# Body Weight Outcomes and Food Expenditures Among Older Europeans: A simultaneous equation approach

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**Abstract.** We analyze the inter-relationships between body weight outcomes and food expenditures among older Europeans using a simultaneous equation model. Several statistical tests were conducted to assess endogeneity of selected variables, the exogeneity, relevance, and validity of instruments used, and the identification of the model. Our results generally suggest, contrary to normative views, that food-away-from-home expenditure is negatively related to body mass index (BMI). BMI is negatively related to the percentage of food spent away from home.

**Keywords:** Body Mass Index, food expenditures, simultaneous equations

## 1. Introduction

Ageing is becoming one of the most salient social, economic, and demographic phenomena in the world. This issue is particularly acute in Europe due to decreasing birth rates and ageing baby boom generation (i.e., the largest generation born in the 1950s and 1960s). Consequently, Europe now has the highest proportion of population aged 65 or over in the world [1]. Population projections by Eurostat indicate that in 2008 about 17,3% of the EU25 population are aged 65 or over and that this will rise to 34,6% in 2050. If those between 60 and 65 years old are also included, the numbers rise to 22,6% for 2008 and 41,4% for 2050.

Another important phenomenon is the obesity epidemic. Obesity is increasing worldwide in dramatic rates. WHO indicated that there were 1.6 billion overweight adults and at least 400 million obese adults in the world in 2005 [2]. By 2015, these figures are expected to rise to 2.3 billion overweight and 700 million obese adults. Obesity effects on health are well supported by the medical literature and include a long non-exhaustive list that includes osteoarthritis, sleep apnea, asthma, high blood pressure, gallbladder disease, cholesterol, type II diabetes, cardiovascular disease, stroke, renal and genitourinary diseases [3-8]. Obesity may also inflict severe emotional harm, such as social stigmatization, depression, and poor body image.

Society is rightly alarmed at the rise in obesity among the young and middle-aged since they generally threaten the health status of the working population. However, obesity is also increasing rapidly among older people with higher health consequences. Older obese patients have been found to have worse health profiles than both non-obese older patients and obese younger patients in terms of many parameters, including blood pressure and cholesterol [9]. Hence, obesity combined with the increased number of older people will place additional burdens on the healthcare system. For example, in a US study using longitudinal data from 1992 to 2001, older men (women) who were overweight or obese at age 65 had 6%–13% (11%-17%) more lifetime health care expenditures than the same age cohort with normal weight [10].

Food consumption is obviously a big part of the problem associated with increased body weight outcomes but have not been given due attention in the literature. In addition, there has been a lot of attention paid lately on the nutritional quality of the food served in the away from home market such as restaurants and fast food establishments. The lawsuits in the US against fast food companies regarding the alleged detrimental health effects of their products have not helped the image of the food-away-from-home (FAFH) industry (e.g. the Pelman vs. McDonalds' lawsuit) and have resulted in some cries for policy intervention from interest groups and public health advocates. However, the important question is: are these demands for policy intervention justified? Is FAFH really positively associated with body weight outcomes? To answer this question, one needs to examine the complex inter-relationships between FAFH expenditures and body weight outcomes. A few studies have examined this issue in the US. For example, You and Davis [11] assessed the influence of household food expenditures, parental time allocation and other parental factors on children's obesity-related health outcomes by using a unique dataset drawn from 300 households in Houston, Texas. Kyureghian et al. [12] used data from National Eating Trends in the US and model the relationship between food expenditures and obesity by service type and meal occasion. However, to our knowledge, no other study has examined the interrelationship between body weight and FAFH expenditures among older Europeans.

To fill this void, we focus our analysis on older Europeans due to the increasing importance of the older segment of the European population. We model this inter-relationship using a simultaneous-equation model. Due to the challenges in developing such a model, we conduct several statistical tests to assess endogeneity of selected variables, the exogeneity, relevance, and validity of instruments used, and the identification of the model.

The following sections present a short literature review, the data, empirical specification, estimation, results, and concluding remarks.

## 2. Literature review

Many researchers have provided economic and non-economic explanations on what determines the caloric imbalance that causes obesity. Several explanations have been proposed. Some authors, for example, argue that it is the "Law of Least Effort", implemented through innovations that reduce the amount of effort required to accomplish a task, and the taste-nutrition trade off, where strong taste preferences have been genetically passed on to humans through generations, which in turn influence consumption and obesity [13]. Other studies suggest that obesity rates are related to agricultural innovation that has lowered food prices and to demand factors such as declining physical activity resulting from technological changes in home and market production [14]. That is, technological change has contributed to the rise in obesity either by lowering the cost of consuming calories and/or by raising the cost of expending them [15]. In addition, the prevalence of fast-food restaurants, prices of alcohol and cigarettes [16], lower time costs of food preparation resulting from technological changes in mass food preparation [17] and even the rise of sprawl patterns of land development [18] have been linked to rising obesity. In a cross-country comparison among OECD countries, Loureiro and Nayga [19] showed that the percentage of female labour force participation positively affects obesity rates. Likewise, Anderson et al. [20] found that the intensity of a mother's work over a child's lifetime has a positive effect on a child's likelihood of being overweight.

Lakdawalla and Philipson [21] discuss the theoretical approaches that economists have taken to study obesity. They distinguish between neoclassical and behavioural theories of weight gain and discuss how these interrelate. The neoclassical theories rest upon the capital investment model of weight [e.g. 14, 15] and the rational addiction model of weight [22]. The capital investment model stresses that agricultural technological advancements have induced lower food prices while the cost of calorie expenditure has become higher at the same time as home and market production became more sedentary. The rational addiction model complements the capital investment model by making food addictive: increasing food consumption today makes it necessary to increase food consumption in the future.

While the neoclassical theories of weight gain assume that individuals are rational and forward looking with respect to their weight, Cutler et al. [17] adopt a behavioural economics view by arguing that individuals have self-control problems and therefore discount the future quasi-hyperbolically vis-à-vis exponentially, as a rational-neoclassical consumer would do. Lakdawalla and Philipson [21] lean toward the neoclassical view since they note that while behavioural theories add a useful explanatory element, they do not adequately explain time trends and differences across countries.

Cawley [22], on the other hand, uses the rational addiction model [23] and considers obesity as the result of an addiction to calories. He found support for the hypothesis that caloric consumption is addictive. Dockner and Feichtinger [24] also apply the rational addiction model to eating decisions. They assume that food consumption is addictive and show that consumption decisions, and the consequent weight path, can exhibit cycles with gradual increases followed by gradual decreases.

In other models, consumers rationally balance satisfaction from current and future consumption with a risk for life from being over- and under-weight [25]. Levy [25] has set out a dynamic model where eating is neither addictive nor a form of habit. He found that when physiological, psychological, environmental and socio-cultural reasons for divergence from a physiologically optimal weight do not exist, the steady state for an expected lifetime-utility maximiser is a state of overweightness. He also showed that the rationally optimal stationary level of overweightness increases with an individual's rate of time-preference but declines with his/her rate of caloric expenditures.

Levy [26] has developed a similar dynamic model where he incorporated taste, price and risk differences between a junk food and a healthy food into an expected lifetime-utility-maximizing framework under the assumptions that junk food is cheaper and tastier than health food. Mancino [27] models food consumption on a per meal basis over a finite planning period. Goldfarb et al. [28] develop a static model that includes the benefits of food consumption ("satisfaction from food") and the negative effects that arise from weight above or below ideal weight. Their model, similar to Levy [25], generates "optimal overweightness".

Suranovic and Goldfarb [29] adopt a bounded rationality approach to an individual's food consumption and dieting decisions. They assume that food consumption has three possible effects on individual utility: a positive benefit from food consumption, a negative utility effect resulting from weight gain and a negative effect caused by dieting. Their results show that an individual will occasionally choose to diet, but that diet will reduce weight only temporarily. Hence, recurrence of weight gain provides a rationale for cyclical dieting.

None of the studies discussed above assessed the inter-relationship between obesity and food expenditures. Our aim is to fill this void in the literature, focusing on an increasingly very important segment of the population: older Europeans. Due to the cross-sectional nature of our data, which will be discussed next, we will be able to examine the inter-relationships between obesity and two types of food expenditures: food at home and food away from home. However, we are not able to focus on the dynamic patterns of these inter-relationships due to lack of access to longitudinal data.

## 3. Data Description

We use a European micro dataset, the Survey of Health, Ageing and Retirement in Europe (SHARE), which contains data on health, socio-economic status and social and family networks of individuals aged 50 or over. Eleven countries have participated in the 2004 SHARE baseline study, representing the various regions in Europe; namely Scandinavia (Denmark and Sweden), Central Europe (Austria, France, Germany, Switzerland, Belgium, and the Netherlands), and Southern Europe (Spain, Italy and Greece).

The SHARE data used in our analysis are drawn from Release 2.0.1 of the Survey of Health, Ageing and Retirement in Europe. SHARE was designed following the US Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA). SHARE is the first European dataset that includes information on physical and mental health as well as income and assets information of the older Europeans.

The data consist of information from 28,517 individuals in the 11 countries mentioned above. Table 1 provides sample characteristics by country, gender and age groups. The age group of less than 50 years old represents younger spouses or partners of age eligible respondents. Table 1 also displays the household response rates and the individual response rates. For methodological details see Börsch-Supan [1] and Börsch-Supan and Jürges [30].

The SHARE dataset contains a variety of physical and mental health measures like Body Mass Index (BMI), chronic diseases and hand grip strength[1]. Several other variables reflect individual's lifestyle like smoking, exercise and excessive drinking of alcohol as well as demographic factors like age, gender, household size, urbanization and total income. In addition, the SHARE dataset includes information about household expenditures on Food-at-Home (FAH) and FAFH[2] as well as purchasing power parity coefficients in the various countries. Although FAH and FAFH are based on recall questions, Browning et al. [35] provide

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[1] Hand grip strength has been shown to be correlated with mental and physical health and is predictive of the incidence of functional limitations, disability and even mortality in old age [31-34]. It is measured using a handheld dynamometer – where respondents are asked to press a lever as hard as they can. The dynamometer shows grip strength in kilograms.

[2] Food Away From Home includes food *eaten* away from home as well as food *prepared* away from home.

evidence that respondents can accurately report such expenditures in recall questions. Recall questions on food expenditures are also common in several surveys like the US Consumer Expenditure Survey (CEX), the Canadian Out of Employment Panel (COEP) and Family Expenditure Survey (FAMEX), the Italian Survey on Household Income and Wealth (SHIW) and others.

Observations with incomplete information on the variables of interest were dropped from the analysis thus leaving us with 25,075 valid cases. Figures 1(*a*) and (*b*) present mean food expenditures for at-home and away-from-home consumption of older Europeans by weight status and regions of Europe. Scandinavians spend on average less for FAH and FAFH than Central and Southern Europeans. The Southern Europeans spend more than other Europeans on FAH but less than Central Europeans on FAFH. In terms of weight status, it appears that as weight increases, mean food expenditures decrease. The exception is Southern Europeans where it seems that on average heavier individuals spend slightly more on FAH than others.

Figures 2(*a*) and (*b*) show mean food expenditures by weight status and age categories. Lower mean expenditures for at-home and away-from-home consumption for older individuals may stem from declining energy needs that are related with ageing. Heavier individuals also spend less on FAFH consumption, with underweight individuals being an exception since their consumption lies on average in between the spending of normal weight and obese individuals. The pattern is not so clear for at-home consumption but in general, it seems that as weight increases mean food expenditures increase for all age groups.

## 4. Empirical Specification

To model the relation between obesity and food expenditures, we use a two-equation model depicted below:

$$BMI = \mathrm{a}_0 + \mathrm{a}_1\, TF + \mathrm{a}_2\, PFAFH + \mathbf{a_3 X} + \mathbf{a_4 Z}_1 + u \qquad (1)$$

$$PFAFH = b_0 + b_1 BMI + \mathbf{b}_2\mathbf{X} + \mathbf{b_3 Z_2} + e \qquad (2)$$

where *BMI* is Body Mass Index, *TF* is total food expenditures, *PFAFH* is percentage of food spent on Food-Away-From-Home, **X** is a vector of demographic variables like age, gender and household size, $\mathbf{Z_1}$ is a vector of health related determinants that can influence BMI, $\mathbf{Z_2}$ is a vector of country-level socio-economic determinants that can influence food expenditures and *u* and *e* are the associated error terms. Even though FAH expenditures are not included explicitly in the system we can draw inferences for FAH when we have in mind that percentage of FAH=100-PFAFH. We use this formulation because it allows us to examine how expenditures are allocated between FAH and FAFH when total food expenditures remain constant rather than just having FAH and FAFH as independent variables.

The $\mathbf{Z_1}$ vector includes variables that are presumed to affect BMI: number of cigarettes smoked per day (*NumCig*), a dummy for physical inactivity (*PHinactiv*), the maximum grip strength of the respondent (*MaxGrip*), number of chronic diseases the person suffers from (*Chronic*), and a dummy that identifies excessive alcohol drinkers (*Drinking*). The $\mathbf{Z_2}$ vector includes variables that are presumed to capture differences in expenditures between countries due to socio-economic conditions: the purchasing parity coefficient (*PPP*), GDP per capita (*GDPPC*, in thousands €), inflation rate (*Inflat*), unemployment rate (*Unempl*) and a socio-economic index (*Socioecon*)[3]. We could have used dummies for each country but we believe that this specification is superior to a specification that captures random differences between countries in relation to food expenditures. *PPP* serves as a proxy for prices that are unavailable in the SHARE dataset. It equalizes the purchasing power of different currencies in home countries for a given basket of goods. PPP takes into account the relative cost of living and the inflation rate of the different countries which then gives a good proxy for between-countries comparison of prices. One can easily see that by the order condition both equations are over-identified[4].

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[3] GDP per capita was extracted from Penn tables (http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php), inflation and unemployment rate were extracted from EconStats (http://www.econstats.com/index_gl.htm) and the socio-economic index was taken from the International Country Risk Guide (http://www.prsgroup.com/ICRG.aspx).

[4] The order condition of identifiability requires that the number of predetermined variables excluded from the equation must not be less than the number of endogenous variables included in that equation less 1, that is:

In the next section, we undertake a series of tests to assess the validity of our selected instruments. Table 2 exhibits the variables used in the analysis, their description, and some basic descriptive statistics.

# 5. Estimation

Two of the widely used single-equation estimation methods are the Instrumental Variables (IV) estimator (two-stage least squares/2SLS) and the general method of moments estimator (GMM). However, the conventional IV estimator is inefficient in the presence of heteroskedasticity and the usual approach when facing heteroskedasticity of an unknown form is to use the GMM estimator. If heteroskedasticity is indeed present, the GMM estimator is more efficient than the simple IV estimator, whereas if heteroskedasticity is not present the GMM estimator is no worse asymptotically than the IV estimator. However, the GMM estimator may have poor small sample properties and if in fact the errors are homoskedastic, IV would be preferable. We conducted tests for the presence of heteroskedasticity proposed by Pagan and Hall [36][5] [37, 38]. As exhibited in Table 3 the null of homoskedastic disturbances is rejected in both equations.

We therefore estimate all our equations with the two-step feasible general method of moments (2S-GMM)[6]. Although a system estimator could be used (e.g. 3SLS), the efficiency gains would be attenuated since a large number of exogenous variables are common across equations [40]. Efficiency gains increase as the exogenous variables across equations become less correlated.

The calculated standard errors are robust to deviations from *i.i.d.* disturbances i.e. arbitrary heteroskedasticity and arbitrary intragroup correlation (the latter is due to the fact that multiple observations may come from the same household in our dataset e.g. husband and wife). Households' identification number served as the cluster/group variable. Before presenting the estimated results, we conduct endogeneity tests for the assumed endogenous regressors, tests on the relevance of the instruments (under- and weak- identification), tests for over-identifying restrictions, and tests for the exogeneity of the instruments [41].

## 5.1 Endogeneity tests

The first step we undertake in this series of tests is to test whether the assumed endogenous regressors are actually endogenous. The null hypothesis is that the specified endogenous variables can be treated as exogenous. The test statistic is distributed as $\chi^2$ with degrees of freedom equal to the number of variables tested. Under *i.i.d.* assumptions, this endogeneity test statistic is numerically equal to a Hausman test statistic [38]. The reported test statistic in Table 4 is robust to violations of homoskedasticity. The null is rejected in both cases. Hence, the endogenous variables cannot be treated as exogenous.

## 5.2 Testing the relevance of the instruments

To test if our instrumental variables are relevant, that is, sufficiently correlated with the included endogenous variables, we use several statistics. The partial $R^2$ of Bound *et al.* [42] is a statistic commonly used for this purpose. The partial $R^2$ is the $R^2$ of the first stage regression with the included instruments "partialled out", which is equivalent to an *F*-test of the joint significance of the excluded instruments [see 38 for more details]. While this statistic is sufficient for the specification of equation (2) where only one endogenous variable is included (*BMI*), when multiple endogenous regressors are used [like equation (1)**]**, other statistics are required. The Shea's partial $R^2$ [43] takes into account the inter-correlations among the instruments. The Shea's partial

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$K - k \geq m - 1$, where $K$ is the number of predetermined variables in the model, $k$ is the number or predetermined variables in a given equation and $m$ is the number of endogenous variables in a given equation.

[5] We used the *ivhettest* command in Stata 10.

[6] Equations were estimated with the *ivreg2* user-written module in Stata 10 [39]. However, in a latter section since we find evidence of weak instruments we also use Limited Information Maximum Likelihood estimation (LIML) and Fuller's LIML which are partially robust to weak instruments.

$R^2$ and the standard partial $R^2$ are equivalent when the model contains only one endogenous regressor. Baum *et al.* [38] propose as a rule of thumb that if the value of the standard partial $R^2$ is large and the value of the Shea's partial $R^2$ is small, then one can conclude that instruments lack sufficient relevance and the model may therefore be unidentified.

We can see from Table 5 that the *F*-test always rejects the null that the coefficients of the instruments from the first stage regressions are zero. Hence, the instruments pass the joint significance test. However, the partial $R^2$ values are small, making further inferences problematic. Other tests are then required. In Table 6, we report the LM test of the Kleibergen and Paap [44] rk statistic, distributed as $\chi^2$ with ($L_1$–$k_1$+1) degrees of freedom where $L_1$ is the number of excluded instruments and $k_1$ the number of endogenous regressors. The LM test is a test of under-identification, i.e. the excluded instruments are correlated with the endogenous variables. The null that the equation is under-identified is rejected in all cases, that is, all equations are identified.

In Table 7, we report the Wald *F* statistic of the Kleibergen and Paap [44] rk statistic which is a weak identification test of whether the excluded instruments are correlated with the endogenous regressors but only weakly. The statistic can be compared to the Stock and Yogo [45] compilation of IV critical values[7]. Baum and Schaffer [46] suggest this comparison even though they acknowledged that the critical values of Stock and Yogo [45] are for the *i.i.d.* case. Baum and Schaffer [46] suggest this as a sensible choice since no studies on testing for weak instruments in the presence of non-*i.i.d.* errors exists. The null hypothesis of Stock and Yogo [45] is that the given group of instruments is weak against the alternative that it is strong. The test rejects if the Wald *F* statistic exceeds the critical value. The null is rejected in the case of equation (2) but not for the case of equation (1). Although the critical values of Stock and Yogo [45] are only for the *i.i.d.* there is some indication that the group of instruments we used for equation (1) is weak. To cope with weak instruments, we complement our estimations with the Limited Information Maximum Likelihood (LIML) and the Fuller's modified LIML (FULL) estimators. The advantage of LIML estimation is that it is median unbiased: the median of its sampling distribution is generally close to the population parameter under the assumption of normal distribution of the error term [see 47].

## 5.3 Testing over-identifying restrictions

We validate our exclusion restrictions by employing over-identification tests using the Hansen's J statistic [46, 48]. The joint null hypothesis is that the instruments are valid instruments, i.e. uncorrelated with the error term. Failing to reject the null hypothesis provides some confidence in our identification assumption. Under the null, the test statistic is distributed as $\chi^2$ in the number of (*L*-*K*) over-identifying restrictions where *L* is the number of instruments (excluded and included) and *K* is the number of regressors of the equation (endogenous and exogenous). Obviously, the statistic cannot be calculated in the case of an exactly identified equation (*L*-*K* equals zero in this case). The Hansen's J statistic for the vector of instruments for equations (1) and (2) are reported in Table 8. The obvious rejection of the null hypothesis casts doubts on the exogeneity of one or more instruments of both instrument vectors.

The C statistic, on the other hand, allows a test of the exogeneity of one or more instruments. It is defined as the difference of the Hansen's J statistic of the equation with the smaller set of instruments and the equation with the full set of instruments i.e., including the instruments whose validity is suspect. This is equivalent to dropping excluded instruments from the instrument list.

We start by testing separately each of the instruments of the instrument vectors. Table 9a reports the Hansen's J statistic for the equation where the suspect instrument is excluded and the C statistic where under the null hypothesis, both the smaller set of instruments and the additional suspect instruments are valid. Rejection of the null requires that the full set of instruments is not valid. Basically we are looking for cases where when the suspect instrument is excluded from the set of full instruments, we fail to reject the null of the Hansen's J

[7] The Stock–Yogo weak instruments tests come in two flavors: maximal relative bias and maximal size. The first flavor is based on the ratio of the bias of the estimator to the bias of OLS and the second flavor is based on the performance of the Wald test statistic (rejection rate of the test). See Baum and Schaffer [46] for more details.

statistic but reject the null of the C statistic. This would in essence mean that the suspect instrument is indeed suspect (C statistic) and that by excluding it from the set of full instruments the rest of the instruments are valid (Hansen's J statistic), or that we fail to reject the null that the smaller set of instruments is valid. For equation (1) both of the tests show that each instrument when tested is indeed suspect (C-statistic) but still, when we excluded it from the set of full instruments the rest are not valid (Hansen's J statistic), which calls for further scrutiny of the instrument list. Therefore, in the second step, we do the same tests by excluding each time all possible pairs of the instruments for equation (1). Table 9b shows that among all possible pairs when both variables *Inflat* and *Unempl* are tested, they are suspect instruments (C-statistics) and when we exclude them from the instrument list the rest of the instruments are valid (Hansen's J statistic). Therefore for equation (1) we remove *Inflat* and *Unempl* from the instrument list.

For equation (2), the tests show (Table 9a) that the variables *Numcig* and *Drinking* are not suspect instruments (C-statistic) and when they are removed from the list of the instruments, the rest of the instruments are not valid (Hansen's J statistic). On the other hand, the tests for variables *PHinactiv*, *MaxGrip* and *Chronic* show that they are indeed suspect instruments (C-statistic) but when they are excluded from the set of full instruments, the rest of the instruments are not valid (Hansen's J statistic). Therefore, we keep the *Numcig* and *Drinking* variables and scrutinize the rest of the instruments. Table 9b shows that among all possible pairs of the *PHinactiv*, *Chronic* and *MaxGrip* instruments, when one of the pairs *Chronic-PHinactiv* or *Chronic-MaxGrip* is tested, it is a suspect pair of instruments (C-statistics) and when we exclude either pair of instruments from the instrument list, the rest of the instruments are valid (Hansen's J statistic). Therefore, we excluded these three variables from the instrument list.

In summary, the instruments we use for TF and PFAFH are *PPP*, *GDPPC* and *Socioecon* and the instruments we use for BMI are *Numcig* and *Drinking*.

### 5.4 Tests after correct specification of instrument list

After the correct specification of the instrument list, we re-run all tests reported in Tables 3 to 8 and report them in Table 10. Three points are worth noting: a) the heteroskedasticity test for equation (1) shows the absence of heteroskedasticity since we fail to reject the null of homoskedastic disturbances, b) the endogeneity test for equation (2) shows that we fail to reject the null that the specified endogenous variable (*BMI*) can be treated as exogenous and, c) the weak identification tests show that both instrument sets, $\mathbf{Z_1}$ and $\mathbf{Z_2}$ are weak.

Given the above points, we estimate equation (2) by OLS and report the FULL and LIML estimators for equation (1). Moreira's conditional likelihood (CLR) method (Moreira, 2003) cannot be employed for equation (1) since we have two endogenous variables.

## 6. Results

### 6.1 Body Mass Index equation

Table 11 shows the results from each equation. For equation (1) 2S-GMM, LIML and FULL methods are reported. Both endogenous variables (*TF*, *PFAFH*) have a negative and statistically significant coefficient. But what is the interpretation of these variables given the *ceteris paribus* context? The simple case is the interpretation of an increase of total food expenditures (*TF*): that is given that the percentage of FAFH (*PFAFH*) is held constant, an increase of total food expenditures is interpreted as an increase of FAFH. On the other hand, an increase of the percentage of FAFH (*PFAFH*) given that *TF* is held constant denotes a proportional increase of FAFH with respect to *TF*. Therefore, if FAFH is increased by *k*, then TF is increased by *k* (which implies that FAH is increased by *k*).

Obviously, expenditures and quantities mean two different things since the former also includes the concept of quality. Therefore, increases in food expenditures do not necessarily imply increases in consumed quantity. It could also imply that the household is spending more on better quality food. Two results come out for these coefficients: (a) individuals with higher FAFH expenditures have lower BMI's and (b) proportional increases in the FAH and FAFH expenditures are related to lower BMI's. Given that we know nothing about the quantity of foods consumed and that the demand for most foods are inelastic, this could as well be the result of buying better food quality rather than more quantity. These findings may imply that cries for policy intervention that would mandate some form of warning signs in the FAFH market similar to the situation in the smoking industry may not be entirely appropriate. Initiatives should perhaps target promotion of the quality of restaurant foods rather than just requiring some form of labeling that would inform consumers about the nutritional content of the foods.

We also find that older Northern and Central Europeans have lower BMIs (*Scandinavian*, *Central*) than Southern Europeans. For an average height person in our sample, Scandinavians and Central Europeans weigh 9.84Kg and 2.41Kg less than Southern Europeans, respectively (based on 2S-GMM/FULL results). In addition, urbanization seems to increase BMI of older Europeans. Specifically, older individuals residing in large cities and towns have higher BMIs than older individuals residing in villages, ceteris paribus. Household size and income both positively affect BMI. Number of cigarettes smoked per day and age are negatively related to BMI.

### 6.2 PFAFH expenditures equation

The parameter estimate of BMI in equation (2) suggests that BMI is negatively related to the percentage spent on FAFH products. In particular, for every 1 unit ($Kg/m^2$) increase in BMI (or by 2.79Kg for an average height individual), monthly percentage of FAFH expenditures will decrease by more than 0.2%. This may be an indication that overweight or obese individuals put an effort in controlling their BMI by spending less percentage of their food budget on FAFH products. Northern Europeans spend 3.2% lower percentage of their food budget on FAFH than Southern Europeans per month, while there is no statistically significant difference between Central and Southern Europeans. Perhaps tighter family bonds and the significance of the family tradition of eating together regularly at home in Southern Europe can explain this divergence between North and South Europe. Furthermore, gender (being male), urbanization, education, and total income positively affect the percentage of food spent away from home. On the other hand, as age increases, the percentage of FAFH expenditures decreases. This is also true for household size. In addition, as purchase power parity coefficient (*PPP*) and the socioeconomic index (i.e. better socioeconomic conditions) increase, the percentage of FAFH expenditures increases. On the other hand, higher GDP per capita is negatively associated with the percentage of food spent away from home.

## 7. Discussion and conclusions

The primary contribution of this article is the exploration of the relationship between body weight outcomes and food expenditures. To the best of our knowledge, this is the first time this issue is being explored among an increasingly very important segment of the population: the older Europeans who are expected to account for more than 40% of Europe's population by 2050.

To model the relation between body weight outcomes and food expenditures, we used a simultaneous equation system composed of two equations. Our results suggest, contrary to normative views, that away from home food expenditures negatively affect BMI and that BMI is negatively related to the percentage of the food budget spent away from home. Given that we lack data on quantity of the consumed food at- and away-from home, we maintain that higher expenditures on FAFH might also be related to purchase of better food quality (i.e., more nutritious food) rather than quantity alone which in turn could explain the negative relation to BMI. It is also possible that heavier older individuals will spend less percentage of their food budget on food away from home for weight control purposes. Future research could focus on definitively assessing the reasons for this finding.

Our findings are surprising but have significant implications given the increasing scrutiny that the food away from home sector is getting from governments and consumer interest groups with regards to the obesity issue. So is this scrutiny justified and thus warrant policy intervention? As previously mentioned, the behavioural economics argument is that individuals have self-control problems and do not make decisions that serve their own interests. This view, however, is complex normatively since it requires that we use something other than the Pareto approach to evaluating welfare. Given our findings, the implication seems to be that a policy intervention related to the food away from home and obesity issue is not warranted for older Europeans. But if a policy prescription is really needed, then a policy that is directed at promoting better nutritional quality of foods for food-away-from-home might be in order. However, our findings may not hold true for other segments of the population such as adolescents and younger adults. In addition, given the restrictive time dimension of the dataset we are unable to explore the dynamics of the relationship between food and weight. Future research should replicate our study for other segments of the population in Europe and also explore the effect of past food expenditures on current weight outcomes, given data availability.

**Table 1**. Sample characteristics: SHARE Data

| | | **Gender** | | **Age** | | | | **Response rates** | |
|---|---|---|---|---|---|---|---|---|---|
| **Country** | **Total** | **Male** | **Female** | **Under 50** | **50 to 64** | **65 to 74** | **Over 75** | **Household response rate*** | **Individual Response Rate*** |
| Austria | 1,893 | 782 | 1,111 | 44 | 949 | 544 | 356 | 55.60% | 87.50% |
| Germany | 3,008 | 1,380 | 1,628 | 65 | 1,569 | 887 | 487 | 39.20% | 90.50% |
| Sweden | 3,053 | 1,414 | 1,639 | 56 | 1,589 | 816 | 592 | 63.20% | 93.00% |
| Netherlands | 2,979 | 1,368 | 1,611 | 102 | 1,697 | 716 | 464 | 81.00% | 93.30% |
| Spain | 2,396 | 994 | 1,402 | 42 | 1,080 | 701 | 573 | 63.40% | 86.20% |
| Italy | 2,559 | 1,132 | 1,427 | 51 | 1,342 | 785 | 381 | 63.10% | 91.80% |
| France | 3,193 | 1,386 | 1,807 | 141 | 1,627 | 768 | 657 | 54.50% | 79.70% |
| Denmark | 1,707 | 771 | 936 | 92 | 916 | 369 | 330 | 61.60% | 87.80% |
| Greece | 2,898 | 1,244 | 1654 | 218 | 1,450 | 714 | 516 | 53.00% | 73.70% |
| Switzerland | 1,004 | 462 | 542 | 42 | 505 | 252 | 205 | 46.90% | 84.60% |
| Belgium | 3,827 | 1,739 | 2,088 | 128 | 1,947 | 992 | 760 | 38.80% | 86.90% |
| ***Total*** | *28,517* | *12,672* | *15,845* | *981* | *14,671* | *7,544* | *5,321* | *61.60%* | *85.30%* |

* Weighted average for main sample [see 30, for methodological details]

**Table 2**. Variable description

| ***Variable names*** | ***Variable description*** | ***Mean*** | ***S.D.*** |
|---|---|---|---|
| *TF* | Monthly household food expenditures in €, ppp-adjusted | 495.38 | 313.48 |
| *PFAFH* | Percentage of monthly household food away from home expenditure, ppp-adjusted | 12.69 | 14.65 |
| *BMI* | Body Mass Index | 26.37 | 4.29 |
| *Scandinavian* | Dummy for Scandinavian countries | 0.17 | 0.38 |
| *Central* | Dummy for Central Europe countries | 0.56 | 0.50 |
| *Southern* | Dummy for Mediterranean countries | 0.27 | 0.44 |
| *Gender* | Dummy for males | 0.45 | 0.50 |
| *EducYears* | Years of education | 10.15 | 4.46 |
| $Urb_1$ | Dummy, household resides in a big city or suburbs | 0.32 | 0.47 |
| $Urb_2$ | Dummy, household resides in a large town | 0.19 | 0.39 |
| $Urb_3$ | Dummy, household resides in a small town | 0.25 | 0.44 |
| $Urb_4$ | Dummy, household resides in a village | 0.23 | 0.42 |
| *Hsize* | Household size | 2.21 | 1.00 |
| *Age* | Age | 63.68 | 10.19 |
| *Log(Inc)* | Logarithm of total income, ppp-adjusted | 10.06 | 2.32 |

| | | | |
|---|---|---|---|
| *NumCig* | Number of cigarettes smoked per day | 3.20 | 8.02 |
| *PHinactiv* | Dummy for physical inactivity (never or almost never engaging in neither moderate nor vigorous physical activity) | 0.08 | 0.27 |
| *MaxGrip* | Maximum of grip strength measures | 34.49 | 12.30 |
| *Chronic* | Number of chronic diseases | 1.45 | 1.39 |
| *Drinking* | Dummy for drinking more than 2 glasses of alcohol every day | 0.14 | 0.35 |
| *PPP* | Purchase power parity coefficient | 1.02 | 0.12 |
| *GDPPC* | GRP per capita (in thousands of euros) | 27.24 | 3.64 |
| *Inflat* | Inflation rate | 1.94 | 0.68 |
| *Unempl* | Unemployment rate | 7.80 | 2.22 |
| *Socioecon* | Socioeconomic conditions index | 8.82 | 1.02 |

**Table 3**. Pagan and Hall [36] heteroskedasticity tests

| | **Equation** (1) **- BMI** | **Equation (2) - PFAFH** |
|---|---|---|
| **Pagan Hall statistic** | 336.725 | 394.865 |
| **p-values** | $\chi^2_{20}$ p-value = 0.000 | $\chi^2_{20}$ p-value = 0.000 |

**Table 4**. Endogeneity tests

| | **Endogenous variables** | **Chi-square(p-value)** |
|---|---|---|
| Equation (1) | *TF*<br>*PFAFH* | 88.368 (0.00) |
| Equation (2) | *BMI* | 23.594 (0.00) |

**Table 5**. Standard partial $R^2$, Shea's partial $R^2$ and $F$-test of the joint significance of the excluded instruments

| | **Endogenous variables** | **Shea's partial $R^2$** | **Standard partial $R^2$** | ***F*-test (p-value)** |
|---|---|---|---|---|
| Equation (1) | *TF* | 0.0146 | 0.0239 | 69.33 (0.00) |
| | *PFAFH* | 0.0018 | 0.0030 | 12.74 (0.00) |
| Equation (2) | *BMI* | 0.0503 | 0.0503 | 113.47 (0.00) |

**Table 6**. Kleibergen and Paap [44] rk LM statistic

| | **LM statistic (p-value)** |
|---|---|
| **Equation (1)** | 51.229 (0.00) |
| **Equation (2)** | 501.388 (0.00) |

**Table 7**. Kleibergen and Paap [44] rk Wald *F* statistic

| | **Wald *F* statistic** | **Stock and Yogo [45] weak identification test critical values:** | |
|---|---|---|---|
| | | 5% maximal IV relative bias | 13.97 |
| | | 10% maximal IV relative bias | 8.78 |
| | | 20% maximal IV relative bias | 5.91 |
| | | 30% maximal IV relative bias | 4.79 |
| **Equation (1)** | 10.432 | | |
| | | 10% maximal IV size | 19.45 |
| | | 15% maximal IV size | 11.22 |
| | | 20% maximal IV size | 8.38 |
| | | 25% maximal IV size | 6.89 |
| | | 5% maximal IV relative bias | 18.37 |
| | | 10% maximal IV relative bias | 10.83 |
| | | 20% maximal IV relative bias | 6.77 |
| | | 30% maximal IV relative bias | 5.25 |
| **Equation (2)** | 113.469 | | |
| | | 10% maximal IV size | 26.87 |
| | | 15% maximal IV size | 15.09 |
| | | 20% maximal IV size | 10.98 |
| | | 25% maximal IV size | 8.84 |

**Table 8**. Hansen's J statistic of overidentifying restrictions

| | **Equation (1) - BMI** | **Equation (2) - PFAFH** |
|---|---|---|
| **Hansen's J statistic** | 33.166 | 49.826 |
| $\chi^2_4$ **p-value** | 0.000 | 0.000 |

**Table 9a**. Test of subsets of regressors (Hansen's J statistics and C statistic)

| | **Equation (1) - BMI Instrument tested** | | | | | **Equation (2) - PFAFH Instrument tested** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *PPP* | *GDPPC* | *Inflat* | *Socioecon* | *Unempl* | *Numcig* | *PHinactiv* | *maxGrip* | *Chronic* | *Drinking* |
| **Hansen's J statistic (excluding suspect instrument)** | 18.878 | 17.129 | 23.062 | 20.161 | 16.454 | ***47.131*** | 45.907 | 11.700 | 6.593 | ***47.753*** |
| $\chi^2_3$ **p-value** | 0.0001 | 0.0002 | 0.0000 | 0.0000 | 0.0003 | ***0.0000*** | 0.0000 | 0.0085 | 0.0861 | ***0.0000*** |
| **C statistic** | 14.288 | 16.038 | 10.104 | 13.006 | 16.712 | ***2.695*** | 3.919 | 38.125 | 43.233 | ***2.073*** |
| $\chi^2_1$ **p-value** | 0.0002 | 0.0001 | 0.0015 | 0.0003 | 0.0000 | ***0.1007*** | 0.0477 | 0.0000 | 0.0000 | ***0.1499*** |

**Table 9b**. Test of subsets of regressors (Hansen's J statistics and C statistic)

| | Equation (1) - BMI<br>Instrument tested | | | | | | | | | | Equation (2) - PFAFH<br>Instrument tested | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *PPP, GDPPC* | *PPP, Inflat* | *PPP, Socioecon* | *PPP,Unempl* | *GDPPC, Inflat* | *GDPPC, Socioecon* | *GDPPC,Unempl* | *Inflat, Socioecon* | *Inflat, Unempl* | *Socioecon, Unempl* | *Phinactiv, MaxGrip* | *Phinactiv, Chronic* | *MaxGrip, Chronic* |
| **Hansen's J statistic (excluding suspect instrument)** | 5.402 | 16.275 | 16.774 | 12.544 | 17.081 | 15.325 | 15.355 | 18.617 | **1.652** | 15.415 | 8.326 | **4.121** | **2.035** |
| $\chi^2_3$ **p-value** | 0.0201 | 0.0001 | 0.0000 | 0.0004 | 0.0000 | 0.0001 | 0.0001 | 0.0000 | **0.1986** | 0.0001 | 0.0156 | **0.1274** | **0.3616** |
| **C statistic** | 27.764 | 16.891 | 16.392 | 20.622 | 16.085 | 17.842 | 17.812 | 14.549 | **31.514** | 17.752 | 41.500 | **45.705** | **47.791** |
| $\chi^2_1$ **p-value** | 0.0000 | 0.0002 | 0.0003 | 0.0000 | 0.0003 | 0.0001 | 0.0001 | 0.0007 | **0.0000** | 0.0001 | 0.0000 | **0.0000** | **0.0000** |

**Table 10.** Tests for equations after instrument specification

| | | Equation (1) - BMI | | Equation (2) - PFAFH |
|---|---|---|---|---|
| | | ***TF*** | **PFAFH** | **BMI** |
| Heteroskedasticity tests | Pagan Hall statistic (p-value) | 12.132 (0.669) | | 305.809 (0.000) |
| Endogeneity tests | Chi-square (p-value) | 105.723 (0.000) | | 1.256 (0.2624) |
| Relevance of the instruments | Shea's partial $R^2$ | 0.0093 | 0.0011 | 0.0024 |
| | Standard partial $R^2$ | 0.0086 | 0.0010 | 0.0024 |
| | $F$-test (p-value) | 43.29 (0.000) | 9.22 (0.000) | 10.84 (0.000) |
| | Kleibergen and Paap [44] rk LM statistic | 22.311 (0.000) | | 22.228 (0.000) |
| Weak identification test | Kleibergen and Paap [44] rk Wald $F$ statistic | 7.628 | **Stock-Yogo weak ID test critical values:**<br>10% maximal IV size 13.43<br>15% maximal IV size 8.18<br>20% maximal IV size 6.40<br>25% maximal IV size 5.45 | 10.835<br>**Stock-Yogo weak ID test critical values:**<br>10% maximal IV size 19.93<br>15% maximal IV size 11.59<br>20% maximal IV size 8.75<br>25% maximal IV size 7.25 |

**Table 11**. Estimation results

| | Equation (1) Dep. variable BMI | | | Equation (2) Dep. Variable PFAFH |
|---|---|---|---|---|
| | ***2S-GMM*** | ***LIML*** | ***FULL*** | ***OLS*** |
| *Constant* | 37.047*** (1.825) | 38.027*** (2.227) | 37.047*** (1.825) | 20.545*** (2.866) |
| *TF* | -0.010*** (0.002) | -0.010*** (0.002) | -0.010*** (0.002) | - |
| *PFAFH* | -0.293*** (0.081) | -0.344*** (0.102) | -0.293*** (0.081) | - |
| *BMI* | - | - | - | -0.205*** (0.031) |
| *Scandinavian* | -3.487*** (0.500) | -3.663*** (0.577) | -3.487*** (0.500) | -3.198*** (0.798) |
| *Central* | -0.856*** (0.180) | -0.875*** (0.196) | -0.856*** (0.180) | 0.580 (0.666) |
| *Gender* | 1.629*** (0.202) | 1.730*** (0.242) | 1.629*** (0.202) | 1.998*** (0.218) |
| *EducYears* | 0.153** (0.059) | 0.186** (0.072) | 0.153*** (0.059) | 0.562*** (0.037) |
| $Urb_1$ | 1.284*** (0.324) | 1.432*** (0.382) | 1.284** (0.324) | 2.472*** (0.445) |
| $Urb_2$ | 0.411* (0.234) | 0.423* (0.254) | 0.411* (0.234) | 0.128 (0.470) |
| $Urb_3$ | 0.289 (0.205) | 0.281 (0.223) | 0.289 (0.205) | -0.120 (0.422) |
| *Hsize* | 0.607*** (0.216) | 0.566** (0.241) | 0.607*** (0.216) | -1.327*** (0.165) |
| *Age* | -0.107*** (0.020) | -0.118*** (0.024) | -0.107*** (0.020) | -0.196*** (0.018) |
| *Log(Inc)* | 0.175*** (0.046) | 0.193*** (0.054) | 0.175 (0.046) | 0.279*** (0.062) |
| *NumCig* | -0.030*** (0.010) | -0.031*** (0.011) | -0.030*** (0.010) | - |
| *Drinking* | 0.161 (0.217) | 0.154 (0.236) | 0.161 (0.217) | - |
| *PPP* | - | - | - | 8.555*** (2.229) |
| *GDPPC* | - | - | - | -0.310*** (0.084) |
| *Socioecon* | - | - | - | 0.295* (0.155) |

*, **, *** indicate significance at 10%, 5% and 1% level respectively. Standard errors in parenthesis.

(*a*)

(*b*)

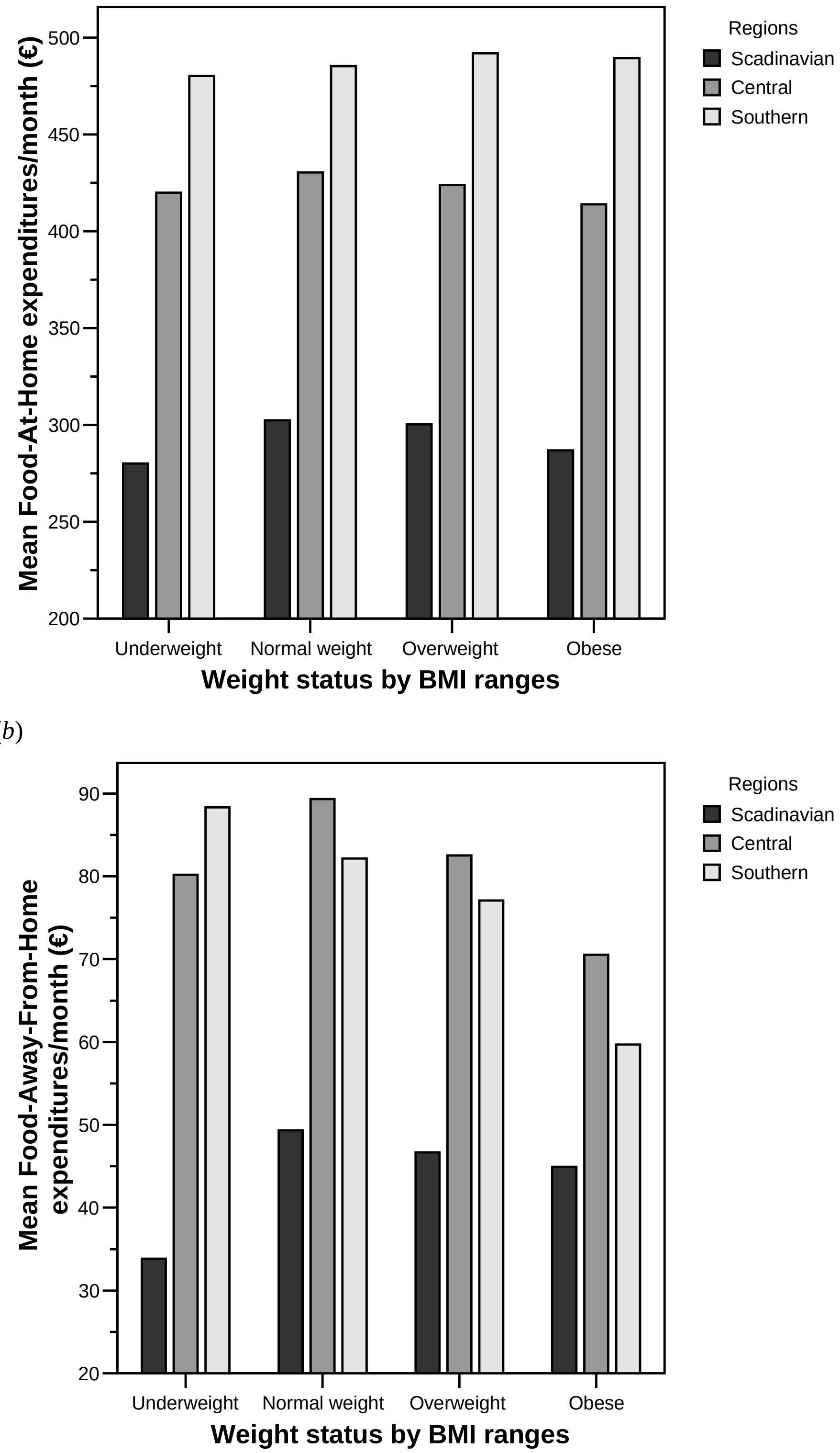
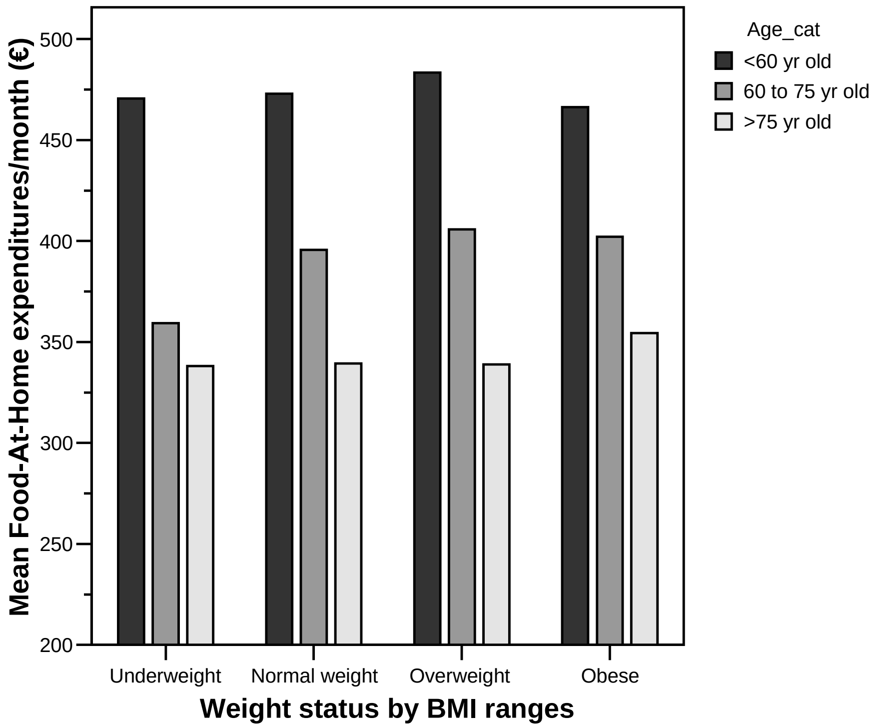



**Figure 1.** *Mean food expenditures by weight status and regions*

(*a*)




(*b*)

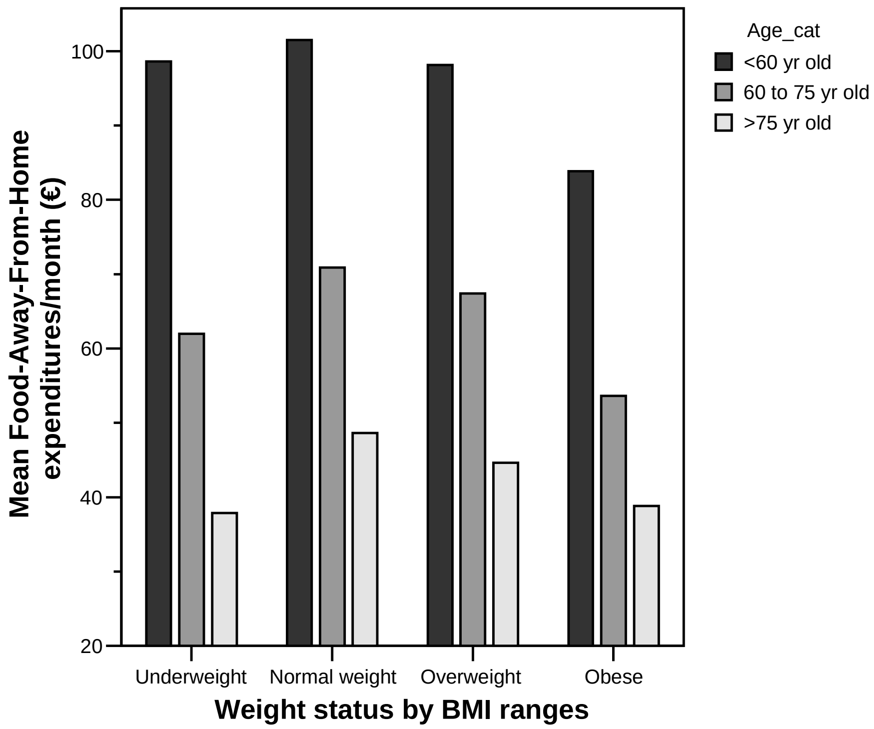



**Figure 2.** *Mean food expenditures by weight status and age*

## References

1. Börsch-Supan, A. (2005), "Introduction", In *Health, Ageing and Retirement in Europe - First Results from the Survey of Health, Ageing and Retirement in Europe* (A. Börsch-Supan, A. Brugiavini, H. Jürges, J. Mackenbach, J. Siegrist, G. Weber, Eds.). Mannheim Research Institute for the Economics of Aging, Mannheim, Germany.
2. World Health Organization (2006), "Obesity and Overweight", *Fact Sheet No 311*. World Health Organization.
3. Whitmer, R.A., Gunderson, E.P., Barrett-Connor, E., Quesenberry, C.P., Jr., Yaffe, K. (2005), "Obesity in middle age and future risk of dementia: a 27 year longitudinal population based study", *British Medical Journal* 330: 1360-1364.
4. Ejerblad, E., Fored, C.M., Lindblad, P., Fryzek, J., McLaughlin, J.K., Nyren, O. (2006), "Obesity and risk for chronic renal failure", *Journal of the American Society of Nephrology* 17: 1695-1702.
5. Esposito, K., Giugliano, F., Di Palo, C., Giugliano, G., Marfella, R., D'Andrea, F., D'Armiento, M., Giugliano, D. (2004), "Effect of ifestyle changes on erectile dysfunction in obese men: A randomized controlled trial", *Journal of the American Medical Association* 291: 2978-2984.
6. van der Steeg, J.W., Steures, P., Eijkemans, M.J.C., Habbema, J.D.F., Hompes, P.G.A., Burggraaff, J.M., Oosterhuis, G.J.E., Bossuyt, P.M.M., van der Veen, F., Mol, B.W.J. (2008), "Obesity affects spontaneous pregnancy chances in subfertile, ovulatory women", *Human Reproduction* 23: 324-328.
7. Grundy, S.M. (2004), "Obesity, metabolic syndrome, and cardiovascular disease", *Journal of Clinical Endocrinology & Metabolism* 89: 2595-2600.
8. Bray, G.A. (2004), "Medical Consequences of Obesity", *Journal of Clinical Endocrinology & Metabolism* 89: 2583-2589.
9. Palkhivala, A. (2002), "Obesity hits elderly harder than younger patients", *Special to Doctor's Guide news, Available at http://www.pslgroup.com/dg/220d4e.htm*.
10. Yang, Z., Hall, A.G. (2007), "The financial burden of overweight and obesity among elderly Americans: The dynamics of weight, longevity, and health care cost", *Health Services Research* 43: 849-868.
11. You, W., Davis, G.C. (2007), "Household food expenditures, parental time allocation, and childhood obesity", *Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, July 29-August 1, Portland, Oregon*: 1-40.
12. Kyureghian, G., Nayga, R.M., Jr., Davis, G.C., Lin, B.-H. (2007), "Food away from home consumption and obesity: An analysis by service type and by meal occasion", *Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, July 29-August 1, Portland, Oregon*.
13. Wansink, B., Huckabee, M. (2005), "De-marketing obesity", *California Management Review* 47: 1-13.
14. Lakdawalla, D.N., Philipson, T.J. (2002), "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination", *National Bureau of Economic Research Working Paper No. W8946*.
15. Philipson, T.J., Posner, R.A. (2003), "The long-run growth in obesity as a function of technological change", *Perspectives in Biology and Medicine* 46: S87-S107.
16. Chou, S.-Y., Grossman, M., Saffer, H. (2004), "An economic analysis of adult obesity: results from the Behavioral Risk Factor Surveillance System", *Journal of Health Economics* 23: 565-587.
17. Cutler, D.M., Glaeser, E.L., Shapiro, J.M. (2003), "Why have Americans become more obese?" *Journal of Economic Perspectives* 17: 93-118.
18. Plantinga, A.J., Bernell, S. (2005), "A Spatial Economic Analysis of Urban Land Use and Obesity", *Journal of Regional Science* 45: 473-492.
19. Loureiro, M.L., Nayga, R.M., Jr. (2005), "International dimensions of obesity and overweight related problems: An economics perspective", *American Journal of Agricultural Economics* 87: 1147-1153.
20. Anderson, P.M., Butcher, K.F., Levine, P.B. (2004), "Maternal employment and childhood obesity", In *The Economics of Obesity: A Report on the Workshop Held at USDA's Economic Research Service* (T. Philipson, C. Dai, L. Helmchen, J.N. Variyam, Eds.), pp. 14-17. Economic Research Service/USDA.
21. Lakdawalla, D.N., Philipson, T.J. (2006), "Economics of obesity", In *The Elgar companion to health economics* (A.M. Jones, Ed.), pp. 72-82. Edward Elgar Publishing Limited, Northampton, MA.
22. Cawley, J. (1999), "Obesity and addiction", In *PhD Dissertation, Department of Economics, The University of Chicago*.
23. Becker, G.S., Murphy, K.M. (1988), "A theory of rational addiction", *The Journal of Political Economy* 96: 675-700.
24. Dockner, E.J., Feichtinger, G. (1993), "Cyclical consumption patterns and rational addiction", *The American Economic Review* 83: 256-263.
25. Levy, A. (2002), "Rational eating: can it lead to overweighhtness or underweightness?" *Journal of Health Economics* 21: 887-899.

26. Levy, A. (2003), "A theory of LTR Junk-food consumption", *University of Wollongong, Working paper 03-05*.
27. Mancino, L. (2003), "Americans' food choices: The interaction of intentions, impulses, and convenience", *Ph.D. Thesis, University of Minnesota*.
28. Goldfarb, R.S., Leonard, T.C., Suranovic, S. (2006), "Modeling alternative motives for dieting", *Eastern Economic Journal* 32: 115-131.
29. Suranovic, S.M., Goldfarb, R.S. (2006), "A behavioral model of cyclical dieting", In *Advances in Health Economics and Health Services Research* (K. Bolin, J. Cawley, Eds.). JAI.
30. Börsch-Supan, A., Jürges, H., Eds. (2005). *The Survey of Health, Aging, and Retirement in Europe – Methodology*, Strauss GmbH, Mannheim Research Institute for the Economics of Aging (MEA), Manheim, Germany.
31. Christensen, H., Mackinnon, A.J., Korten, A., Jorm, A.F. (2001), "The "common cause hypothesis" of cognitive aging: Evidence for not only a common factor but also specific associations of age with vision and grip strength in a cross-sectional analysis." *Psychology and Aging* 16: 588-599.
32. Rantanen, T., Guralnik, J.M., Foley, D., Masaki, K., Leveille, S., Curb, J.D., White, L. (1999), "Midlife Hand Grip Strength as a Predictor of Old Age Disability", *Journal of the American Medical Association* 281: 558-560.
33. Frederiksen, H., Gaist, D., Petersen, H.C., Hjelmborg, J., McGue, M., Vaupel, J.W., Christensen, K. (2002), "Hand grip strength: A phenotype suitable for identifying genetic variants affecting mid- and late-life physical functioning", *Genetic Epidemiology* 23: 110-122.
34. Rantanen, T., Masaki, K., Foley, D., Izmirlian, G., White, L., Guralnik, J.M. (1998), "Grip strength changes over 27 yr in Japanese-American men", *Journal of Applied Physiology* 85: 2047-2053.
35. Browning, M., Crossley, T.F., Weber, G. (2003), "Asking consumption questions in general purpose surveys", *The Economic Journal* 113: F540-F567.
36. Pagan, A.R., Hall, D. (1983), "Diagnostic tests as residual analysis", *Econometric Reviews* 2: 159-218.
37. Schaffer, M.E. (2002), "ivhettest: Stata module to perform Pagan-Hall and related heteroskedasticity tests after IV", *Department of Economics, School of Management and Languages, Heriot-Watt University, Edinburgh, Statistical Software Components S428801. Downloadable from* http://ideas.repec.org/c/boc/bocode/s428801.html.
38. Baum, C.F., Schaffer, M.E., Stillman, S. (2003), "Instrumental variables and GMM: Estimation and testing", *The Stata Journal* 3: 1-31.
39. Baum, C.F., Schaffer, M.E., Stillman, S. (2007), "ivreg2: Stata module for extended instrumental variables/2SLS, GMM and AC/HAC, LIML, and k-clas regression", *Boston College Department of Economics, Statistical Software Components S425401. Downloadable from* http://ideas.repec.org/c/boc/bocode/s425401.html.
40. Park, J., Davis, G.C. (2001), "The theory and econometrics of health information in cross-sectional nutrient demand analysis", *American Journal of Agricultural Economics* 83: 840-851.
41. Murray, M.P. (2006), "Avoiding invalid instruments and coping with weak instruments", *Journal of Economic Perspectives* 20: 111-132.
42. Bound, J., Jaeger, D.A., Baker, R.M. (1995), "Problems with instrumental variables estimation when the correlation between the instruments and the endogeneous explanatory variable is weak", *Journal of the American Statistical Association* 90: 443-450.
43. Shea, J. (1997), "Instrument relevance in multivariate linear models: A simple measure", *The Review of Economics and Statistics* 79: 348-352.
44. Kleibergen, F., Paap, R. (2006), "Generalized reduced rank tests using the singular value decomposition", *Journal of Econometrics* 133: 97-126.
45. Stock, J.H., Yogo, M. (2005), "Testing for weak instruments in linear IV regression", In *Identification and inference for econometric models: Essays in honor of Thomas Rothenberg* (D.W.K. Andrews, J.H. Stock, Eds.). Cambridge University Press, New York.
46. Baum, C.F., Schaffer, M.E. (2007), "Enhanced routines for instrumental variables/generalized method of moments estimation and testing", *The Stata Journal* 7: 465-506.
47. Bascle, G. (2008), "Controlling for endogeneity with instrumental variables in strategic management research", *Strategic Organization* 6: 285-327.
48. Hansen, L.P. (1982), "Large sample properties of generalized method of moments estimators", *Econometrica* 50: 1029-1054.