-1.004]	1.00	[0.98-1.02]	0.86	[0.82-0.90]
Prefrail–Death	1.003	[1.001-1.006]	1.34	[0.27-6.59]	0.51	[0.32-0.80]
Frail–Prefrail	0.998	[0.998-0.999]	1.01	[0.97-1.04]	1.11	[1.04-1.19]
Frail–Death	1.005	[1.004-1.005]	1.00	[0.98-1.01]	1.01	[0.95-1.08]

Table A4d: Transition hazard ratios of the unmet need for care model, other covariates: age, area deprivation. Area deprivation is split into five quintiles, with quintile 1 being the most deprived. 44 686 (Male), 56 744 (Female). CI (95% Confidence interval).

Male	**Age [CI]**	**Unmet care [CI]**	**Deprivation [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	0.75 [0.45-1.28]	0.91 [0.89-0.94]
Robust–Death	1.002 [0.996-1.008]	1.01 [0.06-17.16]	0.45 [0.15-1.40]
Prefrail–Robust	0.997 [0.996-0.997]	0.78 [0.46-1.31]	1.16 [1.12-1.21]
Prefrail–Frail	1.004 [1.004-1.005]	1.77 [1.27-2.48]	0.88 [0.84-0.92]
Prefrail–Death	1.001 [0.999-1.004]	1.02 [0.86-1.23]	0.95 [0.69-1.31]
Frail–Prefrail	0.998 [0.998-0.999]	1.02 [0.94-1.10]	1.03 [0.97-1.09]
Frail–Death	1.004 [1.003-1.004]	1.00 [0.97-1.03]	1.07 [1.01-1.13]
Female			
Robust–Prefrail	1.003 [1.003-1.004]	0.74 [0.55-0.98]	0.92 [0.90-0.94]
Robust–Death	1.002 [0.999-1.006]	1.03 [0.12-8.78]	0.68 [0.54-0.86]
Prefrail–Robust	0.996 [0.995-0.996]	0.74 [0.55-0.98]	1.11 [1.08-1.14]
Prefrail–Frail	1.004 [1.004-1.005]	1.02 [0.98-1.05]	0.89 [0.87-0.92]
Prefrail–Death	1.003 [0.996-1.010]	1.05 [0.01-141]	0.27 [0.04-1.98]
Frail–Prefrail	0.998 [0.998-0.998]	1.01 [0.97-1.05]	1.11 [1.06-1.15]
Frail–Death	1.004 [1.004-1.005]	0.99 [0.98-1.01]	1.05 [1.01-1.09]

Table A4e: Transition hazard ratios of the unmet need for care model, other covariates: age, marital status. Marital status is categorised as married (=1) or not married (=0). BIC: 44 990 (Male), 57 062 (Female). CI (95% Confidence interval).

Male	**Age [CI]**	**Unmet care [CI]**	**Marital status [CI]**
Robust–Prefrail	1.004 [1.004-1.005]	0.76 [0.46-1.26]	0.84 [0.77-0.92]
Robust–Death	1.004 [0.998-1.011]	1.02 [0.39-2.66]	0.46 [0.08-2.71]
Prefrail–Robust	0.997 [0.997-0.997]	0.78 [0.48-1.28]	1.26 [1.13-1.41]
Prefrail–Frail	1.004 [1.003-1.004]	1.76 [1.26-2.45]	0.80 [0.70-0.93]
Prefrail–Death	1.001 [0.996-1.006]	1.03 [0.82-1.29]	0.69 [0.10-4.73]
Frail–Prefrail	0.999 [0.998-0.999]	1.00 [0.96-1.04]	0.92 [0.77-1.10]
Frail–Death	1.004 [1.003-1.004]	1.01 [0.96-1.07]	1.01 [0.84-1.21]
Female			

Robust–Prefrail	1.003 [1.003-1.003]	0.75 [0.56-1.01]	0.85 [0.80-0.91]
Robust–Death	1.005 [1.002-1.008]	1.03 [0.02-43.8]	0.62 [0.32-1.20]
Prefrail–Robust	0.996 [0.996-0.996]	0.76 [0.56-1.01]	1.07 [0.98-1.16]
Prefrail–Frail	1.004 [1.004-1.004]	1.01 [0.98-1.03]	0.81 [0.75-0.88]
Prefrail–Death	1.003 [1.000-1.005]	1.04 [0.17-6.44]	0.49 [0.24-0.98]
Frail–Prefrail	0.998 [0.998-0.999]	1.01 [0.97-1.06]	1.04 [0.92-1.18]
Frail–Death	1.005 [1.004-1.005]	1.00 [0.98-1.01]	1.17 [1.03-1.33]

Appendix A5: Comparison of care receipt and wealth

Table A5: (a) Comparison of hazard ratios between (i) care receipt versus no care receipt and (ii) the wealthiest versus the least wealthy quintile. Note that the hazard ratio for the wealth quintiles is inverted compared to other hazard ratios in this manuscript (which show wealthier quintiles relative to less wealthy quintiles) to facilitate comparison with the care receipt hazard ratios. It was not possible to accurately constrain the 95% confidence interval of robust-death for males due to a low number of transitions. CI: 95% Confidence Interval.

Male	**Receive care vs No care [CI]**	**Least wealth vs Most wealth [CI]**
Robust–Prefrail	2.09 [1.70-2.58]	1.73 [1.56-1.93]
Robust–Death	0.17 [-]	2.32 [1.40-5.35]
Prefrail–Robust	0.47 [0.39-0.55]	0.54 [0.48-0.63]
Prefrail–Frail	2.56 [2.27-2.90]	2.25 [1.90-2.74]
Prefrail–Death	1.10 [0.84-1.45]	1.20 [0.89-1.76]
Frail–Prefrail	0.65 [0.55-0.77]	0.73 [0.57-0.98]
Frail–Death	1.04 [0.86-1.26]	0.94 [0.76-1.16]
Female		
Robust–Prefrail	1.75 [1.50-2.04]	1.65 [1.50-1.83]
Robust–Death	0.88 [0.14-5.59]	1.13 [0.64-3.22]
Prefrail–Robust	0.48 [0.42-0.54]	0.63 [0.56-0.71]
Prefrail–Frail	2.26 [2.05-2.48]	2.15 [1.87-2.52]
Prefrail–Death	1.17 [0.87-1.57]	1.98 [1.37-3.33]
Frail–Prefrail	0.64 [0.56-0.74]	0.52 [0.43-0.65]
Frail–Death	1.13 [0.92-1.40]	0.98 [0.78-1.29]

Appendix A6: Sensitivity analysis for receipt of care definition

Table A6: Sensitivity analysis for receipt of care definition. Transition hazard ratios provided. The broader definition additionally includes the use of meals on wheels and the use of a day centre in the past month (a). Receipt of care is split into three ordinal categories indicating level of care: none, low-level and high-level (c.f. No or Yes used in the main definition). Results are split by gender. This analysis is modelled on ELSA waves 6-9 only, as this data is not available for earlier waves. To allow comparison with the main definition of care receipt (responses: no or yes), hazard ratios using main definition with waves 6-9 only are also provided (b). It was not possible to accurately constrain the robust-death in receipt of care due to the small number of recorded transitions. CI: 95% Confidence Interval.

a: Receipt of care: none, low-level, high-level.

	Male		Female	
Transition	**Level of care [CI]**	**Wealth [CI]**	**Level of care [CI]**	**Wealth [CI]**
Robust–Prefrail	1.48 [1.11-1.97]	0.87 [0.83-0.91]	1.35 [1.04-1.75]	0.88 [0.84-0.92]
Robust–Death	1.60 [0.24-10.7]	0.97 [0.70-1.35]	0.32 [0.00-23.5]	0.94 [0.70-1.28]
Prefrail–Robust	0.55 [0.43-0.70]	1.20 [1.13-1.27]	0.45 [0.37-0.55]	1.15 [1.10-1.21]
Prefrail–Frail	1.72 [1.51-1.96]	0.83 [0.76-0.89]	2.00 [1.79-2.23]	0.83 [0.78-0.88]
Prefrail–Death	1.06 [0.77-1.46]	0.82 [0.71-0.95]	0.87 [0.57-1.33]	0.88 [0.75-1.03]
Frail–Prefrail	0.60 [0.50-0.71]	1.18 [1.05-1.33]	0.59 [0.51-0.69]	1.22 [1.12-1.33]
Frail–Death	1.31 [1.07-1.59]	1.06 [0.96-1.18]	1.79 [1.45-2.21]	0.99 [0.89-1.10]

b: Receipt of care: No or Yes.

	Male		Female	
Transition	**Received care [CI]**	**Wealth [CI]**	**Received care [CI]**	**Wealth [CI]**
Robust–Prefrail	1.93 [1.11-3.34]	0.87 [0.83-0.91]	1.68 [1.13-2.51]	0.88 [0.84-0.92]
Robust–Death	0.70 [-]	0.97 [0.69-1.37]	0.15 [-]	0.94 [0.69-1.27]
Prefrail–Robust	0.38 [0.25-0.56]	1.20 [1.13-1.27]	0.33 [0.25-0.44]	1.15 [1.09-1.21]
Prefrail–Frail	2.58 [2.07-3.22]	0.82 [0.76-0.89]	2.74 [2.33-3.23]	0.82 [0.77-0.87]
Prefrail–Death	1.02 [0.56-1.85]	0.83 [0.72-0.96]	0.84 [0.43-1.65]	0.88 [0.74-1.05]
Frail–Prefrail	0.45 [0.33-0.60]	1.17 [1.04-1.32]	0.51 [0.41-0.64]	1.21 [1.11-1.31]
Frail–Death	1.40 [0.96-2.05]	1.06 [0.95-1.17]	1.83 [1.22-2.73]	0.99 [0.90-1.10]

Appendix A7: Sensitivity analysis for unmet need for care definition

Table A7: Sensitivity analysis for unmet need for care definition. Transition hazard ratios provided. In this alternative, broader definition (a), unmet care need is where older people who report that their care 'hardly ever', 'sometimes' or 'usually' meets their needs are considered to have unmet need for care. In the main analysis, (b), a person who reported that their care 'usually' meets their needs was not considered to have an unmet need. Results are split by gender. CI: 95% Confidence Interval.

a: Unmet need for care when care 'hardly ever', 'sometimes' or 'usually' meets participants' needs

	Male		Female	
Transition	**Unmet care [CI]**	**Wealth**	**Unmet care [CI]**	**Wealth**
Robust–Prefrail	0.73 [0.55-0.98]	0.87 [0.85-0.89]	0.84 [0.71-0.99]	0.89 [0.87-0.91]
Robust–Death	1.02 [0.20-5.18]	0.21 [0.08-0.53]	1.01 [0.73-1.41]	0.76 [0.61-0.93]
Prefrail–Robust	0.74 [0.56-0.99]	1.15 [1.11-1.19]	0.82 [0.70-0.96]	1.15 [1.12-1.18]
Prefrail–Frail	2.10 [1.78-2.47]	0.87 [0.83-0.91]	1.37 [1.22-1.54]	0.86 [0.84-0.89]
Prefrail–Death	1.02 [0.90-1.16]	1.04 [0.86-1.25]	1.00 [0.72-1.38]	0.50 [0.34-0.74]
Frail–Prefrail	1.15 [0.95-1.40]	1.27 [1.19-1.36]	1.02 [0.97-1.06]	1.18 [1.13-1.24]
Frail–Death	0.99 [0.97-1.01]	1.11 [1.05-1.18]	0.99 [0.98-1.01]	1.09 [1.04-1.14]

b: Unmet need for care when care 'hardly ever' or 'sometimes' meets participants' needs

	Male		Female	
Transition	**Unmet care [CI]**	**Wealth**	**Unmet care [CI]**	**Wealth**
Robust–Prefrail	0.76 [0.45-1.29]	0.87 [0.85-0.90]	0.78 [0.58-1.06]	0.88 [0.86-0.90]
Robust–Death	1.01 [0.12-8.74]	0.43 [0.14-1.35]	1.03 [0.05-20.4]	0.76 [0.62-0.93]
Prefrail–Robust	0.78 [0.46-1.32]	1.18 [1.14-1.22]	0.78 [0.58-1.06]	1.13 [1.10-1.16]
Prefrail–Frail	1.71 [1.21-2.42]	0.83 [0.80-0.87]	1.00 [0.97-1.03]	0.84 [0.82-0.87]
Prefrail–Death	1.03 [0.85-1.24]	1.01 [0.80-1.27]	1.05 [0.06-17.0]	0.37 [0.16-0.88]
Frail–Prefrail	1.02 [0.94-1.10]	1.05 [0.98-1.12]	1.01 [0.97-1.05]	1.15 [1.10-1.21]
Frail–Death	1.00 [0.96-1.03]	1.10 [1.04-1.17]	0.99 [0.98-1.01]	1.13 [1.08-1.18]

Appendix A8: Sensitivity analysis for including year of birth as a covariate

Table A8: Transition hazard ratios of the receipt of care model, other covariates: age, wealth and birth year. Birth year is relative to the mean year of birth. Bayesian Information Criterion (BIC): 50 215 (Male), 61 306 (Female). CI: 95% Confidence Interval.

Male	**Age [CI]**	**Received care [CI]**	**Wealth [CI]**	**Birth year [CI]**
Robust – Prefrail	1.003 [1.002-1.004]	1.97 [1.59-2.43]	0.87 [0.85-0.90]	0.98 [0.97-0.99]
Robust –Death	1.002 [0.998-1.006]	0.85 [0.14-5.10]	0.78 [0.67-0.92]	0.94 [0.90-0.98]
Prefrail – Robust	0.997 [0.996-0.997]	0.46 [0.39-0.55]	1.17 [1.13-1.21]	1.00 [0.99-1.01]
Prefrail –Frail	1.003 [1.002-1.005]	2.54 [2.25-2.87]	0.82 [0.78-0.85]	1.00 [0.99-1.01]
Prefrail –Death	1.003 [1.001-1.005]	1.04 [0.79-1.37]	0.96 [0.89-1.05]	0.95 [0.93-0.97]
Frail– Prefrail	0.999 [0.998-1.001]	0.65 [0.55-0.77]	1.08 [1.01-1.16]	1.00 [0.98-1.02]
Frail– Death	1.004 [1.003-1.005]	1.02 [0.84-1.23]	1.02 [0.96-1.08]	0.98 [0.97-1.00]
Female				
Robust – Prefrail	1.002 [1.001-1.002]	1.66 [1.42-1.94]	0.88 [0.86-0.90]	0.98 [0.97-0.99]
Robust –Death	1.004 [0.999-1.008]	1.02 [0.21-4.90]	0.98 [0.82-1.17]	0.96 [0.91-1.01]
Prefrail – Robust	0.996 [0.995-0.997]	0.47 [0.42-0.54]	1.12 [1.09-1.16]	1.00 [0.99-1.01]
Prefrail –Frail	1.003 [1.002-1.004]	2.25 [2.05-2.48]	0.83 [0.80-0.86]	0.99 [0.98-1.00]
Prefrail –Death	1.005 [1.002-1.007]	1.02 [0.75-1.37]	0.84 [0.76-0.94]	0.95 [0.92-0.97]
Frail– Prefrail	0.997 [0.996-0.998]	0.64 [0.56-0.73]	1.17 [1.12-1.23]	0.98 [0.97-1.00]
Frail– Death	1.006 [1.005-1.007]	1.11 [0.91-1.35]	1.01 [0.95-1.07]	1.00 [0.98-1.01]

A9 Sensitivity analysis: Subject characteristics

Characteristic	n	(%)
Receipt of care (wave 6)		
No	9651	81.4
Low-level	1277	10.8
High-level	927	7.8
Unmet need for care (wave 1)		
No	8707	91.8
Yes	779	8.2

In the sensitivity analysis, an alternative, broader definition of receipt of care is used. The broader definition of received care added the use of meals on wheels and the use of a day centre in the past month, to the activities of daily living and instrumental activities of daily living. Care activities were also categorised as high or low-level care in the sensitivity analysis (compared to a binary yes/no for receipt of care in the main analysis). All activities of daily living, along with meals on wheels were categorised as high-level care and all instrumental activities of daily living, help climbing stairs without resting and use of a day centre were recorded as low-level care. The activities of daily living and instrumental activities of daily living are listed In Appendix A2.

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