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Abstract

Obesity is one of the main health policy concerns in western societies today. In spite of its strong policy implications, the research devoted to the issue has been somewhat limited. This paper empirically examines the existence of income-related inequalities in obesity in Spain, using the National Health Survey (2001) and recently developed methods to estimate inequalities in obesity and its decomposition. Our findings indicate evidence of significant income inequalities in obesity prevalence. Yet, the contribution of education is the main explanatory variable of the prevalence of obesity, followed by income, physical exercise and region of residence. The results suggest that the individual's social environment is a non-dismissible variable in explaining the proliferation of obesity in Spain.

Keywords: obesity, social environment, inequalities in health and health information.

1. Introduction

Obesity is one of the major health policy concerns in western societies both for its prevalence and its preventable nature. Obesity is one of the main causes of preventable morbidity and mortality in the developed word, and an understanding of its causes is vital to an adequate implementation of policies to control or reduce its effects. It remains unclear how the range of weight gain responses is generated; in particular, little is known about the role of economic modernisation and social stratification (Phillips and Kubisch 1985). There is some agreement in the literature that suggests that obesity is mainly caused by the interplay of a variety of factors, including the economic and social changes - besides pure biological and genetic factors- , that arguably result from urbanisation and development processes which in turn arise as responsible of the set up of an "obesogenic environment" (Wang *et al*, 2002), and ultimately in the shape of individuals body mass and obesity[1].

The hypothesis of the existence and motivation of a socio-economic status (SES) vector in the prevalence of obesity is a highly controversial policy issue today. In a review of around a hundred separate studies, Sobal and Stunkard (1989) find clear-cut evidence of an association between socio-economic status and obesity. More specifically, some studies find an inverse association between social class and obesity (Sobal, 1991). The British Heart Foundation (2002) finds that men and women in unskilled occupations are four times more likely to be morbidly obese than professional groups. Environmental effects also play a role: for instance, one might argue that consumption of fatty foods is likely to be associated with a lower SES and is less a matter of concern to the least educated sectors. Yet, little is known about the potential socio-economic vector underlying the prevalence of obesity. While some authors argue that fat storage is linked to SES (Sundquist and Johansson, 1998) more recent studies argue that inequalities in obesity have to do with gender, age and ethnicity (e.g., Dreeben, 2001, and Zhan and Wang, 2004). Indeed, in a study of obesity and SES using longitudinal data, Averett and Korenman (1993) question the existence of a direct association between obesity and income. Some relevant

[1] The socio-economic and epidemiological burden of obesity is reflected in its direct impact on individual well being and in its indirect effect on the prevalence of health disorders which in countries like Spain are the primary causes of mortality (Costa-Font and Gil, 2005).

issues are summarised in Stunkard and Sorensen (1993). Since obesity and SES influence each other, before analysing the specific association between income and health that has been the subject of a large amount of research, we need to measure, and break down, the socio-economic related inequalities in obesity. The association between obesity and SES has significant policy implications in itself, and may indirectly reveal the existence of a level of health-related inequality that may not be observable when examining self-reported health status data.

One of the potential effects of SES is its influence on lifestyle choices that in turn have an effect on food intake (Chou *et al.*, 2004). Some ‘unhealthy’ lifestyles may well be more prevalent in socio-economic groups at the tail end of income distribution. For instance, the opportunity to save time to preparing meals (Cutler *et al.*, 2003) and the lower price of fatty foods (Lakdawalla and Philipson, 2002) has exerted a greater influence on lower income groups. If this is so, then pro-active policies might have to be implemented in order to promote healthier food intake in lower socio-economic groups. Potential income inequality may reveal some prior discrimination against obese population in the labour market. Income as a proxy for socio-economic position might indicate that individuals with lower income levels suffer from the ‘hierarchy effect’ in which they are less likely to obtain a high return for their work, a situation that causes first anxiety and then obesity. In fact, in cross–section estimates from 1987-1995 in the US, Ruhm (2000) finds that body mass index and obesity are inversely related to state unemployment rates.

An alternative explanation points to the fact that an association between obesity and socio-economic position may be country-specific and culturally driven. For instance, one might argue that healthy products (e.g., olive oil) are relatively more expensive in certain countries and so poorer people are less likely to consume them. Some studies also find that knowledge of the health risks associated with obesity also deters individuals from being overweight (Kan and Tsai, 2004). However, the transmission of information is costly and unequally distributed, and benefits highly educated individuals (Bundorf *et al.*, 2004), so one might expect lower skill and lower income (Cowley, 2004) to be associated with a higher prevalence of obesity and lower health status. Furthermore, socio-economic cultural contexts limiting individual choice and behavior might lead to the eating of calorie-dense, industrially produced foods. Equally, what some groups perceive as “normal feeding” behavior may not be perceived as such by others; for instance, thinness can be a marker of social distinction and physical activity a commoditised product (e.g., fitness clubs), so that the chances of having the right weight are likely to be associated with socio-economic conditions. Furthermore, obesity may to be subject to social stigma and may cause exclusion from certain jobs (Stunkard, 2000).

In the light of recent literature on health inequalities (Wagstaff and van Doorslaer, 2000), one might support the hypothesis that socio-economic position proxies one's position in society; accordingly, lower socio-economic groups are more likely to suffer from stress and anxiety (Wilkinson, 1997), which may lead to higher obesity in the lower deciles of income distribution. Indeed, in some western countries such as the United States, the prevalence of obesity has risen dramatically (Nestle and Jacobson, 2000) to over 30% today (Flegal *et al.*, 2002) and it is rising at alarming rates throughout Europe (EOTF & EASO, 2002; Rigby and James, 2003). It is estimated to be responsible for 9.1% of total US medical expenditure (Finkelstein *et al*, 2003). Obesity is also progressively becoming a primary health problem in southern European countries. According to the Spanish Ministry of Health, one out of every two individuals in Spain is overweight and 14.5% are obese.[2] The scenario is even more worrying if we bear in mind that after the United Kingdom, Spain is the EU country with the highest increases in obesity rates over the last decade (WHO, 2002);[3] it is one of the countries where the impact of obesity on avoidable mortality is the highest, being responsible for approximately 5.5% of total mortality and about 18,000 deaths yearly (Banegas *et al.*, 2003). The 'obesity epidemic' has a marked effect on mortality rates in Spain, given the association between chronic diseases and obesity (Costa-Font and Gil, 2005). Cardiovascular diseases are the first cause of death (31% men and 41% women) and digestive system disorders account for 5% of total mortality in women and 10% in men (Spanish National Institute of Statistics, 2002). Rough estimates by SEEDO in 2000 (Spanish Society for the Study of Obesity) show that obesity could be responsible for as much as 7% of total health expenditure.

[2] Furthermore, recent estimates of the WHO Monica Project find that 16% of men and 25% of women suffer from obesity in Catalonia (Evans *et al.*, 2001).

[3] However, only 34% of obese people were undergoing specific treatment to prevent the consequences of obesity such as the emergence of chronic illnesses (Martínez *et al.*, 2004).

This paper examines the existence of income-related inequalities in obesity as measured by Body Mass Index (BMI) in Spain. The situation of Spain is of particular interest in research into obesity, because it is a Mediterranean country in which certain healthy foods are relatively inexpensive. We use recently developed methodology to estimate and break down inequalities and inequities, and thus quantify and compare the income-related effect to that of other factors such as education. Our findings indicate that there are significant income-related inequalities in obesity, which are largely explained by education and income and operate through other environmental variables. The results have significant implications for government health policy.

The paper is structured as follows. Section 2 presents the methodology for the measurement of obesity and income-related obesity inequalities. Section 3 discusses the microdata used to perform these calculations. Section 4 reports the empirical results and section 5 concludes.

2. Methods

2.1 Conceptual background

One can conceptually refer to the health production process on the basis of a health production function: $H_i = H\left(X_{i,j}, S_{i,j}, Z_{i,j}\right)$ where X represents different consumption goods and Z an individual's characteristics. Thus, we hypothesise that individual's income will have a positive and significant effect. However, given the existence of a level of stress S, which is associated with individual's income, one might argue that the role of income in producing health is likely to have a non-linear effect. Indeed, although stress has psychological components, it has economic causes as well. Empirical studies of obesity, such as those examining the determinants of health, suffer from significant unobserved heterogeneity. It may be that the effect of certain well-known variables (e.g., education, age, gender, etc.) proxies effects of unobservable variables.

The socio-economic determinants of obesity are multiple. Empirical evidence is still relatively scarce and mostly aimed at explaining the causes of what is known as the 'obesogenic environment' (French et al, 2001). This construct is the result of the economic effects of industrialisation and urbanisation due to economic growth that has led to an increasingly sedentary workforce and lifestyle. The reduction of energy expenditure is accompanied by a dietary shift towards the consumption of increasingly high-calorie diets with a high proportion of fats, saturated fats and sugars. From an evolutionary perspective, organisms behave so as to maximise the survival of their genes. Under conditions of natural selection and food scarcity, this leads to the reproduction of the fittest individuals. Yet if individual preferences are based on an environment of this kind and scarcity periods are rare, individuals would be expected to gain weight unless an increase in physical activity counteracts such effects (Logue, 1998). This imbalance may become structural due to the excess calorie intake, which is in turn reinforced by other unhealthy lifestyles.

Some studies examine a behavioural model of obesity to explain the determinants of calorie consumption, such as changes in relative prices and the density of fast food restaurants (Chou et al., 2002), reductions in the time costs of meals (Cutler *et al.*, 2003), and unemployment and job strenuousness (Ruhm, 2000). Using time series analysis of US states for 1972 to 1991, Ruhm (2000) found that obesity increases and physical activity declines during business cycle expansions. Lakdawalla and Philipson (2002) found evidence of a robust association between physical activity and obesity. From a theoretical perspective, having the 'proper weight' is envisaged as both an input of the health production function and as an 'intermediate output' (Kenkel, 1995). Recent data indicate that obesity affects not only current, but also future consumption of health services (Daviglus *et al.*, 2004), and the existence of a socio-economic vector suggests that those effects are likely to be publicly financed in countries such as Spain through an expansion of NHS expenditure associated with obesity.

In addition to the economic determinants of obesity, its socio-cultural contexts are recognised as key factors explaining the development of an individual's weight. Since obesity is a household-produced good, individuals' self-image and social interactions are likely to play a role in explaining their weight. Indeed, there is evidence to suggest that individuals' social interactions are not significantly independent of their body mass production (Costa-Font and Gil, 2004). At the same time, eating and physical activity patterns in industrialised nations are likely to be, to some extent, culturally driven behaviours. Wansink (2004) finds that the eating environment (that is, the environmental factors associated with food intake) is associated with the amount of food eaten. Recently, Kan and Tsai (2004) found evidence using quantile regression that knowledge of obesity risk factors affects individuals' obesity and that this affect differs for males and females. Another variable connected with health knowledge is schooling, which potentially increases the efficiency of health production (Kenkel, 2000; Grossman, 2004), and, according to the health capital theory, is likely to influence obesity by contributing to individuals' income. Finally, the effect of schooling on obesity may also result from time preference (Fuchs, 1982). Indeed, individuals' consumption level depends on the rate at which future health benefits are discounted in their consumption decisions, and their fitness is negatively associated with a high rate of time preference measured using country-based aggregate data (Komlos et al., 2004).

2.2 Measurement of obesity

As in previous work, our measure of obesity is derived from respondents' reports of their height and weight and from the calculation of the widely accepted BMI or "body mass index" indicator (i.e., weight in kilograms divided by the square of height in metres, kg/m^2). The World Health Organisation classification defines a BMI of 25 to 29.9 kg/m^2 as overweight and a BMI of ≥30 kg/m^2 as obese.[4] Measuring BMI using self-reported rather than observational data may involve the risk of an additional underestimation of the prevalence of obesity. Indeed, though according to some studies (Chou *et al.*, 2004) and specifically in Spain (e.g. Quiles-Izquierdo and Vioque, 1996, Costa-Font and Gil, 2005), there is very little underestimation of obesity rates. Our procedure for measuring obesity involves transforming a dichotomous obesity measure into a continuous variable by using the predictions of a Linear Probability Model (LPM) of the form

$$y_i = \alpha + \sum_k \beta_k x_{k,i} + \varepsilon_i \qquad (1)$$

where y_i=1 (if individual *i* is obese), ε_i is the random error term and x_k is a set of exogenous determinants of obesity. It follows that

$$P(y_i = 1) = \alpha + \sum_k \beta_k x_{k,i} \tag{2}$$

We use an LPM on the grounds that linearity in parameters is a useful property for our purposes of decomposing the inequality index of obesity (cf. Van Doorslaer *et al.*, 2004 and García-Gómez and López, 2004a). In addition, probit decomposition analysis using marginal effect to estimate elasticity did not exhibit significant differences. Yet, in examining the determinants of obesity we should bear in mind that certain determinants such as gender and age are unavoidable. Indeed, women have much more peripheral body fat in the legs and hips than men and obesity is found to be higher in middle age groups (Costa-Font and Gil, 2004).

2.3 Measurement of inequality

As is standard in the literature, we use the obesity concentration index as our measure of income-related inequalities with regard to obesity (Van Doorslaer and Koolman, 2004). The concentration index (CI) of obesity on income, which is very similar to the better-known Gini coefficient for pure obesity inequality,[5] can be adequately calculated, from individual level data, following the covariance method (Jenkins, 1988) as:

$$CI = \left(\frac{2}{\bar{y}}\right) \text{cov}(y_i, R_i) \tag{3}$$

where $\bar{y}$ is the (weighted) mean obesity of the sample, R_i is the income fractional rank of the ith individual (the cumulative proportion of the population ranked by income up to the ith individual) and cov(·) denotes the (weighted) covariance. This index ranges between a minimum value of −1 up to a maximum of +1 and this occurs when all the population's obesity is concentrated in the hands of the richest and poorest person respectively. A value of zero would mean that every member has the same obesity measure or, in other words, that obesity is equally distributed over income in the sense that the *pth* percentage of the population ranked by income has exactly the *pth* percentage of total obesity for any *p*.

[4] Although this is the most widely used measure of obesity, it poses several problems. For instance, the BMI does not take into consideration body composition (adiposity vs. lean weight) or body fat distribution. This means it may fail to predict obesity among very muscular individuals and the elderly (Koplemann, 2000).

[5] The inequality measures differ in that the ranking variable is income (CI) rather than obesity (Gini).

According to Wagstaff *et al.* (2003) there is a direct way to decompose the degree of inequality into the contributions of each explanatory factor. This requires first the adjustment of an LPM of obesity against a set of x_k exogenous covariates as described by equation (2). Then the CI for the probability of being obese can be expressed as:

$$CI = \sum_k \left(\beta_k \frac{\overline{x_k}}{\overline{P}} \right) C_k \tag{4}$$

where the term in brackets is the elasticity of P (obesity) with respect to x_k evaluated at the population means and C_k denotes the concentration index of x_k against income. Thus, if we define the estimated obesity elasticity with respect to determinant *k* as,

$$\hat{\eta}_k \equiv \frac{\hat{\beta}_k \overline{x}_k}{\overline{P}} \tag{5}$$

then we can rewrite the decomposition of the CI of obesity on income as a weighted sum of the inequality in each of its determinants, with the weights or shares equal to the obesity elasticities of the determinants,

$$CI = \sum_k \hat{\eta}_k \hat{C}_k \tag{6}$$

This decomposition, as was pointed out by Van Doorslaer and Koolman (2004), has the advantage of clarifying how each correlate of obesity contributes to total income-related obesity inequality in two parts: (i) its impact on obesity, as measured by obesity elasticity (η_k) and (ii) its degree of unequal distribution across income, as measured by the concentration index (C_k).

Moreover, following Kakwani et al. (1997) total inequality with regard to obesity can be usefully broken down into “potentially avoidable” and “unavoidable” or intrinsic inequality. The unavoidable part of inequality can be attributed, for instance, to differences in the age and gender composition of the population by income. Interestingly, we can (indirectly) standardise the estimated CI of equation (5) by calculating the age-gender expected inequality (CI*) and then subtract its influence (i.e., partial effects of age and gender on obesity) from the total CI in order to obtain an estimate of the potentially avoidable inequality (I*=CI−CI*).

3. Data and variable definitions

The data used in this paper were taken from the Spanish National Health Survey 2001 (CIS, 2001). This is a biannual, cross-sectional nationally representative survey and is designed for the purpose of gathering data on aspects such as self-perceived health state of the population, primary and specialised health care utilisation, consumption of medicines, perceived mortality, life habits, conducts related to risk factors, anthropometrical characteristics, preventive practices and also socioeconomic characteristics of individuals. The SNHS-2001 follows a stratified tri-phase sample procedure in which in the first stage units are the census sections and in the second stage units are the main family dwellings, investigating all households who have their habitual residence there. The stratification criterion used was the size of the municipality to which the section belongs. To facilitate reliable estimates on a national and regional level, a sample of approximately 22,000 dwellings distributed into 1,844 census sections was selected.

Our investigation is based on the adult questionnaire of the SNHS-2001 which was administered to 21,067 individuals from all Spanish regions aged 16-99. After dropping some individuals with missing values for obesity determinants (mainly those who did not report their weight and/or height) the sample contained 18,033 subjects. We used income as our measure of SES, which is highly correlated with other dimensions of SES such as economic activity or occupational status. The income measure (the ranking variable) used was total monthly household income. Household earnings are measured in the SNHS-2001 as a categorical variable with 6 response categories. Instead of simply taking the midpoint of each income bracket, for each household we calculated an income figure based on information extracted from the *Continuous Household Budget Survey* (CHBS) 2001, taking into account age, gender and level of education of the head of the household as our criteria.[6] Once net monthly household income was estimated we divided it by an equivalence factor (equal to the number of household members elevated to 0.5), to adjust for differences in household size.

[6] A subset of "honest households" (those who report a discrepancy in absolute terms between expenditures and income lower than 10%) was selected in the CHBS-2001 to estimate a log equation of household expenditures on household income. This information was then applied to the whole sample to derive an estimated net monthly household income.

The explanatory variables used to estimate the regression model for obesity are: i) the logarithm of equivalent household income; ii) eight age-sex categories corresponding to groups 16-29, 30-44, 45-64, 65+ for men and women (the omitted category corresponded to women younger than 30). These demographic variables constitute what can be considered as the determinants of unavoidable inequalities; iii) living arrangements, given that there is evidence of a positive inter-household effect appearing within married couples, which we believe can be extended to those cohabiting. Furthermore, we include iv) four education level categories (the category omitted is unschooled/illiterate) to measure alternative effects associated with the generation of health knowledge (Kenkel, 1991). Given that Spain is a heterogeneous country, we need to control for differences associated with cultural eating patterns in different areas; we therefore v) include dummy variables for the sixteen Autonomous Communities or regional variables (the category omitted is La Rioja).

Given that previous studies show that smokers have higher metabolic rates than non-smokers and tend to consume fewer calories (Chou *et al.*, 2004), we include vi) smoking habits. However, recent evidence suggests that the fall in smoking does not necessarily contribute to rising obesity rates in the US (Gruber and Frakes, 2005). Equally, there is still evidence, especially among women, of a resistance to quit smoking because of the fear of weight gain. Factors associated with dietary habits are important (Boumtje *et al.*, 2005) such as vii) the frequency of consumption of certain foods (the omitted category is eggs) and viii) breakfast habits. Finally, since obesity is essentially an imbalance between calorie intake and expenditure, we include data on physical activity, namely ix) frequency of physical activity both at work and during spare time. This is found to be relevant in some studies, which suggest that post-industrial societies tend to be relatively sedentary and utilise fewer calories on a daily basis (Grueber and Frakes, 2005)[7]. Indeed, it is well established that physical activity leads to weight loss because it increases the body metabolism and energy expenditure; and finally x) the number of hours slept per day. This regression model can be considered as a reduced form model whose estimates

[7] About 30% of adult population in the US take no physical activity in their leisure time (Rosenberger, *et al.*, 2005).

provide an indication of how exogenous changes in obesity covariates can affect the role of socio-economic inequality in obesity (Table 1).[8]

4. Results

Our adjusted database suggests that the overall prevalence of obesity for a sample of Spanish individuals aged 16-99 in 2001 was 12.4% (Table 1). This figure should be interpreted with caution since it is lower than the predicted figure based on observational measurement procedures of height and weight that suggest a number of 14.5% obese in Spain Aranceta *et al.*, 2003). Table 1 also presents the mean and standard errors for each explanatory variable of the obesity equation. Table 2 presents evidence of the distribution of obesity among income deciles. The data unambiguously reveal that obesity declines with an increase in economic status: while 17.5% of respondents in the lowest income decile are obese, this figure falls to 7.3% in the top income decile. These differences are even more pronounced in the case of women.

In Table 3 (column 2) we present the LPM coefficient estimates. As previously mentioned, these estimates are used to calculate and decompose the obesity inequality index (Van Doorslaer *et al.*, 2004). As expected, income has a negative and statistically significant effect on the prevalence of obesity, the condition being more frequent in women aged 45 and older. Interestingly, the prevalence of obesity increases with age though this relationship seems to fall off during the last stages of life in the case of men; in agreement with previous studies (Chou *et al.*, 2004), we recorded an inverted U-shape. Not surprisingly, higher levels of education were significantly associated with a lower weight to height ratio, in concordance with previous studies that indicate that obesity declines with knowledge of the risk involved (Kan and Tsai, 2004). Our data also confirm the emergence of a regional pattern (cf. Aranceta *et al.*, 2003), with comparatively high prevalence rates in Andalusia, Extremadura and Castile-La Mancha and low rates in northern Spain (the Basque Country and Navarre). Other reports have also suggested that inequalities in health follow north-south patterns and, in the case of Spain, are not associated with the institutional organisation of the health system (Costa-Font, 2005). It is also worth noting

[8] This set of obesity determinants has been successfully proven for the case of Spain by the authors (Costa-Font and Gil, 2004 and 2005).

that smoking and doing physical activity or sports (mainly during spare time) have an inverse effect on obesity, indicating that non-smoking might lead to an increase in an individual' body mass (Chou *et al.*, 2004).[9] Finally, most of food consumption variables were not statistically significant.

Table 3 also reports the estimation of obesity elasticities and concentration indices for each explanatory variable on income (columns 3 and 4 respectively). Obesity elasticity with respect to income is negative and significant (-1.318) and larger than in other studies (Chou *et al.*, 2004) although the exact magnitude of the income effects might well be overestimated (Cawley, 2004). Other significant elasticities are consumption of sweets, while education and physical activity are responsible for a reduction in obesity. Moreover, Table 3 presents the concentration indices of all variables and their significance calculated by bootstrapping methods. The CI of the log income (0.02684) presents an unequal income distribution, shown to be statistically significant by bootstrapped standard errors. In terms of age and sex groups, the concentration of the older population in low-income groups is striking, though for women this condition starts at earlier ages. As might be suspected, the more educated adults are strongly concentrated amongst the richest, while the opposite is true for low educated individuals.[10]

Next, in Table 4 we show the estimation of the inequality index of obesity. The CI of predicted obesity on income is negative (-0.1070) and statistically significant, indicating that there is a pro-rich obesity inequality in Spain. In other words, SES as measured by income is negatively related to obesity (i.e., obesity is concentrated in low income groups). This pattern of obesity inequality is much higher than that found in the US adult population (-0.055 as estimated by Zhang and Wang, 2004) though Spain's obesity rate is clearly lower. In the second row in Table 4 we present an estimate of obesity inequality that is not explained by age and gender (I*=CI-CI*), indicating what we term the degree of potentially avoidable inequality. The resulting figure (I*=-0.0936) has the same pattern as its raw counterpart, and shows that just a modest share in the degree of income-related inequality in obesity is due to differences in the

[9] However, this does not necessarily mean that individuals substitute "food for cigarettes" as suggested in Chou *et al.* (2004).
[10] These features have been observed in the EU context, for instance, by Van Doorslaer and Koolman (2004).

age-gender structure of the population. In other words, this result indicates that the vast majority of inequalities in obesity are indeed avoidable.

Some interesting results emerge from the decomposition analysis and the contributions of the explanatory variables to the degree of income-related inequalities in obesity (Table 4). A striking finding is that income only explains approximately 33% of the inequalities. This means that if income were equally distributed across the income range or if it had zero obesity elasticity, then *ceteris paribus* income-related obesity inequality would still be substantial.[11] Without any doubt, this reflects that factors other than income are more relevant to explain inequalities in obese adults. In fact our results confirm that education accounts for the most sizeable contribution: 42% of the measured obesity inequality. This result adds strength to the argument that knowledge may be a key variable in explaining individuals' body above the obesity threshold. Finally, the rest of factors show a comparatively minor contribution to the income-related inequalities in obesity: demographics 12.5%, physical exercise 8.73% and region of residence 5.78%.

[11] A similar magnitude was found by García-Gómez and López (2004b) in their analysis of income related self-assessed health inequalities according to Spanish region.

5. Discussion

This paper has empirically examined the determinants of obesity in Spain, estimates a measure of inequality and decomposes inequalities into difference components following recently developed methods (Van Doorslaer, and Koolman, 2004). We use data from the SNHS 2001 and recently devised methods to estimate income-related inequalities in obesity and their decomposition. Interestingly, we find significant evidence of SES inequalities in obesity, even though Spain is a Mediterranean country. Our results are consistent with the idea that SES inequalities in obesity are found mainly in the white population (Zhang and Wang, 2004), which indicates that income heterogeneity is either larger or leads to larger significant differences in lifestyles across whites. Surprisingly, the results of the decomposition analysis indicate that inequalities in obesity are mainly explained by differences in education (42%) rather than income-related differences (33%). This is potentially interesting for health policy decision making since it suggests that policies to deal with the onset of inequalities in obesity should not rely, exclusively at least, on the fiscal promotion of healthy food products through indirect redistribution mechanisms, but should provide information and raise awareness on the benefits of healthy lifestyles and eating habits.

As in previous studies (Costa-Font and Gil, 2004) we found appreciable differences in the prevalence of obesity within Spain. To some extent, our findings complement previous results (García-Gómez and López, 2004b) indicating that there are significant inequalities in health; governments should therefore tackle the causes of morbidity such as obesity (that is, negative outputs), before attempting to deal with the emergence of inequalities in outcomes (that is, ill-health). On the other hand, other results are consistent with previous findings that suggest that inequalities in health are explained mainly by income related inequalities rather than inequalities in the use of health care funding (Costa-Font and Gil, 2006). Moreover, our results are also relevant in the context of the introduction of incentives to be applied through market and regulatory mechanisms. Although some research indicates that BMI is negatively associated with the real price of groceries (Cawley, 1999), other evidence (see Leicester and Windmeijer, 2005) question the possible effects of imposing new taxes on the quantity of fat in food products. Indeed, given the existence of significant income-related inequalities in obesity in Spain, one might well argue that the introduction of taxes would be regressive and would increase these income inequalities (Leicester and Windmeijer, 2005). However, promoting or subsidising healthy lifestyles (e.g., physical activity and good eating and sleeping habits) may well change the behaviour of certain low-income groups currently more oriented to the consumption of junk food.[12] Thus, the prevention of certain unhealthy habits is likely to have desirable effects on body weight, which as we find happen not to be independent of the individual's socio-economic position.

Our study has a number of limitations. First, the data were compiled over a period of only one year, which may mean that important questions relating to time and regional variation were not taken into account. These issues are left for future research. Furthermore, the fact that our obesity data are self-reported may have introduced a certain bias and may lead to an underestimation of the obesity rates. However, certain studies that compare observational and self-reported data find a significantly high correlation between the two measures (Chou *et al.*, 2004) suggesting that the inequality estimates would not be affected, unless there is a reason for most affluent individuals not to report their true weight and height. Finally, an unavoidable limitation – present in all studies of income-related inequalities in health – is the 'endogeneity bias' that would arise if one assumes that obese individuals live with other obese individuals, a situation that might lead to a reduction of their income.

[12] Some evidence from the US (McCrory and colleagues, 1999) demonstrate that, in particular, the consumption of fried chicken and hamburgers were both correlated with body fatness

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Table 1. Descriptive statistics and variable definition (N=18,033)

Variable	Definition	Mean	s.e
Obesity	Dummy variable: 1 obese; 0 otherwise	0.1236	0.002
Log. income	Logarithm of total monthly net equivalent income	11.46	0.004
M16-29	Male aged 16-29	0.140	0.002
M30-44	Male aged 30-44	0.145	0.002
M45-64	Male aged 45-64	0.135	0.002
M65+	Male aged 65 and over	0.083	0.002
F30-44	Female aged 30-44	0.147	0.003
F45-64	Female aged 45-64	0.130	0.002
F65+	Female aged 65 and over	0.093	0.002
Living arrangements	Dummy variable: 1 living with your partner; 0 not living	0.614	0.004
Education 1	Dummy variable: 1 University education; 0 otherwise	0.143	0.002
Education 2	Dummy variable: 1 Secondary education; 0 otherwise	0.270	0.003
Education 3	Dummy variable: 1 Primary education; 0 otherwise	0.486	0.004
Region 1	Dummy variable: 1 resident in Andalucía; 0 otherwise	0.090	0.002
Region 2	Dummy variable: 1 resident in Aragón; 0 otherwise	0.048	0.001
Region 3	Dummy variable: 1 resident in Asturias; 0 otherwise	0.039	0.001
Region 4	Dummy variable: 1 resident in Baleares, Is. ; 0 otherwise	0.038	0.001
Region 5	Dummy variable: 1 resident in Canarias, Is. ; 0 otherwise	0.046	0.001
Region 6	Dummy variable: 1 resident in Cantabria; 0 otherwise	0.038	0.001
Region 7	Dummy variable: 1 resident in Castilla-La Mancha; 0 otherwise	0.048	0.001
Region 8	Dummy variable: 1 resident in Castilla-León; 0 otherwise	0.075	0.001
Region 9	Dummy variable: 1 resident in Catalonia; 0 otherwise	0.097	0.002
Region 10	Dummy variable: 1 resident in Valencia; 0 otherwise	0.075	0.002
Region 11	Dummy variable: 1 resident in Extremadura; 0 otherwise	0.049	0.001
Region 12	Dummy variable: 1 resident in Galicia; 0 otherwise	0.067	0.001
Region 13	Dummy variable: 1 resident in Madrid; 0 otherwise	0.100	0.002
Region 14	Dummy variable: 1 resident in Murcia; 0 otherwise	0.036	0.001
Region 15	Dummy variable: 1 resident in Navarra; 0 otherwise	0.033	0.001
Region 16	Dummy variable: 1 resident in País Basco; 0 otherwise	0.074	0.002
Smoking	Dummy variable: 1 smokes; 0 do not smoke	0.356	0.004
Fresh fruits	Ordered variable [a]	1.712	0.008
Meat	Ordered variable (includes: poultry, beef, pork, lamb, etc.) [a]	2.298	0.006
Fish	Ordered variable [a]	2.582	0.006
Pasta, rice, potatoes	Ordered variable [a]	2.081	0.006
Bread and cereals	Ordered variable [a]	1.296	0.006
Vegetables	Ordered variable (includes: green vegetables) [a]	2.090	0.007
Pulses	Ordered variable [a]	2.655	0.006
Cold meats	Ordered variable (includes: ham, sausages, etc.) [a]	2.874	0.010
Dairy products	Ordered variable (includes: milk, cheese, yoghurt, etc.) [a]	1.300	0.006
Sweets	Ordered variable (includes: biscuits, jams, etc.) [a]	2.537	0.010
Breakfast habits	Categorical variable [b]	2.520	0.010
Phys. exercise at work	Ordered variable (includes: activity at school or home) [c]	1.860	0.006
Phys. exercise at leisure	Ordered variable [d]	1.773	0.006
Sleep	Number of hours usually slept per day	7.427	0.010

[a] Up to 5 consumption frequencies: 1- daily; 2- three or more times a week; 3- once or twice a week; 4- less than once a week; 5- never or almost never. [b] Up to 6 non-exclusive responses: 1- coffee, milk, tea, chocolate, cocoa, yoghurt; 2- bread, toast, biscuits, cereals, pastries, etc.; 3- fruit and/or juice; 4-food like eggs, cheese, ham, etc.; 5-other types of food; 6-never, does not usually have breakfast. [c] Up to 4 responses: 1- seated the

majority of the working day; 2- standing up most of the working day without carrying out large journeys or efforts; 3- walking, carrying some weight, frequent journeys; 4- hard work requiring considerable physical effort. [d] Up to 4 responses: 1- no activity or sedentary life; 2- unusual physical activity (less than once a month); 3- occasional physical activity (once or several times a month, but less than once per week); 4- regular physical activity (once or several times a week).

Table 2. Income distribution of obesity (%)

Income decile	Total (%)	Male (%)	Female (%)
1	17.61	14.01	20.49
2	16.42	15.61	17.25
3	10.10	9.56	10.61
4	12.06	12.56	11.58
5	14.08	11.05	16.33
6	13.87	12.26	15.38
7	10.01	9.36	10.67
8	12.16	13.15	10.70
9	9.73	11.24	7.81
10	7.28	8.63	5.67
Mean	12.36	11.72	13.00

Table 3. Obesity determinants, elasticity and concentration indices of independent variables

	β_k	$\hat{\eta}_k$	$\hat{C}_k$
Log income	**-0.01422**	-1.31832	**0.02684**
M16-29	**0.04103**	0.04657	**0.02172**
M30-44	**0.07330**	0.08620	**0.14161**
M45-64	**0.10207**	0.11192	**0.05962**
M65+	**0.08465**	0.05718	**-0.14533**
F30-44	**0.03428**	0.04084	**0.03744**
F45-64	**0.13521**	0.14182	**-0.04678**
F65+	**0.14833**	0.11145	**-0.17804**
Living arrangements	**0.01725**	0.08570	0.00643
Education 1	**-0.11113**	-0.12864	**0.36656**
Education 2	**-0.10299**	-0.22549	**0.10938**
Education 3	**-0.06482**	-0.25488	**-0.10371**
Region 1	**0.07131**	0.05201	**-0.18253**
Region 2	0.02918	0.01142	**0.07864**
Region 3	**0.06215**	0.01942	**0.36632**
Region 4	**0.03802**	0.01160	**0.18180**
Region 5	**0.05051**	0.01879	**-0.10038**
Region 6	**0.04566**	0.01402	-0.02841
Region 7	**0.04573**	0.01776	**-0.12504**
Region 8	0.00837	0.00508	**-0.06280**
Region 9	0.01397	0.01093	**0.06886**
Region 10	**0.03799**	0.02298	**-0.03064**
Region 11	**0.04244**	0.01693	**-0.25408**
Region 12	0.00312	0.00169	**-0.05614**
Region 13	**0.03119**	0.02531	**0.13997**
Region 14	**0.04811**	0.01399	**-0.05576**
Region 15	-0.00127	-0.00034	0.02763
Region 16	-0.00842	-0.00504	**0.07784**
Smoking	**-0.02361**	-0.06807	**0.03500**
Fresh fruits	0.00268	0.03726	**-0.00658**
Meat	**-0.01072**	-0.19944	**-0.01104**
Fish	-0.00191	-0.03986	**-0.00669**
Pasta/rice	0.00258	0.04346	0.00316
Bread/cereals	0.00522	0.05472	0.00229
Vegetables	-0.00217	-0.03677	**-0.01422**
Pulses	0.00499	0.10715	**0.00934**
Cold meats	**0.00403**	0.09376	**-0.00526**
Dairy products	0.00195	0.02049	**-0.01263**
Sweets	**0.00865**	0.17756	0.00320
Breakfast habits	0.00194	0.03965	0.00027
Physical ex. at work	**-0.00743**	-0.11182	**-0.00657**
Physical ex. at leisure	**-0.02095**	-0.30079	**0.03350**
Sleep	-0.00355	-0.21331	**-0.00330**
Constant	**0.29719**		

Note: Regression coefficients differing significantly from zero (at $P<0.05$) are in bold typeface. Statistical inference of the concentration index coefficients has been computed by bootstrapping methods.

Table 4. Inequalities in obesity and decomposition

	Coefficient	%
CI (Concentration index of obesity)	-0.1070	
I*=CI-CI* (Avoidable inequality of obesity)	-0.0936	
Contributions of obesity determinants:		
Income	-0.0354	33.08%
Demographics	0.0134	12.50%
Living arrangements	0.0006	-0.51%
Education	-0.0454	42.43%
Region	-0.0062	5.78%
Physical Exercise	-0.0093	8.73%
Other Lifestyles	-0.0022	-2.02%