Socio-economic determinants of anthropometric measures of abdominal adiposity among older people in England

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Abstract

Objective: to look into the socio-economic determinants of levels of three anthropometric measures of abdominal adiposity among older people in England -body mass index, waist circumference (WC), and waist-hip ratio (WHR)- and of changes along two health risk classifications: the World Health Organisation classification based on BMI levels and the WHO combined classification based on BMI and waist circumference measurements..

Design: quantile regression and multinomial analysis using data from the English Longitudinal Study of Ageing (ELSA), wave 2 (2004-05) and wave 4 (2008-09)

Results: The quantile analysis on levels led to disparate results depending on the wave, which would question results previously published based on only one wave. However, we found that age tends to present an inverse U-shaped relationship with BMI and WC, smoking is negatively associated with BMI and positively with WC and WHR, alcohol consumption is negatively associated with BMI and WC levels, net total wealth is negatively related with the three anthropometric measures, educational attainment is negatively associated with each measure, and depression is positively associated with each measure. The multinomial analysis found that living in a larger household size increases the likelihood of becoming or remaining unhealthy irrespective of which classification we used. Furthermore, using the BMI-based categorisation, the initial category is highly relevant as a predictor of the category four years later and alcohol consumption would be positively associated with being or becoming obese. From the combined BMI-WC categorisation, we found that net total wealth would be negatively associated with becoming or remaining unhealthy whereas depression is a significant predictor of becoming or remaining unhealthy.

Keywords: malnutrition, obesity, socio-economic determinants, older people, body mass index, waist circumference, waist-hip ratio.

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1. Introduction

It is generally accepted that being either underweight or obese are health risk factors amongst the older population and that the former poses greater risk than being obese among older people (ref. 1). However, how to define obesity in the older population is a matter of debate (ref. 2).

Obesity is measured by a variety of methods[4]. The two field methods most often used in large surveys and epidemiological studies are anthropometry and bioelectrical impedance[5]. The three main anthropometric measures of abdominal adiposity are the body mass index (BMI) –a measure of general adiposity- and the waist circumference and the waist-hip ratio (both measures of central adiposity). Of these, BMI is, by far, the most well-known and widely used indicator of adiposity. Bioelectrical impedance analysis, in turn, estimates body composition by measuring the conductance of low-level electrical current that is passed through the body.

Body Mass Index

There seems to be a U-shaped pattern between BMI and mortality among older people irrespective of sex, with largest risks associated with lower BMI followed by BMI levels denoting obesity, though mortality risk is usually lowest for those with a BMI between 25.0–29.9 kg/m^2, whom according to the World Health Organisation (WHO) would be classified as overweight (ref. 3; ref. 4; ref.5).[6]

The WHO classification has been criticised especially when applied to older people –in particular because of the seemingly healthy consequences amongst the elderly of being overweight. There is less disagreement, though, about the health consequences for older people of qualifying as either underweight or obese under the WHO classification. Albeit not unanimously[7], it is generally accepted that a BMI value of 20 Kg/m^2 or under is a good measure of underweight among older people[8] and the WHO guidelines for obesity are also widely used in studies of older people (e.g. ref. 8). Consequently, we defined two BMI-related risk health states for older people: malnutrition (BMI<20 Kg/m^2) and obesity (BMI>30 Kg/m^2).

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[4] See ref. 6 for a short summary and ref. 7 for a book-length exposition.
[5] Other methods, such as densitometry, dual-energy X-ray absorptiometry, and magnetic resonance imaging, though more precise, are more expensive to administer.
[6] Ref. 8 argues that studies that focus on mortality would be masking the true relationship between BMI and health status: they found that BMI is positively associated with three biomarkers of health risk: high-sensitivity CRP (mg/dL) (for inflammation), HbA1c (%) (for metabolic function), and HDL cholesterol (mg/dL) (for cardiovascular function).
[7] Ref. 21
[8] See, for example, ref. 22. Ref. 23 and ref. 24 also use this guideline in their studies of malnutrition among elderly subjects.

Even regardless their relationship with mortality risk, BMI levels have been found to be positively associated with three biomarkers of health risk: high-sensitivity CRP (mg/dL) (for inflammation), HbA1c (%) (for metabolic function), and HDL cholesterol (mg/dL) (for cardiovascular function) – see ref. 9. Furthermore, ref. 10 found that older adults with a BMI under 18.5 Kg/m^2 were at higher risk of diabetes than those with BMI levels between 18.5 Kg/m^2 and 24.9 Kg/m^2. Similarly, a recent study among older people in Taiwan (ref. 11) found that BMI was positively associated with undiagnosed diabetes in men and were significantly associated with impaired fasting glucose in both men and women. Significant associations have also been found between obesity and mobility disability and physical impairment among older people (ref. 12; ref. 2; and ref.13). Moreover, about 5.5% of all cancers in the UK have been attributed to overweight and obesity –an estimated 17,294 excess cases in 2010 (ref. 14). Finally, the association between BMI and frailty also shows a U-shaped curve, with greatest risk outside the 25-29.9 Kg/m^2 BMI levels (ref. 15).

Alternative Anthropometric Measures

BMI is a good predictor of mortality among older people in the US only after adjusting for waist circumference (ref. 16). The World Health Organisation (ref. 17) produced a combined BMI-waist circumference classification of adults' relative health risk to type 2 diabetes and cardiovascular disease (Table 1).

Table 1
Risk to type 2 diabetes and cardiovascular disease
by combined BMI and Waist Circumference categories

	Waist circumference (cms.)			
		Low	high	Very High
	Males	<94	94-102	>102
BMI (kg/m^2)	Females	<80	80-88	>88
Normal weight (18.5 to <25)		No increased risk	No increased risk	Increased risk
Overweight (25 to <30)		No increased risk	Increased risk	High risk
Obese (30 to <35)		Increased risk	High risk	Very high risk

Source: ref. 17

Waist circumference predicts long-term mortality among older people with chronic heart failure, whereas BMI does not (ref. 18). Waist-hip-ratio is a strong predictor of all-cause mortality in high-functioning older adults, whereas neither BMI nor waist circumference were associated with mortality (ref. 19). In the same vein, mortality risk among people aged 75 and over is associated with waist-hip ratio whereas the BMI measure tends to overestimate this risk; in turn, waist circumference is not related to mortality risk (ref. 20).

Lisko et al. investigated the predictive power of mortality of BMI, waist circumference and waist-hip ratio among people aged 90 and over and found that low BMI and a low waist circumference were positively associated with mortality among men, whilst for women waist-hip ratio adjusted for BMI was the only statistically significant predictor of mortality (ref. 25). Contrastingly, ref. 26 found that excess deaths were similarly attributable to BMI and a number of alternative anthropometric measures, including waist circumference and waist-hip ratio, among US adults. Similarly, among older people higher BMI levels (both for men and women) and waist circumference and waist-to-hip measures (in men) were significantly associated with increased survival (ref. 27).

Waist circumference is significantly associated with increased risks of major depressive symptoms among US adults (ref. 28). In contrast, Ho et al. (ref. 29) found that BMI was inversely associated with depressive symptoms among older people in China, but did not find any significant association between depressive symptoms and either waist circumference or waist-hip ratio.

Given the disparate findings in the literature, in this paper we use BMI, waist circumference and the waist-hip ratio as measurements of underweight and obesity.

Goya Wannamethee et al. (ref. 30) recommended a composite measure of waist circumference and mid-arm muscle circumference (a measure of muscle mass) as a proxy for body composition among older subjects. We have not included any electrical impedance measures, because they are not incorporated in the HES/ELSA surveys. In addition, Nishiwaki et al. (ref. 31) suggested that BMI would overestimate the prevalence of obesity among older people because it does not allow for spine curvature (i.e. kyphosis)[9] and therefore alternative measures, such as armspan[10] or demi-span[11], have been proposed instead of height. However, no measures of mid-arm circumference, armspan or demi-span are included in HSE or ELSA, and therefore, we could not use any of such alternative measures.[12]

Socio-economic position (SEP), social roles and circumstance, and cultural aspects have a bearing on the nutritional and healthy/unhealthy weight status among older people (ref. 32-34).

[9] See, for example, ref. 31.
[10] See, for example, ref. 35-36.
[11] Ref. 37
[12] Incidentally, the prevalence of kyphosis or lordosis in the UK is not high: they made up only 0.0029% of the primary diagnosis of all finished consultant episodes (increasing to 0.0035% amongst people aged 75 or over) and 0.00002% of all outpatient attendances in NHS Hospitals and NHS commissioned activity in the independent sector in England in 2010-11. (Source: ref. 38).

A number of papers have studied socio-economic determinants of obesity and/or malnutrition, or both, for different countries and time periods (e.g. ref. 38-43[13]). However, only a handful looked specifically into older people as opposed to merely introducing age as an explanatory factor in models spanning the entire adult population.

Costa-Font, Fabbri and Gil (ref. 44) analysed the differences in BMI distributions between Spain and Italy and looked in particular into three cohorts: those people aged between 18-39, 40-59, and 60-75. Among the latter group, the BMI gap between both countries remained relatively constant for both sexes.

Costa-Font, Fabbri and Gil (ref. 45) report the contribution of different independent variables on the BMI gap by age cohorts (defined as ages 18-35, 36-50, and 51-65) between Spain and Italy. Among men aged between 51 and 65 years old, the obesity gap between these countries is explained by the influence of eating habits and peer effects, whereas among women in this age cohort peer effects is the only significant variable accounting for the difference in BMI levels between both countries.

Pieroni and Salmasi looked into the British Household Panel Survey datasets for 2004 and 2006 to study the socio-economic determinants of body weight by means of quantile regressions. Compared to the complete sample, they did not find significant differences in the coefficients of the covariates affecting the weight distribution of people aged over 50, except for age in central quantiles (ref. 46).

Lee et al. (ref. 47) studied the association between mortality risk and changes in weight and body composition among older men in the US. They found a higher risk of mortality for men with weight, total lean mass and total fat loss, as well as a slightly higher risk among those who had gained total fat mass.

We seek to answer two research questions:

- which socio-economic variables have been associated with each of the three main anthropometric measures of abdominal adiposity of older people between 2005 and 2009; and
- which socio-economic variables are associated with the transitions between three categories of BMI-related risk health and with transitions between combined BMI-Waist Circumference risk health categories among older people between 2004/06 and 2008/09.

This paper is structured as follows. Section 2 describes the data and Section 3 explains the econometric approaches. Section 4 presents and discusses the results whilst Section 5 concludes.

[13] See ref. 48 for a survey of economic causes of obesity.

2. Data

We used the English Longitudinal Study of Ageing (ELSA), wave 2 (which corresponds to years 2004-05) and wave 4 (2008-09). ELSA is a representative annual cross-sectional survey of people aged 50 years and over, living in private households in England[14] –the sample is drawn from households that previously responded to the Health Survey of England (HSE) [15].

Figures 1 to 3 present the average BMI levels and the incidence of underweight (BMI<20 Kg/m^2) and of obesity (BMI>30 Kg/m^2) for men and women aged 50 and over between 1998 and 2009, respectively, using data from the HSE. Over this period, obesity has increased for both men and women, whereas the prevalence of underweight has stayed more or less constant at around 1.3 per cent for men and 3.1 per cent for women.

<Insert here Figures 1, 2 & 3>

We included the following variables as covariates (see Annex for a description of each variable):

- Age and age squared
- Total net (non-pension) wealth. We included total net (non-pension) wealth because it is deemed preferable to income in ELSA-based studies (ref. 49-50).
- Highest Educational Qualification. Recently, using different statistical approaches, both ref. 51 for 10 European countries and ref. 52 in France found that higher measures of BMI and waist circumference in adults are associated with lower educational levels.
- Economic activity. We defined it as a dichotomous variable with economic activity=1 for being in employment and economic activity=0 for being unemployed or inactive.
- Household size
- Ethnicity. We defined it as a dichotomous variable with ethnicity=1 for being white and ethnicity=0 for being Asian, Black, or Mixed.
- Marital status. We defined it as a dichotomous variable with marital status=1 for being married or in cohabitation (and status=0 for being single, divorced, separated or widowed).

[14] For a description of ELSA Wave 2, see ref. 53, and ref. 54 for a description of Wave 4.
[15] For a description of the HSE, see ref. 55.

- Smoking. The effects of smoking on body weight remain unclear. For example, whilst Fang et al. (ref. 56) found negative effects of smoking among underweight individuals whilst non-significant effects among obese subjects, ref. 57 found positive effects of smoking along the whole BMI distribution: it increases BMI at low and moderate BMI levels and decreases BMI at high BMI levels.
- Alcohol consumption. The association between alcohol consumption and BMI levels seems to be conditional on gender. A study of adult higher level drinkers across 10 European countries found that females were more likely to have a lower BMI whereas male drinkers generally weighed more than male abstainers (ref. 58). Similarly, ref. 59 and ref. 60 found that moderate alcohol consumption was associated with a lower risk of obesity in older women. In turn, ref. 61 found that alcohol consumption is associated with lower risk of obesity among older men.
- Digestive system condition. Obesity and underweight are associated with a number of digestive disorders such as gastro oesophageal reflux disease, Barrett's oesophagus, precancerous polyps and cancer in the colon, acute pancreatitis, fatty liver disease, etc. We included the HES question on digestive system problems to control for these gastroenterological conditions[16].
- Loneliness. Whilst mixed results have been found regarding the relationship between loneliness and BMI among young cohorts (ref. 62), loneliness is generally more accepted as a predictor of malnutrition among older people (ref. 63-64).
- Depression, which has been found to be associated with low appetite and malnutrition in older people (ref. 65).
- Sitting height ratio (SHR). A number of authors have recommended incorporating this variable as a covariate in nutritional studies given that the BMI indicator might overestimate the prevalence of overweight and obesity among adults (e.g. ref. 66,67[17], 68). Moreover, a study among Chinese older people found SHR a predictor of systolic blood pressure, pulse pressure, fasting blood glucose, LDL and HDL cholesterol, and diabetes even when differences in BMI levels were accounted for (ref. 69), giving more weight to the inclusion of SHR as a confounder.

  On the other hand, we also checked whether an SHR-adjusted BMI would be significant different from the observed BMI indicator. For this test, we followed the procedure recommended in Norgan and Jones (ref. 70) and ran a univariate regression model between

[16] Unfortunately, we could not control for diabetes as the HES datasets do not include the variable “doctor-diagnosed diabetes excluding pregnant” in 2007 and 2008. However we included this variable in an extended model for 2009, whose results we report.

[17] Although see ref. 71 for a contrasting finding to ref. 67.

BMI and the SHR (at each wave) and obtained the SHR-adjusted BMI as the sum of the predicted BMI for the mean SHR and the residuals of the regression. Similarly to Bouças Ribeiro et al. (ref. 72) we failed to find any statistically significant differences between both metrics (r^2=0.9874 at wave 2 and r^2=0.9868 at wave 4). Hence, we kept SHR as a covariate in our model but used the observed BMI measurements as dependent variable.

To investigate changes over time, we defined two additional variables to operationalise the transitions:

- BMI risk category. We defined BMI risk categories given that, as mentioned earlier, being underweight or obese constitute health risk factors among older people. Because being underweight poses a higher risk than being obese, we distinguished between these two unhealthy categories. Hence, we have the three following possible BMI risk categories:
  - Unhealthy underweight (BMI < 20.0 9 kg/m^2)
  - Unhealthy obese (BMI > 29.9 kg/m^2)
  - Healthy: normal or overweight (BMI >20.0 and <29.9 kg/m^2)

These three categories at each wave leads to nine possible transitions between waves. Table 2 presents the movers in and stayers[18] between each BMI risk category between both waves:

Table 2
Transitions between BMI Risk Categories
ELSA Waves 2 and 4

Transitions	Cases
Underweight - Underweight	57
Underweight -Normal/Overweight	18
Underweight -Obese	1
Normal/Overweight - Underweight	29
Normal/Overweight -Normal/Overweight	2,149
Normal/Overweight -Obese	176
Obese-Normal/Overweight	123
Obese-Obese	783
Total	3,366

- WHO combined BMI-waist circumference risk category. We used the WHO classification as shown in Table 1, but we added BMI < 18.5 Kg/m^2 as a measure of underweight -and, hence, of risk. Table 3 presents the transitions across the categories between Wave 2 and Wave 4:

[18] We did not use the movers-stayers Markov chain approach because we only had two periods (See ref. 73). For other recent longitudinal studies, see ref. 74-75.

Table 3
Transitions between WHO combined Risk Categories
(including Underweight)

No increased risk to No increased risk	786
No increased risk to Increased risk	194
No increased risk to High or Very High risk	73
Increased risk to No increased risk	94
Increased risk to Increased risk	302
Increased risk to High or Very High risk	271
High or Very High risk to No increased risk	38
High or Very High risk to Increased risk	132
High or Very High risk to High or Very High risk	1,419
Underweight to Underweight	11
Underweight to No increased risk	8
No increased risk to Underweight	8
Total[*]	3,336

[*] There have been no instances of transitions between being underweight in one wave and being at increased or higher risk though not underweight in the other wave –or vice versa.

ELSA Waves 2 and 4Table 4 presents a summarised classification of the previous table, which we used in our model. The only healthy outcome is a combination of BMI and waist circumference that poses no increased risk.

Table 4
Transitions between WHO combined Risk Categories
(including Underweight)

Healthy to Healthy	786
Healthy to Unhealthy	275
Unhealthy to Healthy	140
Unhealthy to Unhealthy	2,135
Total	3,336

3. Econometric techniques

To analyse the socio-economic determinants of BMI, waist circumference and waist-hip ratio we carried out a cross-sectional analysis with data from each wave to study the socio-economic determinants of obesity. We ran quantile regression models by gender for each wave –that is, two models per dependent variable per wave; twelve models in total. (Before running the quantile regressions, we checked for equivalence of the coefficients across selected quantiles -0.05, 0.10, 0.50, 0.75, 0.90 and 0.95- using the Wald test to see whether the quantile regression approach was justified.[19] We found that some covariates were significantly different from each other across some of the quantiles in each of the models, which led us to reject of the null hypothesis of equivalence and, consequently, to the adoption of quantile regressions[20]).

Quantile regression models are increasingly used in statistical analyses of obesity and malnutrition[21] because they allow for given socio-economic or clinical covariate to have different impacts along the BMI distribution. Quantile regression models are preferable to least-squares regression models when the statistical relationship between the independent variable and the covariates varies across conditional quantiles –that is, across segments of the sample defined according to conditional covariates (ref. 76). If this is the case, results from the conditional means are not informative enough, and are actually misleading when generalised to the whole distribution.

It is well-known that unlike least-squares regression, where the focus is on the conditional mean function that relates the mean changes in a dependent variable with the vector of covariates of one independent variables, quantile regression focuses on the quantiles of the conditional distribution of the dependent variable expressed as functions of the observed covariates of independent variables (ref. 77-78). The θ^{th} quantile of a sample ($0 < \theta < 1$) may be defined as the minimum of:

$$\left[\sum_{t \in \{t \mid y_t \geq b\}} \theta \left| y_t - b \right| + \sum_{t \in \{t \mid y_t < b\}} (1-\theta) \left| y_t - b \right| \right]$$

where $\{y_t = 1,2,...,T\}$ is a random sample on a random variable Y and b is a parametric function –in our case, a linear function of parameters.

We computed the confidence intervals by using the Hall-Sheather bandwidth rule (ref. 78, ch. 3). We have also applied the bootstrapped standard errors of the quantile regression coefficients obtained by the Parzen, Wei and Ying (ref. 83) method after setting the number of replicates at 600 (following ref. 84)[22], but to save space we only report the results from the former method, as both have rendered similar results.

[19] Intriguingly, most papers which use quantile regressions do not report whether equivalence tests have been carried out before choosing quantile regression over least-squares or not. We understand that formally testing for the equivalence of the estimates across quantiles (and reporting the results in terms of the rejection or not of the equivalence hypothesis) should be considered best practice.
[20] Results can be requested from the corresponding author.
[21] Recent examples include ref. 79-82.
[22] We used the quantreg package (ref. 86) in R (ref. 87).

Secondly, we look into the socio-economic determinants of the changes across unhealthy and healthy BMI levels over time. For this, we made use of the longitudinal character of ELSA: we used a balanced panel excluding those respondents in wave 2 who were not interviewed in wave 4 as well as the new sample members added at wave 4.[23]

As defined in the previous section, both BMI risk and the WHO combined categories are polychotomous (or polytomous) categorical variables; consequently, we ran multinomial logit regression models[24] to analyse their association with the socio-economic covariates.[25]

4. Results

Socio-economic determinants of BMI, waist circumference and waist-hip ratio levels

It is well-known that cross-sectional data analysis does not allow for age or cohort[26] effects (ref. 85). The associations between the covariates and the dependent variables would remain fairly constant over time, at least in terms of signs and statistical significance, in the absence of these effects. However, if any of these confounding factors are present, different results from cross-sectional data for different time periods may be observed.

We observed differences in the statistical significance and/or signs of the coefficients of some variables in the cross-sectional quantile regressions for men.

An inferential procedure such as quantile regressions applied to data from the same source (the HES survey in this case) but for different years should render confidence intervals with similar probability coverage and same signs –except that:

- the relationship between the covariates and the dependent variable changed over time
- some methodological problems embedded in the data source (for example, sample size or changes in the definitions of certain variables) turned impossible to make inferences from cross-sectional results for different time periods
- there were confounding age and cohort effects, or a combination of these, which were not or could not be disentangled given the cross-sectional nature of the data

[23] We only looked into waves 2 and 4 because some key variables were not collected at waves 1 and 3.
[24] For an introduction to multinomial logit models, see ref. 88 (chapter 7).
[25] An alternative approach for BMI would be to look into changes in its levels; however, we were interested in the transitions into and out of risk levels rather than in changes in the levels in themselves.
[26] Also known as 'generation effects' (see, for example, ref. 89, chapter 11).

There are no theoretical reasons to assume that the association between socio-economic factors and any of the three anthropometric measures of abdominal adiposity we used as dependent variables has changed in England between the years under study.

With regards to methodological issues, the documentation of the HES, on which ELSA data are based, does not report of any major changes which might affect the consistency of the results.

Hence we have to assume that the disparate results are to do with confounding age and cohort effects. Moreover, in their longitudinal study using two waves of the British Household Panel Survey, Pieroni and Luca (ref. 90) added a time dummy variable, which was significant across all the quantiles (and in the OLS model). This led these authors to conclude that there would exist "unobserved time heterogeneity of individuals born in different periods" (op. cit., p. 7). We attempted to reduce this heterogeneity by running the cross-sectional quantile regressions on the balance panel samples –that is, we included the same individuals in both waves.

Furthermore, with regards to age effects, by introducing age and age squared as covariates in all the models we only accounted for possible age difference effects within each sample, but we cannot be certain of having controlled for age changes effects (ref. 91, chapter 13). This should lead to some caution in inferring results from cross-sectional analysis of socio-economic determinants of nutritional status. With this caveat, Tables 5-7 present the results for selected quantiles, as well as the OLS results, for BMI, Waist Circumference and Waist-Hip ratio, respectively.

Results for BMI (table 5)

Once adjusted for sitting height ratio, we found the following statistical associations for BMI levels:

- Age, where significant, presents an inverse U-shaped relationship with BMI.
- Smoking is negatively associated with BMI for some quantiles, and the same applies to alcohol consumption (here the relation is stronger).
- Being white increases the likelihood of being obese for men, whereas for women it increases the chance of being underweight.
- Living in a larger household would be related with being overweight or obese among men, but would have positive health effects among underweight women (as the larger the household, the larger the BMI measurement within this group).
- We obtained disparate findings for net total wealth, but generally speaking it is negatively related with BMI levels.
- Being married or in cohabitation might be associated with BMI levels among underweight women, but the direction of the association is unclear.

- Being in employment has almost no significant association with BMI.
- When significant, depression is positively associated with BMI.
- Loneliness is not related to BMI levels.
- A higher educational qualification is negatively related with BMI levels, particularly in the bottom half of the BMI distribution

Results for Waist Circumference (table 6)

- Age: Only in wave two we found any significant coefficients, which showed the inverse U-shaped pattern
- Smoking, when significant, was positively related with waist circumference measurements
- Alcohol consumption, when significant, showed an inverse relationship with waist circumference measurements, especially among the top 25 per cent of the distribution
- Being white is positively associated with waist circumference measurements among men in the two 25 per cent of the distribution, but negatively associated among women
- Living in a larger household is positively related with waist circumference measurement among men in the top half of the distribution but for women the association, though also positive, only holds in the bottom half of the distribution
- Net total wealth was strongly and negatively correlated with waist circumference measurement among women
- Marital status is hardly associated with waist circumference measures
- Being in employment is negatively associated with waist circumference measures among women
- We found a strong and positive relationship between being depressed and waist circumference measurement
- We found divergent regression results for loneliness, though it could be positively associated with waist circumference measurement in the top 10 per cent of the distribution (and also negatively associated in the bottom 10 per cent for men)
- Educational attainment is negatively associated with waist circumference measurement

Results for Waist-Hip Ratio (table 7)

For waist-hip ratio we found the most disparate results. The most consistent findings are:

- Smoking is positively associated with waist-hip ratio for both men and women for along most of the distribution
- Net total wealth is negatively associated in Wave 2, but not in Wave 4
- When significant, being depressed is positively associated with waist-hip ratio
- Educational attainment is negatively associated with waist-hip ratio

Socio-economic determinants of the changes across unhealthy and healthy categories

BMI-based classification (table 8)

- Considering that Wave 2 correspond to data from 2004-05 and Wave 4 to data from 2008-09, it is hardly surprising that being underweight or obese in Wave 2 is a very strong predictor of remaining in the same category by Wave 4 –except that we failed to find any statistical significance in the relationship between being underweight in Wave 2 and being obese in Wave 4. It is more (less) likely for someone to be underweight in Wave 4 if they underweight (obese) in Wave 2, as opposed to of normal weight. However, even though we found that it is more likely to be obese in Wave 4 if the person was already obese in Wave 2 –as opposed to of normal weight-, being underweight in Wave 2 does not reduce the probability of being obese in Wave 4 compared to being of normal weight in Wave 2.
- The BMI-health risk category in Wave 2 is the only predictor for being underweight in Wave 4. However, being or becoming obese by Wave 4 is positively related to two other covariates: living in a larger household and alcohol consumption. Furthermore, we found that the sitting height ratio measure in Wave 2 is also positively related to being or becoming obese in Wave 4.

Table 8
Multinomial logistic regression
Dependent variable: Transitions between BMI Health Risk Categories
ELSA Waves 2 and 4

Base category = Normal or Overweight in Wave 4				
Underweight in Wave 4				
	Estimate	**Robust Std. Err.**	**t**	**P>|t|**
Sex	0.381	0.39	0.98	0.329
Marital Status	0.091	0.649	0.14	0.888
Underweight in Wave 2	*5.579*	*0.405*	*13.79*	*0*
Obese in Wave 2	*-13.621*	*0.251*	*-54.23*	*0*
Loneliness	-0.082	0.116	-0.71	0.478
Depression	0.072	0.125	0.57	0.565
Age	-0.112	0.329	-0.34	0.734
Age2	0.001	0.002	0.44	0.663
Household Size	-0.122	0.492	-0.25	0.805
Smoking	-0.442	0.35	-1.26	0.207
Economic Status	-0.058	0.401	-0.14	0.886
Wealth	0	0	-1.2	0.23
Alcohol consumption	-0.003	0.088	-0.03	0.973
Sitting Height Ratio	7.933	7.13	1.11	0.266
Constant	-5.362	12.922	-0.41	0.678
Obese in Wave 4				
	Estimate	**Robust Std. Err.**	**t**	**P>|t|**
Sex	0.148	0.136	1.09	0.274
Marital Status	-0.154	0.186	-0.83	0.408
Underweight in Wave 2	-0.476	1.07	-0.44	0.656
Obese in Wave 2	*4.365*	*0.136*	*31.98*	*0*
Loneliness	0.066	0.048	1.38	0.169
Depression	0.036	0.054	0.67	0.502
Age	0.148	0.126	1.17	0.241
Age2	-0.001	0.001	-1.49	0.135
Household Size	*0.242*	*0.134*	*1.8*	*-0.072*
Smoking	0.055	0.137	0.4	0.69
Economic Status	-0.153	0.169	-0.91	0.365
Wealth	0	0	-1.24	0.214
Alcohol consumption	*-0.059*	*0.033*	*-1.79*	*-0.073*
Sitting Height Ratio	*7.508*	*4.251*	*1.77*	*-0.077*
Constant	*-10.73*	*4.585*	*-2.34*	*-0.019*

N= 3,273

Wald chi2(28) = 12,691.30

Prob > chi2 = 0.0000

Log pseudolikelihood = -1078.6997

Pseudo R2 = 0.5194

Combined BMI-Waist Circumference categories (table 9)

- Living in a larger household size increases the likelihood of becoming or remaining unhealthy.

- In contrast, net total wealth is negatively associated with becoming or remaining unhealthy.
- Age shows an inverse U-shaped relationship with remaining within a BMI-waist circumference unhealthy combination. The same holds for being depressed: people who were classified as unhealthy in terms of their BMI-waist circumference category and were also depressed in Wave 2 were more likely to remain within the unhealthy category by Wave 4 compared to those who were not depressed in Wave 2.

Table 9
Multinomial logistic regression
Dependent variable: Transitions between WHO combined BMI-Waist Circumference Risk Categories
ELSA Waves 2 and 4 (reduced version - see Table 4)

Base transition = From Healthy to Healthy												
	Healthy-Unhealthy				**Unhealthy-Healthy**				**Unhealthy-Unhealthy**			
	Coef.	**Robust Std. Err.**	**z**	**P>|z|**	**Coef.**	**Robust Std. Err.**	**z**	**P>|z|**	**Coef.**	**Robust Std. Err.**	**z**	**P>|z|**
Sex	-0.047	0.153	-0.31	0.759	0.235	0.205	1.15	0.25	-0.03	0.092	-0.32	0.748
Marital Status	-0.045	0.211	-0.21	0.831	-0.286	0.301	-0.95	0.342	-0.006	0.135	-0.04	0.965
Loneliness	0.013	0.052	0.25	0.806	-0.079	0.078	-1.01	0.312	-0.001	0.033	-0.03	0.978
Depression	0.007	0.07	0.1	0.921	0.063	0.087	0.73	0.467	0.078	0.04	1.96	*-0.049*
Age	0.197	0.123	1.61	0.108	0.143	0.152	0.94	0.345	0.315	0.082	3.86	*0*
Age 2	-0.001	0.001	-1.63	0.103	-0.001	0.001	-0.91	0.363	-0.002	0.001	-3.91	*0*
Household Size	0.34	0.159	2.15	*-0.032*	0.292	0.23	1.27	0.205	0.257	0.102	2.51	*-0.012*
Smoking	0.074	0.13	0.57	0.568	0.244	0.146	1.68	*-0.094*	-0.048	0.083	-0.57	0.568
Economic Statu	0.019	0.192	0.1	0.921	-0.219	0.256	-0.85	0.393	-0.148	0.119	-1.24	0.216
Wealth	0	0	-2.38	*-0.017*	0	0	-0.23	0.815	0	0	-2.84	*-0.005*
Alcohol consum	-0.032	0.037	-0.88	0.377	-0.011	0.047	-0.23	0.817	-0.031	0.022	-1.39	0.165
Constant	-8.076	4.245	-1.9	*-0.057*	-6.781	5.371	-1.26	0.207	-9.786	2.81	-3.48	*0*

N= 3,273

Wald chi2(33) = 61.93

Prob > chi2 = 0.0017

Log pseudolikelihood = - 2967.7182

Pseudo R2 = 0.0113

5. Conclusions

This paper has looked into the socio-economic determinants of three anthropometric measures of abdominal adiposity -body mass index, waist circumference and waist-hip ratio- among people aged 50 or over in England in 2004-05 (ELSA Wave 2) and 2008-09 (ELSA Wave 4), and also into the transitions across health risk categories between these years.

With regards to the socio-economic determinants of levels of BMI, waist circumference or waist-hip ratio, we found disparate results depending on the wave, even though we ran our models using a balanced panel –that is, with data from the same individuals in both waves. This leads us to conclude that researchers should be more cautious when reporting results regarding socio-economic determinants of nutrition or obesity from one cross-sectional dataset. Despite these differing results, we can draw the following general conclusions:

- Age tends to present an inverse U-shaped relationship with BMI and Waist Circumference
- Smoking is negatively associated with BMI and positively with WC and WHR
- Alcohol consumption is negatively associated with BMI and WC levels
- Net total wealth is negatively related with the three anthropometric measures.
- Educational attainment is negatively associated with each measure.
- Depression is positively associated with each measure.

The transitional element of this paper allowed us to obtain some results with regards to the probability of remaining or becoming healthy or unhealthy according to two classifications developed by the World Health Organisation –one based on BMI levels and the other one on the combination between BMI and WC.

We found that living in a larger household size increases the likelihood of becoming or remaining unhealthy irrespective of which classification we used. Other conclusions depend on the classification adopted (and therefore on the definition of healthy/unhealthy):

Using the BMI-based categorisation, we found that the initial category is highly relevant as a predictor of the category four years later and that alcohol consumption would be positively associated with being or becoming obese.

From the combined BMI-WC categorisation, we found that net total wealth would be negatively associated with becoming or remaining unhealthy whereas depression is a significant predictor of becoming or remaining unhealthy.

One limitation of this study, and of its data source, is that it only considered non-institutionalised subjects. For example, in a study of older residents in institutionalised and non-institutionalised settings in India obesity was found more prevalent among non-institutionalised older people (ref. 92). Also for India, malnutrition was more prevalent among older people in residential and nursing homes than those living at home (ref. 93).

Conflict of interest: The authors declare no conflict of interest.

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Table 5
Quantile Regression Coefficients
Dependent Variable: Body Mass Index

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Males - Wave 2	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Intercept	1.4	2.27	1.76	4.38	2.27	4.96	1.94	6.6	1.27	2.16	2.19	3.64	1.69	3.18	2.21	8.4
Age			0.03	3.49												
Age Sq			0	-3.97											0	-2.12
Smoking					-0.02	-2.72					0.03	2.45				
Alcohol							-0.01	-2.63	-0.01	-2.49			-0.01	-2.58	0	-2
Ethnicity											0.15	3.06	0.09	3.68		
Sitting Height Ratio	1.16	3.03			1.11	3.38	2.18	6.35	2.03	10.92	1.81	3.14	1.76	6.9	1.31	6.07
Household Size									0.04	2.18	0.03	2.19	0.04	2.86	0.02	2.2
Net Total Wealth	0	2.52	0	-2.34												
Married																
Employment																
Depression							0.02	2.59	0.02	4.78	0.02	2.36	0.02	2.1	0.01	3.76
Loneliness																
Educational attainment																

Table 5 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Males - Wave 4	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	73.72	2.12	50.66	2.32	76.17	2.2	74.43	7.44	73.24	2.55					2.76	13.87
Age							0.33	2.01								
Age Sq							0	-2.35								
Smoking							-0.07	-2.56	-0.26	-7.12	-0.29	-8.05				
Alcohol	0.98	2.51									-1.14	-3.17	-1.04	-2.09		
Ethnicity											8.76	2.81				
Sitting Height Ratio							28.2	3.16							0.81	4.1
Household Size					1.64	2.2					2.96	2.2			0.03	3.74
Net Total Wealth									0	-2.57	0	-4.57				
Married																
Employment																
Depression									1.91	4.06						
Loneliness																
Educational attainment							-0.58	-2.98	-1.71	-4.65					-0.01	-2.88

Table 5 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Females - Wave 2	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	1.81	4.24	1.52	4.46	1.79	3.57			1.82	3.62	2.05	4.57	1.39	2.39	1.85	6.5
Age			0.02	4.52	0.03	2.25					0.03	2.43	0.05	4.16	0.02	2.76
Age Sq			0	-5.16	0	-2.23					0	-2.79	0	-4.5	0	-2.87
Smoking																
Alcohol					-0.01	-2.16	-0.02	-3.76	-0.01	-3.71	-0.01	-3.94	-0.02	-5.07	-0.01	-3.31
Ethnicity	-0.07	-2.35	-0.11	-4.21									-0.11	-3.34		
Sitting Height Ratio	1.78	4.98	1.69	4.34	1.36	4.13	3.4	5.78	1.57	4.29	1.26	2.94	1.47	2.97	1.68	6.41
Household Size	0.03	5.36			0.03	2.58									0.02	2.62
Net Total Wealth	0	-4.7	0	-5.24	0	-3.44	0	-3.46	0	-3.5	0	-4	0	-3.66	0	-5.98
Married	-0.02	-3.17														
Employment																
Depression																
Loneliness																
Educational attainment	-0.01	-2.67	-0.01	-2.21			-0.01	-3.02							-0.01	-2.21

Table 5 (cont'd)

	Percentile															
	-5		**-10**		**-25**		**-50**		**-75**		**-90**		**-95**		**OLS**	
Females - Wave 4	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	2.43	8.83	2.48	8.34	2.24	3.42	1.69	3.26	3.08	5.92	3.15	5.67	3.01	3	2.74	12.48
Age																
Age Sq																
Smoking			-0.01	-2.15	-0.04	-3.48					-0.03	-2.24			-0.03	-3.18
Alcohol					-0.01	-2.23	-0.02	-3.81	-0.01	-2.84	-0.02	-4.21	-0.02	-2.86	-0.01	-3.29
Ethnicity			-0.1	-6.7			0.16	2.21								
Sitting Height Ratio	0.86	4.8	0.9	2.61	1.25	3.19	2.46	3.63	1.29	4.75	1.14	3.1			1.32	6.35
Household Size	0.03	2.76	0.02	2.45	0.03	2.61									0.02	2.27
Net Total Wealth	0	-2.18	0	-4.48	0	-16.11									0	-4.61
Married	0.01	2.49	0.01	2.64									0.01	2.95		
Employment					-0.03	-2.1	-0.05	-2.2							-0.03	-2.36
Depression			0.01	2.56	0.01	2.49	0.03	3.36	0.02	3.39	0.02	3			0.01	3.43
Loneliness																
Educational attainment			-0.01	-2.99	-0.01	-2.57	-0.02	-3							-0.01	-3.46

Note: we only report coefficients statistically significant at 10 percent of confidence level.

Table 6

Quantile Regression Coefficients

Dependent Variable: Waist Circumference

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Males - Wave 2	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept					47.25	2.06	89.04	4.3	79.04	2.71			125.39	3.95	71.61	3.89
Age	1.56	2.88			1.4	2.17										
Age Sq	-0.01	-3.05			-0.01	-2.18										
Smoking											2.35	5.53	1.37	3.75		
Alcohol											-0.67	-2.92	-0.64	-2.38		
Ethnicity											9.81	3.9	9.16	5.05		
Household Size					1.65	2.11					2.71	2.37	2.93	3.17	1.37	2.27
Net Total Wealth									0	-2.51						
Married																
Employment													2.97	2.29		
Depression					0.95	2.56	1.21	3.39	1.47	5.11	0.8	2.02			0.93	3.57
Loneliness	-1.25	-4.35	-0.72	-2.8					0.71	2.56			0.95	2.59		
Educational attainment							-0.51	-2.64	-0.48	-2.25					-0.32	-2

Table 6 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Males - Wave 4	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept			78.45	3.85	93.42	4.42	100.07	7.23	95.04	5.07	89	4.23	86.67	3.21	93	7.08
Age																
Age Sq																
Smoking									-0.17	-5.56						
Alcohol											-0.59	-2.31				
Ethnicity											11.59	5.01	3.71	2.06		
Household Size			1.59	2.29					1.96	2.4	2.66	3.06	3.65	2.46	1.6	2.71
Net Total Wealth					0	9.16					0	-10.64				
Married																
Employment													4.2	2.34		
Depression									1.04	3.16	1.12	2.54	2.06	2.98		
Loneliness																
Educational attainment							-0.69	-3.5	-1.21	-5.11					-0.52	-3.13

Table 6 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Females - Wave 2	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept							63.41	3.85	88.75	4.38	89.64	4.42	73.22	2.26	52.98	3.16
Age			1.9	2.32	1.24	2.37	0.82	2.09					1.71	2.08	1.18	2.53
Age Sq			-0.01	-2.09	-0.01	-2.18	-0.01	-2.29			-0.01	-2.52	-0.02	-2.68	-0.01	-2.61
Smoking							1.33	2.19			1.48	2.85				
Alcohol									-0.63	-3.4	-0.61	-3.07			-0.27	-2
Ethnicity			-2.69	-2.06												
Household Size	1.7	2.91	2.36	2.64	1.92	3.95									1.3	2.07
Net Total Wealth	0	-2.31	0	-2.39	0	-5.4	0	-5.82	0	-9.04	0	-14.11	0	-3.43	0	-5.46
Married																
Employment									-2.65	-2.42	-4.34	-3.6	-4.95	-2.07		
Depression							0.71	2.61	1.1	3.49	0.88	2.83			0.61	2.69
Loneliness																
Educational attainment			-0.47	-2.69	-0.7	-4.13									-0.39	-2.38

Table 6 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Females - Wave 4	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	78.07	2.36	65.34	2.51	87.7	4.5	107.13	8.43	125.77	13.01	129.92	5.37	134.08	6.34	98.63	7.69
Age																
Age Sq																
Smoking																
Alcohol									-0.74	-3.6	-0.9	-4.77	-1.39	-3.97	-0.39	-2.88
Ethnicity											-9.05	-5.33	-13.08	-4.61		
Household Size			2.06	3.03							1.82	2.19				
Net Total Wealth	0	-2.58	0	-10.19	0	-3.07					0	-23.85			0	-4.2
Married											0.83	4.19	0.85	2.7		
Employment					-2.06	-2.13	-2.91	-2.97			-3.5	-3.39			-2.31	-2.89
Depression					0.64	2.08	0.72	2.37	0.66	2.05					0.68	2.9
Loneliness											0.87	3.3	0.99	2.23		
Educational attainment	-0.7	-2.6	-0.73	-3.69	-0.68	-3.61	-0.61	-2.77	-0.55	-2.2					-0.51	-3.01

Note: we only report coefficients statistically significant at 10 percent of confidence level.

Table 7
Quantile Regression Coefficients
Dependent Variable: Waist-Hip Ratio

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Males - Wave 2	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	0.48	3.62	0.6	2.83	0.63	5.04	0.81	7.23	1.04	7.28	1.01	8.57	1.04	3.82	0.84	8.14
Age	0.01	3.34														
Age Sq	0	-3.43														
Smoking									0.02	3.26	0.02	5.07			0.01	3.9
Alcohol											0	-3.32				
Ethnicity					0.04	7.02	0.01	2.82			0.02	2.05				
Household Size											0.01	2.13				
Net Total Wealth	0	-2.16			0	-2.35	0	-2.7			0	-2.66				
Married	-0.01	-2.57									-0.02	-2.28				
Employment																
Depression					0.01	2.35	0	2.79	0.01	2.97	0.01	4.87	0.01	2.43	0	3.39
Loneliness			-0.01	-3.03												
Educational attainment					0	-2.12	0	-3.15	0	-2.65			-0.01	-2.64	0	-3.35

Table 7 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Males - Wave 4	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	0.99	4.77	0.94	6.13	0.99	10.49	0.9	7.91	0.87	12.3	1.05	8.22	0.85	7.9	0.94	13.24
Age									0	2.02			0.01	2.13		
Age Sq									0	-2.02			0	-2.6		
Smoking	0	5.18	0	8.88	0	6.22					0	8.79			0	2.3
Alcohol																
Ethnicity																
Household Size																
Net Total Wealth																
Married											0	2.16				
Employment																
Depression									0.01	3.17	0	4.16				
Loneliness																
Educational attainment			-0.01	-3.26	-0.01	-4.1	-0.01	-5.14	-0.01	-3.87	-0.01	-3.95	-0.01	-3.03	0	-5.44

Table 7 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Females - Wave 2	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Intercept	0.59	4.38	0.69	4.45	0.7	7.86	0.65	5.83	0.77	5.63	0.58	2.36			0.72	8.21
Age																
Age Sq																
Smoking	0.02	3.65	0.01	5.13	0.01	3.93	0.02	4.73	0.01	3.19	0.01	3.91			0.01	4.8
Alcohol																
Ethnicity	0.03	3.34	0.02	2.81												
Household Size																
Net Total Wealth			0	-7.45			0	-2.22	0	-4.63	0	-5.15			0	-3.81
Married																
Employment																
Depression	0.01	2.4			0	3.15					0.01	2.18			0	2.84
Loneliness	0	-2.11														
Educational attainment			0	-2.86	0	-4.24	0	-3.82	0	-2.27					0	-3.78

Table 7 (cont'd)

	Percentile															
	-5		-10		-25		-50		-75		-90		-95		OLS	
Females - Wave 4	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	0.66	10.63	0.74	9.02	0.72	16.02	0.82	8.82	1.03	10.32	1.08	8.34	1.14	6.37	0.87	12.77
Age																
Age Sq																
Smoking			0.02	3.36	0.01	2.79	0.01	5.46							0.01	2.09
Alcohol	0	3.14									0	-3.13	-0.01	-3.01		
Ethnicity	0.05	5.47														
Household Size																
Net Total Wealth									0	-10.61					0	-2.65
Married																
Employment																
Depression	0.01	2.83	0.01	2.72	0.01	3.31										
Loneliness	0	-2.74														
Educational attainment	-0.01	-3.84	-0.01	-4.8	0	-3.56			0	-2.47					0	-3.49

Note: we only report coefficients statistically significant at 10 percent of confidence level.

Annex – Variables used from the English Longitudinal Study of Ageing (ELSA)

Variable in our revised model	Definition of the variable in our revised model	Original Variable	Original Description in HSE	Coding Under the HSE_08		Coding Under our Revised Model	
indager	Age	indager	Definitive age variable collapsed at 90 plus	Numeric (for those who aged more than 90, the code is 99).		Numeric (However, 90 for all aged over 90).	
fqethnr	Ethnicity	fqethnr	Ethnicity recoded into white and non-white	Value = 1	Label = White	Value = 0	Label = White
				Value = 2	Label = Non-white	Value = 1	Label = Non-white
heskb	Extent of smoking	heskb	Number of cigarettes smoke per weekday	Numeric		Value = 0	Label = 0
						Value = 1	Label = 0<x<=10
						Value = 2	Label = 10<x<=20
						Value = 3	Label = x>20
wpdes	Economic Status	wpdes	Best description of current situation	Value = 1	Label = Retired	Value = 0	Label = Retired/Sick/Unemployed
				Value = 2	Label = Employed		
				Value = 3	Label = Self-employed		
				Value = 4	Label = Unemployed	Value = 1	Label = Employed
				Value = 5	Label = Permanently sick or disabled		
				Value = 6	Label = Looking after home or family		

Annex (cont'd)

Variable in our revised model	Definition of the variable in our revised model	Original Variable	Original Description in HSE	Coding Under the HSE_08		Coding Under our Revised Model	
marstat	Marital Status	dimar	Respondent current marital status	Value = 1	Label = Single, that is never married	Value = 0	Label = Single/Widowed/Separated
				Value = 2	Label = Married, first and only marriage		
				Value = 3	Label = Remarried, second or later marriage		
				Value = 4	Label = Legally separated	Value = 1	Label = Married/ Remarried
				Value = 5	Label = Divorced		
				Value = 6	Label = Widowed		
Loneliness	Loneliness	scfeela+scfeelb+scfeelc+scfeeld	scfeela: How often respondent feels they lack companionship	Value = 1	Label = Hardly ever or never	Numeric 4<= x <=12	
				Value = 2	Label = Some of the time		
				Value = 3	Label = Often		
			scfeelb: often respondent feels left out	Value = 1	Label = Hardly ever or never		
				Value = 2	Label = Some of the time		
				Value = 3	Label = Often		
			scfeelc: How often respondent feels isolated from others	Value = 1	Label = Hardly ever or never		
				Value = 2	Label = Some of the time		
				Value = 3	Label = Often		
			scfeeld: How often respondent feels in tune with the people around them	Value = 1	Label = Hardly ever or never		
				Value = 2	Label = Some of the time		
				Value = 3	Label = Often		

Annex (cont'd)

Variable in our revised model	Definition of the variable in our revised model	Original Variable	Original Description in HSE	Coding Under the HSE_08		Coding Under our Revised Model
depression	Depression	Psceda+ Pscedb + Pscedc + Pscedd + Pscede + Pscedf + Pscedg + Pscedh	PScedA: Whether respondent has felt depressed much of the time during the past week	Value = 1	Label = Yes	Numeric 0<=x<=8
				Value = 2	Label = No	
			PScedB: Whether respondent felt everything they did during the past week was an effort	Value = 1	Label = Yes	
				Value = 2	Label = No	
			PScedC: Whether respondent felt their sleep was restless during the past week	Value = 1	Label = Yes	
				Value = 2	Label = No	
			PScedD: Whether respondent was happy much of the time during the past week	Value = 1	Label = Yes	
				Value = 2	Label = No	
			PScedE: Whether respondent felt lonely much of the time during the past week	Value = 1	Label = Yes	
				Value = 2	Label = No	
			PScedF: Whether respondent enjoyed life much of the time during the past week	Value = 1	Label = Yes	
				Value = 2	Label = No	
			PScedG: Whether respondent felt sad much of the time during the past week	Value = 1	Label = Yes	
				Value = 2	Label = No	
			PScedH: Whether respondent could not get going much of the time during the week	Value = 1	Label = Yes	
				Value = 2	Label = No	

Annex (cont'd)

Variable in our revised model	Definition of the variable in our revised model	Original Variable	Original Description in HSE	Coding Under the HSE_08		Coding Under our Revised Model	
hhtot	Number of household	hhtot	Number of people in household/ computed	Numeric		Value = 1	Label = 1
						Value = 2	Label =2
						Value = 3	Label = 3 or above
sex	sex	sex	Sex	Value = 1	Label = Male	Value = 0	Label = Male
				Value = 2	Label = Female	Value = 1	Label = Female
bmival_wave	bmival at wave	bmival	Valid BMI - inc estimated>130kg	Numeric		Numeric	
nettotw_bu_v	BU total (non-pension) wealth at wave	nettotw_bu	BU total net (non-pension) wealth	Numeric		Numeric	
shratio2	Sitting height ratio	sithgt/htval	sithgt = Sitting height measurement (cm) htval = Valid height (cm)	Numeric		Numeric	