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Heterogeneity in the effect of obesity on future long-term care use in England

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Abstract

Although there is some recent evidence around the effects of obesity on health care utilisation and costs, not much is known about the relationship between obesity and long-term care utilisation (Public Health England, 2013). Few studies from the USA find that obesity increases the risk of nursing home admissions and use of personal care assistance (Elkins et al. 2006, Ziza et al. 2002, Resnik et al. 2005, Yang and Zhang 2014). Nizalova, Gousia and Forder (2017) show that obesity leads to higher use of informal care but find no effect on other types of long-term care. In this study we explore whether the effect on various types of care differs depending on the degree of obesity among older people in England and whether the findings are sensitive to the incorporation of information on long-term care use prior to death. We find that in addition to the obesity at the level of BMI between 25 and 45 representing a risk for future use of informal care, (super) obesity at the level of BMI at 45 and greater represents a significant risk for all types of care use, including social care and nursing home/residential care.

Keywords: long-term care, social care, elderly people, informal care, obesity, super obesity, BMI

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The data were made available through the UK Data Archive. ELSA was developed by a team of researchers based at the NatCen Social Research, University College London and the Institute for Fiscal Studies. The data were collected by NatCen Social Research. The funding is provided by the National Institute of Aging in the United States, and a consortium of UK government departments co-ordinated by the Office for National Statistics. The developers and funders of ELSA and the Archive do not bear any responsibility for the analyses or interpretations presented here.

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1 INTRODUCTION

The number of obese people in England has been rising steadily for the last 20 years and this trend is expected to persist in the future. According to the Foresight Report about 40 per cent of Britons are projected to be obese by 2025 and Britain is projected to become a largely obese society by 2050 (Foresight, 2007). The resulting challenges are significant. Obesity is associated with a range of long-term conditions such as type II diabetes, cardiovascular disease, muscular skeletal disease, some cancers, mental health problems, liver disease and respiratory disease as well as physical disability, impaired quality of life and decreased cognitive function and dementia among the elderly (Colditz et al., 1990, Whelton et al., 1998, Drumond Andrade et al., 2013, Al Snih et al., 2007, Sturm, Ringel & Andreyeva, 2004, Marchesini et al., 2008, Guh et al., 2009, Ham, Dixon & Brooke, 2012). The prevalence of these conditions has important implications in terms of health and social care expenditures. The NHS costs attributable to overweight and obesity are projected to reach £9.7 billion by 2050 with wider costs to society estimated to reach £49.9 billion per year (Department of Health, 2012). As the prevalence of obesity, along with associated long-term conditions increases in the population, health and social care costs are likely to rise.

Although the policy and research focus has mainly been on the pressures that obesity places on the healthcare system, the associated pressures on the social care system are not expected to be less significant. Health and social care of people with long-term conditions accounts for the 70 per cent of total health and social care spend and in England this number is now more than 15 million people (Department of Health, 2012). The increase in risk of the different long-term conditions is also particularly stark among obese individuals. Obese individuals for example, are around nine times more likely to develop type II diabetes than the non-obese population and around 85 per cent of diabetics are either obese or overweight (Ham, Dixon & Brooke, 2012, National Audit Office, 2001). It is therefore likely that a substantial proportion of these social care costs are associated with excess weight. Obesity is likely to affect not only the demand for social care services, but also the way these are provided. This is particularly the case for severely obese individuals whose physical difficulties may require adapting social care services in terms of housing (e.g. specialist mattresses, doors, toilet frames), workforce (e.g. specialist carers trained in handling severely obese people) and facilities (e.g. bariatric patient transport and specialist leisure services) (Local Government Association, 2013).

All these factors combine to make obesity a major challenge for social care services. Despite the evident link between obesity, long-term conditions and social care needs the research around this area has been limited. In this paper we provide new evidence on the effect of obesity on future use of long-term care services in England. More specifically we explore the effect of obesity on different types of care and test for heterogeneous effects on different types of care by looking at different classifications of obesity.

2 BACKGROUND AND MOTIVATION

Long-term care in the UK usually comprises nursing care, personal care (such as dressing and bathing) and assistance with domestic tasks (such as shopping and preparing meals). Formal long-term care services are provided by a range of agencies including Local Authority social services, community health services and independent (for- and non-profit) sector residential care homes,

nursing homes, home care and day-care services. Long-term care services are financed by the National Health Service (NHS), Local Authorities and charities or by older persons themselves. Access to publicly funded social care services is provided after a needs and financial assessment which is run by the Local Authority (Comas-Herrera et al., 2010). Therefore, the formal long-term care system in England serves as part of a 'safety-net' for those in greater need (Fernandez, Forder & Knapp, 2011). Except for the formal care services, informal care by family members and friends also plays a big role in the UK. The majority of older people with a functional disability living at home (approximately 85 percent) receive care from informal carers (Comas-Herrera et al., 2010). The number and intensity of care of informal carers has increased over the years and according to some estimates the total value of informal care to society in England sums up to £55 billion (National Audit Office, 2014).

The link between obesity and the long-term care use, both formal and informal is not yet well understood. The literature suggests that obesity is a risk factor for a number of long-term conditions such as type II diabetes, cardiovascular disease, muscular skeletal disease, some cancers, arthritis, hypertension and respiratory disease (Guh et al., 2009, Ham, Dixon & Brooke, 2012) all of which are associated with functional and cognitive impairments and therefore greater need for long-term care. Except for the indirect effect via long-term conditions, obesity and especially severe obesity is directly linked to problems with mobility and disability in old age. We can further hypothesise that obesity is likely to be perceived as an imperfect proxy for need and therefore may affect long-term care use through, among other things, carers' and care recipients' perceptions of needs associated with obesity.

Very few studies have looked at the relationship between BMI and long-term care utilisation and most of them come from the U.S. Elkins and Whitmer (2008) find evidence that obesity in midlife is associated with a higher probability of nursing home entry. Similarly, other studies find that obesity in older people increases the risk of nursing home admissions, use of personal care assistance and LTC costs (Resnik, Lapane & Allen, 2005, Zizza et al., 2002, Yang, Zhang, 2014). However, evidence on the effect of obesity on other types of long-term care, including informal care, is scant. A previous PSSRU report (Nizalova, Gousia & Forder, 2017) has explored this issue using data from England and found evidence that obesity is associated with a higher use of informal care, but has no effect on the use of social care services. In this study, we extend this work to account for different degrees of obesity and explore whether higher classes of obesity have a different impact on various types of long-term care services. Severely obese individuals are more likely to have difficulties with mobility and other physical difficulties and therefore may have a higher need for long-term care services. Grouping higher classes of obesity together and using the existing classification for underweight, normal and obese individuals may obscure heterogeneous effects of more severe obesity that previous research has not been able to disentangle.

3 ECONOMETRIC METHODS AND DATA

Specification

Following Nizalova, Gousia and Forder (2017), we hypothesise that obesity will affect the need for long-term care in a number of ways as summarised in Figure 1. First, obesity is a risk factor for a range of chronic diseases, which, in turn are linked to different functional impairments that generate

the need for long-term care. We also distinguish between diagnosed and undiagnosed illnesses to emphasise that even after controlling for the health conditions available in the data, we may still see an independent effect of obesity on future care use, which will still be related to health. Second, some functional limitations may be caused directly by obesity, independent of specific health conditions, reflecting impairment of physical activity resulting from excessive body weight, for example, reduced mobility and self-care capability. We also note in the diagram the potential for certain diseases and functional limitations to be causes of obesity, recognising the issues with establishing the causal effects of obesity on the need for care.

To estimate the effect of different categories of obesity on the use of long-term care we use a multinomial logit model to account for the different types of long-term care as well as the non-respondent cases and cases of people that have died from one wave to the other. The model specification is the following:

$$ln\left(\frac{p_{itj}}{p_{it1}}\right) = \beta_{0j} + W_{it-1}\beta_{1j} + X_{it-1}\beta_{xj} + \varepsilon_{it} \quad (1)$$

In this model i stands for individual, t for time and j stands for the type of outcome. The probability $p_{itj} = prob(y_{itj}|X_{it-1}, W_{it-1})$, stands for the probability that an individual i experiences outcome y_{itj}, at time t. The feasible set of outcomes y_{itj} in the general (older) population includes the use of the different types of long-term use (e.g. formal or informal), no care use, non-response and death. No care is taken as the base category. W_{it} is a vector that includes different categories of obesity, X_{it} is a vector of socio-economic characteristics and other observable risk factors such as long-term conditions and ε_{it} is a random error capturing all other factors affecting long-term care use which are unobserved. If unobserved factors are also correlated with the obesity status and the use of long-term care, then the estimated coefficient of the effect of obesity status, β_{1j}, will be biased and cannot be considered as the true causal effect of obesity. This problem can be partly addressed by exploiting the longitudinal nature of the data and looking at the effect of lagged obesity $(t-1)$ on current levels of long-term care use (t) under the assumption that current unobserved variables affect current obesity levels and the need for long-term care but do not have a persistent effect on future rates of obesity. The endogeneity problem remains if unobserved variables have a historical effect on lagged obesity where this lagged effect also perpetuates to impact directly on current use.

In short, potential endogeneity problems from any short-term (less than 2 year) unobserved causal effects of obesity can be mitigated with the use of lagged control variables, and therefore relating current wave obesity status to the care use in the following two years is an appropriate empirical strategy (equation (1)). Where time-invariant factors are unobserved, this could cause bias. In theory, a fixed effects approach would also reduce this endogeneity issue. However with obesity categories being largely time invariant this is not feasible as there are very few cases where obesity status changes. Furthermore, with multinomial models, many observations will be perfectly predicted, again substantially limiting the valid cases.

Data and variables

The data used comes from the English Longitudinal Study of Ageing (ELSA), a longitudinal biennial survey of individuals aged 50 and over with replacement. It was originally sampled from the pool of

respondents to the Health Survey of England (1998, 1999 and 2001) and collects a vast amount of data on individual and family circumstances and quality of life of older people. Data from waves 1 to 5 were pooled together. We restrict the analysis to people older than 65 years old to capture those with the highest need for social care and the final sample size is 12,322 observations.

Variables

Dependent variable

The dependent variable for the basic model is constructed from a set of questions on whether the person receives help from different sources due to having difficulties with various activities and instrumental activities of daily living (ADLs and iADLs).[1] Based on this information future care use consists of the following types: (i) no care use (base category), (ii) informal care, (iii) privately purchased care, (iv) formal care, (v) non-respondent and (vi) died.[2] Informal care consists of any help provided with ADLs and iADLs from a family member, friend, neighbor or volunteer and formal care is help from social services, home help or other LA arranged care. Privately paid care includes any care, formal or informal, that individuals have paid towards. In a second specification we also take into account those in a nursing or residential care home and the different types of care use then become: (i) no care use (base category), (ii) nursing home or residential care user, (iii) any type of care (informal, formal, privately purchased), (iv) non-respondent and (v) died.

Obesity classifications

A measure of obesity status is constructed from the body mass index (BMI). This is the most common measure of obesity in the literature and the typical classification of people according to their BMI includes the following baseline categories: underweight (BMI less than 18.5), normal weight (BMI 18.5 to 24.99), overweight (BMI 25 to 29.99) and obese (BMI 30+). BMI could be directly calculated for waves 2 and 4 and imputed for wave 1 (using wave 0 data). This was used as a risk factor for outcomes at waves 2, 3 and 5.[3]

Based on the default BMI classification, obesity (i.e. BMI over 30) has been shown to have an effect on informal care but no statistically significant effect on the use formal care services (Nizalova, Gousia & Forder, 2017). In this study we extend this work to account for different degrees of obesity and explore whether higher classes of obesity have a different impact on formal care use. Severely obese individuals are likely to have more mobility or other physical difficulties and therefore be in higher need for formal care services that the default classification fails to reveal (Local Government Association, 2013).

The WHO classifies BMI over 30 into three classes of obesity that include class I (BMI 30-34.9), class II (BMI 35-39.9) and class III (BMI 40+). The baseline specification uses these obesity categories to estimate the effect of different ranges of BMI. Furthermore, we use an alternative specification from

[1] ADLs and iADLs include mobility difficulties (walking 100 yards, climbing several flights of stairs, walking across a room, getting in and out of bed, using the toilet), dressing, bathing, eating and cutting up food, shopping for groceries and doing work around the house or garden, help with taking medication and help with managing bills and money.

[2] See Table 1 for the exact wording of the questions and correspondence between waves.

[3] Excluding the data from waves 0/1 does not change the main results, however it does prevent us from analyzing heterogeneous effects due to the small sample size.

the surgical literature that includes the following classes: severely obese (BMI 30-39.9), morbidly obese (40-49.9) and super obese (50+) (Sturm, 2007).

Finally, we turned to the ELSA sample in order to investigate how formal care use varies at higher levels of BMI and whether this corresponds to the existing classifications. Figure 2 presents the non-parametric relationship between BMI and use of formal care in the data. We see that the use of formal care services does vary at higher levels of BMI, but the 'cut-off' points are not exactly the same as those of the WHO or any alternative (surgical literature) classification. We see that use is lower but rising for BMI levels ranging between 30 and 35 and becomes higher and increasing in a convex way for BMI levels between 35 and 45. The use of formal care is higher and rising in a concave way for BMI levels between 45 and 55 and decreasing for BMI levels approximately above 53. Based on this visual inspection of the data we also explore the effect of different classes of obesity by grouping BMI in the following classes (alternative classification II): obese class I (BMI 30-34.9), obese class II (BMI 35-44.9) and obese class III (BMI 45+).[4]

Table 2 presents the summary statistics for the different BMI classifications in the sample. We see that the majority of people under the obese category (i.e. with a BMI>30) fall in the first class of obesity for all three classifications. This is a substantial percentage of the whole sample, ranging from approximately 20% (WHO and alternative (II) classifications) to 25% (alternative (I) classification). Approximately 5.1% of people belong in the second class of obesity while a very small percentage of 0.18% belong in the higher class of obesity (class III) under the WHO classification. The respective percentages under the alternative classifications (I) and (II) are 1.7% and 6.4% and 0.1% and 0.5% suggesting that the number of people with very high levels of BMI is very small in the sample.

Control factors

Control factors include a number of socioeconomic and behavioural variables and indicators of functional limitations and health conditions. Specifically, we controlled for age, indicators for whether the respondent is female, married, living alone, has no educational qualifications, is working, is non-white or owns accommodation, the number of children and real per capita total household income and wealth. We also include indicators for alcohol drinking, currently smoking and ever smoked and an indicator for physical activity which includes any type of exercise whether vigorous activity at least 1-3 times per month, moderate physical activity at least once a week or light physical activity more than once per week. Functional limitations are defined as the number of limitations with ADLs, iADLs and mobility. Health conditions include high blood pressure, diabetes, cancer, lung disease, heart-related problems, stroke, psychiatric disorders and arthritis. Finally, we included a full set of wave dummies.

4 RESULTS

[4] Due to the small number of observations at very high BMI levels, we group all observations above a BMI of 45 together.

Descriptive analysis

Table 3 presents summary statistics of all dependent and control variables of the regression sample. Approximately 57% of the sample do not receive any type of care while 20.3% receive some type of informal care two years forward. About 2.8% of people receive privately paid care and 1.5% make use of some type of formal care. Grouped together, all types of care, make approximately 24.5% of the sample. The percentage of people in nursing or residential care is very small, 0.1% and the percentage of non-respondents and those that die two years forward is 12.6% and 5.5% respectively.

The sample is on average 73.8 years of age and has a slightly higher percentage of women (55%). Approximately 56.6% of the sample are married and 28.6% are living alone. The average number of children is 2.2 and the percentage of people without educational qualifications is 46%. Almost 2.9% are still working and about 73% are home owners. A high percentage of people engage in some form of physical exercise (83.7%) while also consuming alcohol (85.5%) or have smoked in their life (63.2%) even they are not currently smoking (11%). The average number of functional limitations is between 2.3 and on average the respondents have between 0 and 1 limitations with ADLs or iADLs. The most common health conditions are high blood pressure, arthritis and heart-related problems (47%, 42% and 26% respectively), followed by diabetes, cancer, lung disease, stroke and psychiatric disorders. In terms of BMI, the largest proportion of the sample belongs to the overweight category (43.7%).

To get a visual inspection of the correlation between care use and BMI we estimated a non-parametric Kernel density (Figure 3). From the graph we can see that individuals with higher BMI also have a higher care utilisation two years later. This is the case for all types of care, particularly informal and social care except for care home. In the next section, we investigate this relationship with the use of regression analysis in order to partial out the effect of other factors.

Primary findings

Table 4 and Table 5 present the results of the estimation of the main model with standard errors clustered at the individual level. In Table 4 these include informal care, privately paid care and formal care with not using any care being the base category. In Table 5 the categories include nursing and residential care and all other types of care with not using any care is the base category.[5] These results use the full sample of people aged 65 and above. The tables report the estimated relative risk ratios for the different BMI ranges, split into different panels according to each BMI classification. Panel A uses the default four category classification (under-weight, over-weight, normal weight and obese) and the rest split obesity into more groups. This follows by the WHO classification in Panel B and the other two alternative classifications in Panel C and D.

When looking at the results with all types of care in Table 4, we see that when using the default classification the effect of obesity is statistically significant only in the case of informal care. However, when we break the obesity category into different classes then we find a statistically significant effect on privately paid care and formal care under the WHO classification. Using formal care is 2.12 times more likely for people with a BMI over 40 compared to those with normal weight (Panel B). The effect on formal care is not statistically significant under alternative classification I, while it is still pointing towards higher use of formal care (Panel C). Having a BMI over 45 has a statistically

[5] Non-response and death categories are also included in the estimation but not presented in the tables for brevity.

significant and sizeable effect on the use of formal care under alternative classification II (Panel D). People with a BMI over 45 are 5.8 times more likely to use formal care compared to people with a normal BMI. Similarly using privately paid care is 2.42 times more likely for people with BMI over 40 and 5.02 times more likely for people with BMI over 45. The relative risk ratios for a BMI over 50, although above 1 are not statistically significant. The effect is still significant for informal care for the two higher classes of obesity. Using informal care is 1.95 times more likely for people with BMI over 40 and 2.78 times more likely for people with BMI over 45. The effect on informal care is significant as well for the second obesity class under all classifications.

Concerning the use of nursing and residential care the results in Table 5 show that when using the default BMI classifications there is no significant effect except for all other types of care. Under the WHO classification, the effect of higher classes of obesity on nursing and residential care although positive is not significant. The effect on nursing and residential care use is statistically significant and larger in magnitude for people with a BMI over 45 when we use the alternative classification II. People with a BMI over 45 are 4.84 times more likely to use nursing or residential care compared to people with normal BMI according to this specification. Having a BMI over 50 although statistically significant under the alternative classification I, the estimated relative risk ratio is very small and suggests a reduced likelihood of using nursing or residential care. The latter result should be taken with caution given that the number of observations in this obesity category is 0.1% of the sample (around 12 people).

Overall, there is evidence that at very high levels of BMI there is a statistically significant effect on the use of formal care including nursing and residential care. The estimate of the effect is less precise for people with a BMI over 40 (i.e. using the WHO classification) however it is still positive for both the formal care use and nursing and residential care use but only significant for formal care. The estimated effects under the alternative classification II (i.e. based on the ELSA data) are more significant and higher in magnitude for people with a BMI over 45. However, given the small number of observations with a BMI over 45 and the large magnitude of the estimated effects, these findings are to be treated with caution. As the WHO classification allows us to identify reasonably sized categories which is reflected in the precision of the estimates of the effect of obesity on use of various types of care, we will use this as a preferred classification in the analysis that follows. However, analysis based on the other classification is also available upon request.

Table 8 and Table 9 in the appendix report the results with the whole set of controls including the outcomes of non-respondent and dead. As expected physical activity is associated with a reduced likelihood of using any type of care while the different health conditions, functional limitations and problems with ADLs and iADLs with an increased likelihood of using any type of care. Having children and marital status are associated with an increased likelihood of using informal care and reduced likelihood of using privately paid or formal care suggesting that informal and formal care are substitutes.

Sensitivity analysis

We also run the analysis including data from the End of Life questionnaire. This data allows to use additional observations on the use of formal care that could be lost if an individual died from one wave to the other while there may be higher use of formal care towards the end of life.

The results from this analysis are presented in Table 6 and Table 7. We see that including additional data from the End of Life questionnaire do not change the main findings. People with a BMI over 40 are 2.12 times more likely to use formal care, 2.33 times more likely to use privately paid care and 1.97 times more likely to use informal care compared to people of normal weight, using the WHO BMI classification. This time the effect on formal care is significant at the 5% level. The effect is not significant in relation to nursing and residential care albeit positive and relatively large in magnitude. Having a BMI over 40 is still associated with an increased and statistically significant effect on using all other types of care.

5 DISCUSSION AND CONCLUSIONS

The recent rising trends in the prevalence of obesity come in hand with a number of challenges for the health and social care systems. With an ageing population, the pressures on health and social care costs associated with obesity are expected to increase. Although the impact on health care has received more attention, the implications of obesity for long-term care utilisation and costs are not well understood, despite being potentially significant. Obesity and social care need are linked through both the development of long-term conditions and the physical and social difficulties that may result from the development of severe obesity. This study provides evidence on the effect of obesity on different types of long-term care use. We expand on previous literature by exploring the effect of severe obesity which is expected to be associated with higher need for long-term care.

We used data from the English Longitudinal Study of Ageing and a cohort design to account for both the different types of future care and attrition due to non-response and death. We also controlled for a number of factors including a number of long-term and health conditions.

We found evidence that a higher class of obesity (BMI 40 and over) has a significant effect on the use of formal care services. Although the estimates based on the typical four category classification of BMI (underweight, normal, overweight and obese) show that obesity only affects the use of informal care, breaking obesity down into more categories to capture the effect of higher classes of obesity reveals significant effect on other types of care. Having a BMI over 45 is associated with higher use of formal care services and nursing and residential care. This estimated effect is not statistically significant in the case of nursing and residential care but was significant in relation to formal care, especially after the inclusion of the end of life data. Estimating the model with an alternative classification that took into account the distribution of BMI and formal care use in the ELSA data found that this effect was larger and more significant for people with BMI over 45. However due to the small number of observations with BMI over 45, these findings are to be treated with caution.

This effect is estimated above the effect of other long-term and health conditions suggesting that at these higher levels of obesity, a greater BMI has a direct effect on the use of long-term care by contributing to physical and social difficulties. From a policy point of view, this finding brings evidence on the increasing pressure that obesity epidemic is expected to put on social care costs and provides additional rationale for promoting healthier weight. Adult social care in England has been facing a number of funding pressures in recent years and effectively preventing and treating obesity has the potential to significantly improve quality of life in addition to reducing health and social care costs. Furthermore, the finding that it is higher levels of obesity that contribute more to the demand for social care means that interventions for certain sub groups of the population are likely to be more

effective. Super obesity is likely as well to have resource implications for the delivery of social care services. These may include changes such as housing adaptations (such as specialist beds, toilet frames and stair lifts), specialist carers (trained in handling of severely obese people) and the provision of appropriate transport and facilities (such as bariatric patient transport and specialist leisure activities).

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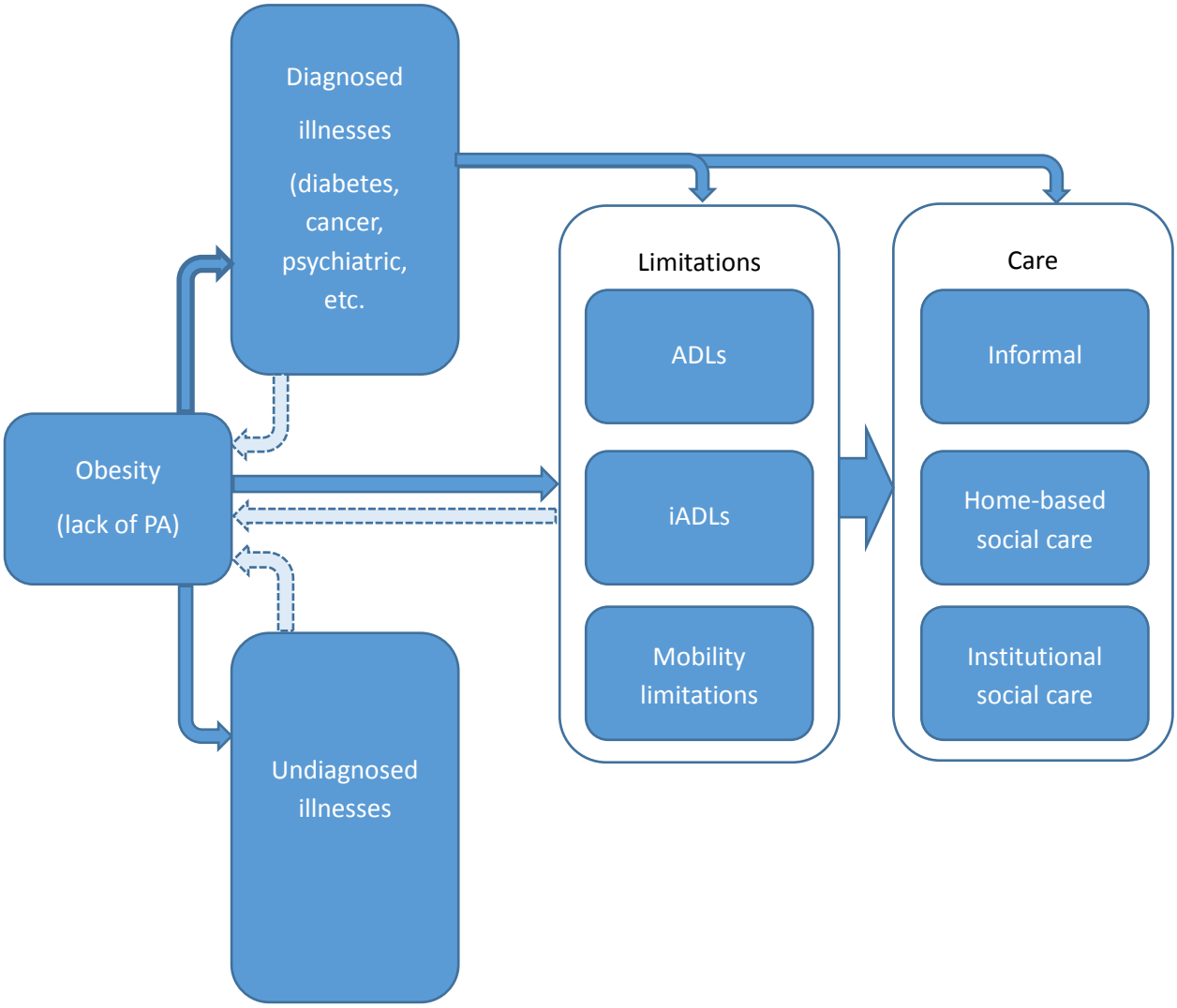
TABLES AND FIGURES

Figure 1. Pathways of impact of risk factors on future use of care



Source: Nizalova, Gousia and Forder (2017)

Table 1. Types of care in ELSA

Variable	Questions in waves 1-2	Questions in waves 3-5
Any care received = 1 if ”yes” to at least one of the Qs	1. Individual outcome code (if in institution) 2. “Thinking about the activities that you have problems with, does anyone ever help you with these activities (including your partner or other people in your household)?”	1. Individual outcome code (if in institution) 2. “Functioning: whether ever has help with mobility, ADL, IADL”
	“Who helps you with these activities?”	“Whether receives help moving around house (wash/dress, preparing meal/eating, etc.) from..” asked individually
Informal care received	husband/wife	spouse or partner
	mother/father	parent
	son	son
	son-in-law	son-in-law
	daughter	daughter
	daughter-in-law	daughter-in-law
	sister	sister
	brother	brother
	grandson	grandson
	granddaughter	granddaughter
	other relative	other relative
	friend/neighbour	friend/neighbour
	other person	other person
	unpaid volunteer	voluntary organisation
Formal care received	social or health service worker	social services/LA arranged care
		nurse
		other health or social services
Privately paid care	privately paid employee	privately arranged care
Nursing home care received	Derived from respondent’s individual outcome code	Derived from respondent’s individual outcome code

Figure 2. Non-parametric relationship between BMI and formal care use

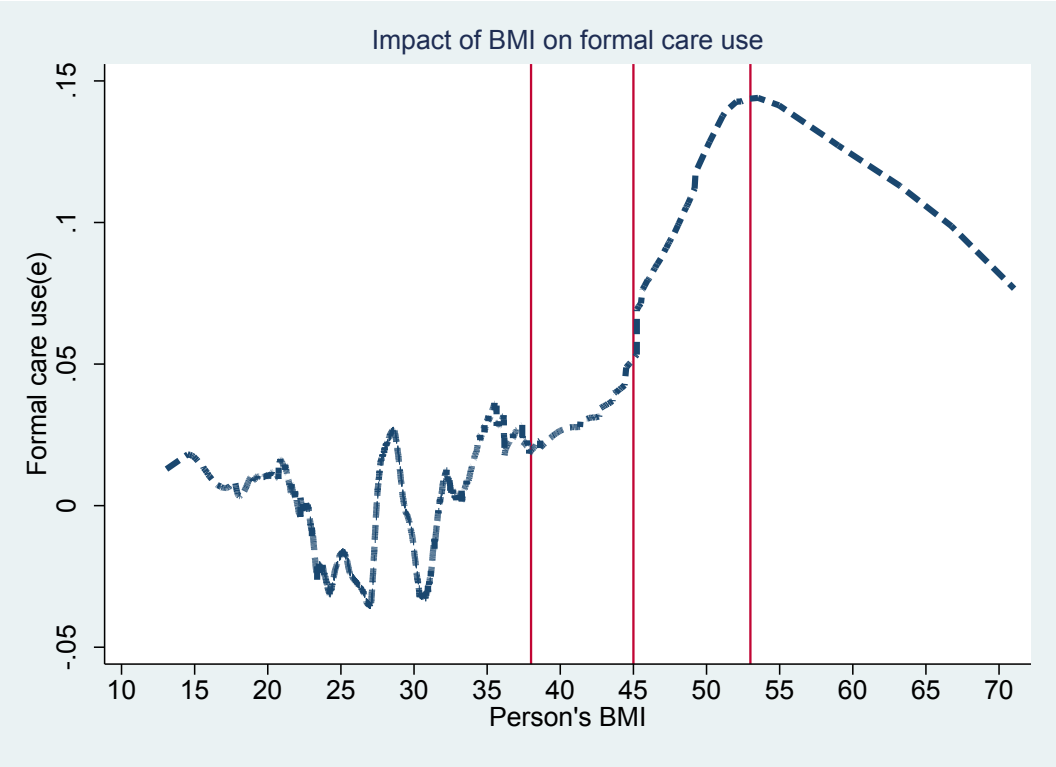


Table 2. Summary statistics of obesity by BMI classification

	BMI	Proportion
WHO classification		
Obese Class I (obese)	30-34.9	0.198
Obese Class II (morbidly obese)	35-39.9	0.051
Obese Class III (super morbidly obese)	40+	0.018
Alternative classification I (surgical literature)		
Obese Class I (severe)	30-39.9	0.252
Obese Class II (morbid)	40-49.9	0.017
Obese Class III (super)	50+	0.001
Alternative classification II (ELSA data)		
Obese Class I	30-34.9	0.198
Obese Class II (severe)	35-44.9	0.064
Obese Class III (super)	45+	0.005
N	*12322*	

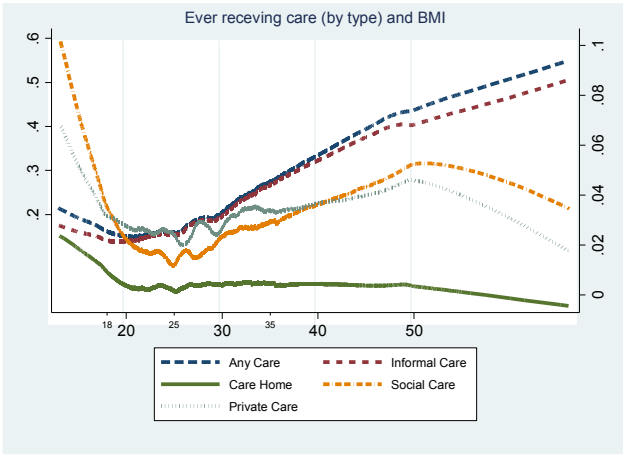
Notes: Summary statistics based on regression sample.

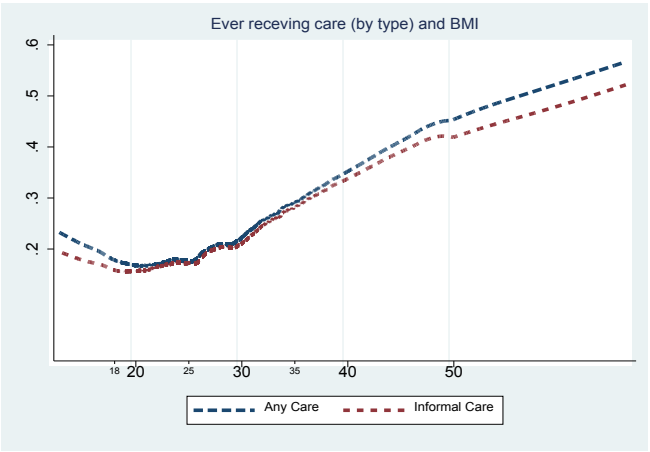
Table 3. Summary statistics

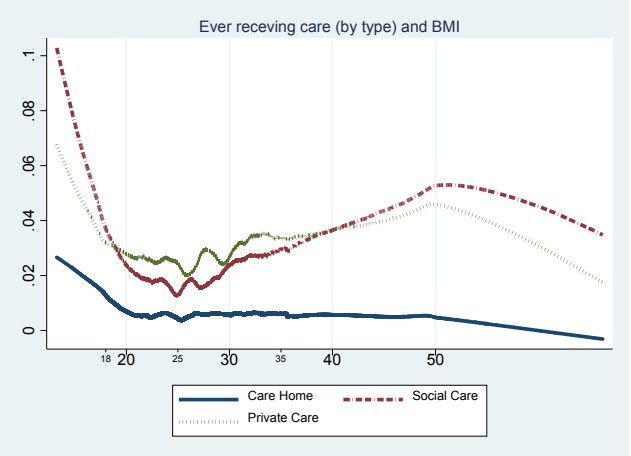
	Mean		*Mean*
No care	0.571	Underweight	0.010
Informal care	0.203	Normal weight	0.275
Privately paid care	0.028	Overweight	0.437
Formal care	0.015		
Nursing home/residential care	0.001		
All other	0.245		
Non-respondent	0.126		
Died	0.055		
Age	73.867	Number of functional limitations	2.324
Female	0.551	Number of limitations with ADL	0.463
Married	0.566	Number of limitations with iADL	0.432
Living alone	0.286	High blood pressure	0.472
Number of children	2.223	Diabetes	0.102
No educational qualifications	0.461	Cancer	0.094
Working	0.029	Lung disease	0.077
Home owner	0.731	Heart-related problems	0.256
Real per capita total household income	10478	Stroke	0.063
Real per capita total household wealth	149426	Psychiatric disorders	0.057
Physical exercise	0.837	Arthritis	0.416
Alcohol drinking	0.855		
Ever smoked	0.632		
Currently smoking	0.110		
N	*12,322*		

Notes: Formal care: care home and LA social care; privately paid care: informal or formal; all other: informal care, privately purchased care, LA social care. Summary statistics based on regression sample.

Figure 3. Non-parametric relationship between care use and BMI 2 years ago







Notes: (a) Top-left panel: all types of care; (b) Top-right panel: any care and informal care; (c) Bottom-left panel: Care home, social care and private care.

Table 4. Multinomial Logit Results by BMI classification. All types of care.

	Informal Care only	Privately paid	Formal care
A. Default classification			
Obese (BMI 30+)	1.23**	1.23	1.05
	(0.09)	(0.20)	(0.19)
Over-weight	0.95	0.98	0.98
	(0.07)	(0.14)	(0.16)
Under-weight	1.50	1.40	1.89
	(0.40)	(0.75)	(0.89)
B. WHO classification			
Obese Class III (BMI 40+)	1.95**	2.42*	2.12+
	(0.40)	(0.89)	(0.93)
Obese Class II (BMI 35-39.9)	1.62**	1.02	1.18
	(0.20)	(0.29)	(0.40)
Obese Class I (BMI 30-34.9)	1.13	1.19	1.01
	(0.09)	(0.21)	(0.26)
Over-weight	0.96	0.97	0.99
	(0.07)	(0.15)	(0.19)
Under-weight	1.27	1.50	1.68
	(0.36)	(0.81)	(0.99)
C. Alternative classification I (surgical literature)			
Obese Class III (BMI 50+)	1.82	1.77	2.37
	(0.94)	(1.24)	(1.95)
Obese Class II (BMI 40-49.9)	2.00**	1.37	1.15
	(0.41)	(0.34)	(0.43)
Obese Class I (BMI 30-39.9)	1.22**	0.92	0.77*
	(0.09)	(0.08)	(0.10)
Over-weight	0.97	0.84*	0.77*
	(0.06)	(0.06)	(0.08)
Under-weight	1.36	1.19	2.33*
	(0.36)	(0.38)	(0.78)
D. Alternative classification II (ELSA data)			
Obese Class III (BMI 45+)	2.78*	5.02*	5.80**
	(1.18)	(3.16)	(3.84)
Obese Class II (BMI 35-44.9)	1.60**	1.20	1.41
	(0.19)	(0.31)	(0.44)
Obese Class I (BMI 30-34.9)	1.12	1.19	1.06
	(0.09)	(0.21)	(0.27)
Over-weight	0.95	0.97	1.03
	(0.07)	(0.15)	(0.20)
Under-weight	1.27	1.51	1.74
	(0.36)	(0.81)	(1.02)

Notes: Relative risk ratios reported. All regressions include all control variables as shown in table 3 and time dummies. Standard errors are clustered at individual level. ** indicates significance at 1% level, * - at 5% level and + - at 10% level.

Table 5. Multinomial Logit Results by BMI classification. Nursing and residential care and other types of care.

	Nursing and residential care	Other care
A. Default classification		
Obese (BMI 30+)	0.73	1.23**
	(0.21)	(0.09)
Over-weight	0.87	0.95
	(0.19)	(0.06)
Under-weight	2.56+	1.50
	(1.43)	(0.38)
B. WHO classification		
Obese Class III (BMI 40+)	2.16	1.97
	(0.00)	(0.00)
Obese Class II (BMI 35-39.9)	0.00[6]	1.54
	(0.00)	(0.00)
Obese Class I (BMI 30-34.9)	0.22	1.13
	(0.00)	(0.00)
Over-weight	0.76	0.96
	(0.00)	(0.00)
Under-weight	2.82	1.33
	(0.00)	(0.00)
C. Alternative classification I (surgical literature)		
Obese Class III (BMI 50+)	0.00**[7]	1.84
	(0.00)	(0.96)
Obese Class II (BMI 40-49.9)	2.18	1.99**
	(3.25)	(0.40)
Obese Class I (BMI 30-39.9)	0.18+	1.23**
	(0.19)	(0.09)
Over-weight	0.76	0.97
	(0.43)	(0.06)
Under-weight	2.84	1.34
	(2.13)	(0.35)
D. Alternative classification II (ELSA data)		
Obese Class III (BMI 45+)	4.84+	3.07**
	(4.06)	(1.23)
Obese Class II (BMI 35-44.9)	0.83	1.53**
	(0.4)	(0.17)
Obese Class I (BMI 30-34.9)	0.61	1.11
	(0.19)	(0.09)
Over-weight	0.85	0.94
	(0.19)	(0.06)
Under-weight	2.51	1.48
	(1.4)	(0.38)

[6] This estimate is very small and the coefficient is 9.81e-08
[7] This estimate is very small and the coefficient is 6.31e-08

Notes: Relative Risk Ratios reported. All regressions include all control variables as shown in table X and time dummies. Standard errors are clustered at individual level. ** indicates significance at 1% level, * - at 5% level and + - at 10% level.

Table 6. Multinomial Logit results with End of life data. All types of care.

	Informal Care only	Privately paid	Formal care
Obese Class III (BMI 40+)	1.97**	2.33*	2.12*
	(0.40)	(0.86)	(0.80)
Obese Class II (BMI 35-39.9)	1.58**	1.03	1.09
	(0.20)	(0.29)	(0.33)
Obese Class I (BMI 30-34.9)	1.11	1.14	0.89
	(0.09)	(0.20)	(0.18)
Over-weight	0.94	0.95	0.96
	(0.06)	(0.14)	(0.15)
Under-weight	1.49	1.38	1.84
	(0.40)	(0.73)	(0.87)

Notes: Relative Risk Ratios reported. Results are based on the WHO classification. All regressions include all control variables as shown in table X and time dummies. Standard errors are clustered at individual level. ** indicates significance at 1% level, * - at 5% level and + - at 10% level.

Table 7. Multinomial Logit results with End of life data. Nursing, residential and other types of care

	Nursing and residential care	Other care
Obese Class III (BMI 40+)	2.25	1.98**
	(1.38)	(0.39)
Obese Class II (BMI 35-39.9)	0.68	1.51**
	(0.38)	(0.18)
Obese Class I (BMI 30-34.9)	0.61	1.11
	(0.19)	(0.09)
Over-weight	0.85	0.95
	(0.19)	(0.06)
Under-weight	2.52+	1.49
	(1.41)	(0.38)

Notes: Relative Risk Ratios reported. Results are based on the WHO classification. All regressions include all control variables as shown in table X and time dummies. Standard errors are clustered at individual level. ** indicates significance at 1% level, * - at 5% level and + - at 10% level.

APPENDIX

Table 8. Multinomial Logit Results. All types of care. Full set of controls.

	Informal Care only	Privately paid care	Formal care	Non-respondent	Died
Obese Class III (BMI 45+)	1.95**	2.42*	2.12+	1.37	1.36
	(0.40)	(0.89)	(0.93)	(0.33)	(0.46)
Obese Class II (BMI 35-44.9)	1.62**	1.02	1.18	1.04	0.88
	(0.20)	(0.29)	(0.40)	(0.16)	(0.20)
Obese Class I (BMI 30-34.9)	1.13	1.19	1.01	0.86	0.72*
	(0.09)	(0.21)	(0.26)	(0.08)	(0.10)
Over-weight	0.96	0.97	0.99	0.83**	0.77*
	(0.07)	(0.15)	(0.19)	(0.06)	(0.08)
Under-weight	1.27	1.50	1.68	1.17	2.32*
	(0.36)	(0.81)	(0.99)	(0.37)	(0.78)
Physical exercise	0.64**	0.73*	0.36**	0.58**	0.36**
	(0.05)	(0.11)	(0.07)	(0.05)	(0.04)
Drinking	0.87+	1.24	0.52**	0.76**	0.71**
	(0.07)	(0.21)	(0.10)	(0.07)	(0.08)
Ever smoked	1.05	0.91	1.10	1.09	1.16
	(0.07)	(0.12)	(0.22)	(0.07)	(0.12)
Currently smoking	0.92	0.88	1.09	0.99	1.43*
	(0.09)	(0.22)	(0.30)	(0.10)	(0.21)
Female	1.35**	2.30**	1.26	1.17*	0.54**
	(0.09)	(0.35)	(0.27)	(0.08)	(0.06)
No qualifications	1.03	0.59**	0.97	1.45**	1.29**
	(0.06)	(0.08)	(0.18)	(0.10)	(0.13)
Non white	0.83	0.63	0.51	1.69*	0.99
	(0.20)	(0.49)	(0.51)	(0.39)	(0.42)
Age	1.05**	1.10**	1.11**	1.04**	1.11**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Married	1.35**	0.63*	0.40**	1.44**	1.01
	(0.11)	(0.12)	(0.11)	(0.14)	(0.14)
Number of children	1.06**	0.89**	0.89*	0.98	0.95
	(0.02)	(0.04)	(0.05)	(0.02)	(0.03)
Alone	0.68**	1.04	0.95	0.77*	0.81
	(0.06)	(0.19)	(0.22)	(0.08)	(0.11)
Working	0.70	1.09	0.00**	1.32	0.51
	(0.16)	(0.65)	(0.00)	(0.24)	(0.30)
Home owner	1.08	1.36+	0.82	0.76**	0.80*
	(0.08)	(0.21)	(0.17)	(0.06)	(0.09)
Wealth (real pc)	1.00*	1.00*	1.00*	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Income (real pc)	1.00*	1.00	1.00	1.00+	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

	Informal Care only	Privately paid care	Formal care	Non-respondent	Died
High blood pressure	1.09	1.27+	1.35	1.06	1.09
	(0.06)	(0.16)	(0.25)	(0.07)	(0.10)
Diabetes	1.09	1.80**	0.96	1.05	1.28+
	(0.10)	(0.33)	(0.23)	(0.11)	(0.17)
Cancer	1.02	1.07	1.24	1.01	2.83**
	(0.10)	(0.20)	(0.33)	(0.11)	(0.36)
Lung disease	1.29*	1.23	1.54	1.14	1.73**
	(0.14)	(0.27)	(0.43)	(0.14)	(0.25)
Heart disease	1.31**	1.33*	1.28	1.24**	1.64**
	(0.08)	(0.18)	(0.24)	(0.09)	(0.16)
Stroke	1.44**	1.41	1.54+	1.28+	1.37+
	(0.17)	(0.30)	(0.39)	(0.17)	(0.22)
Psychological problems	1.16	1.96**	0.88	1.01	0.95
	(0.15)	(0.40)	(0.35)	(0.14)	(0.21)
Arthritis	1.44**	1.45**	0.91	1.07	0.91
	(0.09)	(0.20)	(0.17)	(0.07)	(0.09)
ADL count	1.14**	1.04	1.40**	1.26**	1.15*
	(0.05)	(0.08)	(0.12)	(0.06)	(0.06)
iADL count	1.76**	1.71**	1.84**	1.60**	1.88**
	(0.09)	(0.13)	(0.19)	(0.08)	(0.11)
Functional limitations count	1.31**	1.42**	1.29**	1.06**	1.19**
	(0.02)	(0.05)	(0.06)	(0.02)	(0.03)
Constant	0.00**	0.00**	0.00**	0.04**	0.00**
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
Wave dummies	Yes	Yes	Yes	Yes	Yes
Observations	12,322	12,322	12,322	12,322	12,322

Notes: Relative risk ratios reported. Results based on the WHO classification Standard errors are clustered at individual level.
** indicates significance at 1% level, * - at 5% level and + - at 10% level.

Table 9. Multinomial Logit Results. Nursing, residential and other types of care. Full set of controls.

	Nursing and residential care	Other care	Non-respondent	Died
Obese Class III (BMI 45+)	2.16	1.97	1.38	1.37
	(0.00)	(0.00)	(0.00)	(0.00)
Obese Class II (BMI 35-44.9)	0.00[8]	1.54	1.04	0.89
	(0.00)	(0.00)	(0.00)	(0.00)
Obese Class I (BMI 30-34.9)	0.22	1.13	0.87	0.72
	(0.00)	(0.00)	(0.00)	(0.00)
Over-weight	0.76	0.96	0.83	0.77
	(0.00)	(0.00)	(0.00)	(0.00)
Under-weight	2.82	1.33	1.18	2.32
	(0.00)	(0.00)	(0.00)	(0.00)
Physical exercise	0.32	0.63	0.58	0.36
	(0.00)	(0.00)	(0.00)	(0.00)
Drinking	0.19	0.88	0.76	0.70
	(0.00)	(0.00)	(0.00)	(0.00)
Ever smoked	0.74	1.04	1.09	1.18
	(0.00)	(0.00)	(0.00)	(0.00)
Currently smoking	2.58	0.93	0.99	1.43
	(0.00)	(0.00)	(0.00)	(0.00)
Female	1.03	1.42	1.17	0.54
	(0.00)	(0.00)	(0.00)	(0.00)
No qualifications	1.16	0.98	1.45	1.30
	(0.00)	(0.00)	(0.00)	(0.00)
Non white	0.00	0.81	1.69	0.99
	(0.00)	(0.00)	(0.00)	(0.00)
Age	1.15	1.06	1.04	1.11
	(0.00)	(0.00)	(0.00)	(0.00)
Married	0.22	1.21	1.43	1.01
	(0.00)	(0.00)	(0.00)	(0.00)
Number of children	0.98	1.03	0.98	0.96
	(0.00)	(0.00)	(0.00)	(0.00)
Alone	0.62	0.75	0.77	0.81
	(0.00)	(0.00)	(0.00)	(0.00)
Working	0.00	0.72	1.32	0.51
	(0.00)	(0.00)	(0.00)	(0.00)
Home owner	1.23	1.07	0.76	0.82
	(0.00)	(0.00)	(0.00)	(0.00)
Wealth (real pc)	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)
Income (real pc)	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)
High blood pressure	0.84	1.13	1.06	1.07

[8] This estimate is very small and the coefficient is 9.81e-08

	Nursing and residential care	Other care	Non-respondent	Died
	(0.00)	(0.00)	(0.00)	(0.00)
Diabetes	1.53	1.14	1.05	1.29
	(0.00)	(0.00)	(0.00)	(0.00)
Cancer	0.00	1.04	1.01	2.80
	(0.00)	(0.00)	(0.00)	(0.00)
Lung disease	0.39	1.31	1.14	1.73
	(0.00)	(0.00)	(0.00)	(0.00)
Heart disease	0.89	1.31	1.25	1.65
	(0.00)	(0.00)	(0.00)	(0.00)
Stroke	2.05	1.44	1.28	1.36
	(0.00)	(0.00)	(0.00)	(0.00)
Psychological problems	1.24	1.23	1.02	0.97
	(0.00)	(0.00)	(0.00)	(0.00)
Arthritis	0.68	1.41	1.07	0.92
	(0.00)	(0.00)	(0.00)	(0.00)
ADL count	1.05	1.14	1.25	1.14
	(0.00)	(0.00)	(0.00)	(0.00)
iADL count	1.83	1.76	1.60	1.89
	(0.00)	(0.00)	(0.00)	(0.00)
Functional limitations count	1.27	1.32	1.06	1.19
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.00	0.00	0.04	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Wave dummies	Yes	Yes	Yes	Yes
Observations	12,322	12,322	12,322	12,322

Notes: Relative risk ratios reported. Results based on WHO classification. Standard errors are clustered at individual level. ** indicates significance at 1% level, * - at 5% level and + - at 10% level.