Are there Socio-Economic Inequalities in Obesity in Spain?

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Abstract

Obesity is to date one of the main health policy concerns in western societies that have been argued to vary in line with a hypothetical socio-economic vector. Limited research has been devoted to these issues although it has strong policy implications. This paper examines the existence of income related inequalities in obesity in Spain. We undertake an empirical application using the National Health Survey (2001) and we examine the existence of inequalities by cutting the limit of individuals body weigh in overweight, total obesity and morbid obesity. Our findings indicate that income inequalities exist, although the contribution of education is the main variable explaining the prevalence of obesity as well as regional specific differences and lifestyles which indicate that social environment is and important variable in explaining the proliferation of obesity in Spain.

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

1. Introduction

Obesity is to date one of the major contemporaneous health policy concerns in western societies. Generally speaking, obesity is explained by an alteration of the human body mass –excess adiposity- due to a variety of factors including economic, social as well as biological transformations' that arguably result from urbanisation and development processes in turn leading to the so-called "obsogenic environment" (Wang *et al*, 2002). However, socio-economic and epidemiological burden of obesity is reflected on its direct impact on individual's well being as well as through its indirect effect over the prevalence important health conditions that in countries as in Spain stand as the primary causes of mortality (Costa-Font and Gil, 2005). These features might allow us to define 'obesity' as one of the first causes of preventable morbidity and mortality in the developed word. Yet, the understanding of the causes that lead to the prevalence of obesity stands as a forefront issue to adequately implement policies to control or reduce its effects. It remains unclear how the range of weight gain responses are generated, and in particular the role of economic modernization and social stratification (Phillips and Kubisch 1985). Sobal and Stunkard (1989) find after reviewing about one hundred separate studies, clear-cut evidence of an association between socio-economic position and obesity, and some studies find an inverse association between social class and obesity (Sobal, 1991).

The existence of socio-economic status (SES) vector in the prevalence of obesity is increasingly discussed. The British Heart Foundation (2002) finds that men and women in unskilled occupations are four times more likely to be morbidly obese compared to professional groups. Environmental effects are present as well, for instance one might argue that consumption of fat foods is likely to be associated with a lower socioeconomic status and in general consumption of fatty food might be less of a concern for less educated individuals. The potential socio-economic vector underlying the prevalence of obesity is an issue relatively unknown. 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). On the other hand, Averett and Korenman (1993) after examining the association between obesity and SES using longitudinal data question the existence of a direct association between obesity and wages. Yet, some relevant issues in examining the association between SES and obesity are summarized in Stunkard and Sorensen (1993). On the one hand, obesity influences socioeconomic status, socioeconomic status influences obesity, or a common factor or factors influence both obesity and socioeconomic status. They, a previous question to that of disentangling the specific association between income and wealth, which has been subject to a large amount of research attention, is that of the measurement of socio-economic related inequalities in obesity as well as their decomposition. The association between obesity and SES has significant policy implications in itself, and might indirectly reveal the existence of some health related inequality not necessarily observable when examining self-reported health status data. Indeed, if obesity is a negative outcome of the health production process whether final or intermediate, it provides information on the individual's determinants of those caused leading to health conditions.

One of potential effects of SES is the influence through lifestyle choices that in turn have an effect on food intake (Chou et al, 2004). Some 'unhealthy' lifestyles might be more prevalent in socio-economic groups at the tail of the income distribution. On the other hand, time to prepare meals (Cutler et al, 2003) and the price of fatty food (Lakdawalla and Philipson, 2002) has show to be more prevalent in lower income groups. If this happened to be the case, then some pro-active policies might have to be put forward to tackle lower socio-economic groups in healthier food intake along with other potential determinants of obesity. Potential income inequality might be revealing some prior discrimination of obese population in the labour market. On the other hand, income as a proxy for socio-economic position might indicate on the other hand that individuals at lower income levels suffer from the 'hierarchy effect' whereby they might be less prone to obtain a high return for their work that in turn translates anxiety and thus obesity. Ruhm (2000) fins that body mass index and obesisty are inversely related to state unemployment rates in cross –section estimates from 1987-1995 in the US. However, it might well the that certain socio-economic status might lead to the intake of 'less healthy food' or to pursue certain healthy behaviours (e.g., exercise practice). Alternative explanation point out to the fact that an association between obesity and socio-economic position might be country specific and culturally driven. For instance, one might argue that certain health products (e.g., olive oil), are relatively more expensive and thus poorer people are less likely to consume them. Some studies find, the possession of knowledge on obesity's health risks might prevent individuals of being overweigh (Kan and Tsai, 2004). Yet, the transmission of information is costly and unequally distributed and benefits highly educated individuals (Bundotf et al, 2004). Therefore, one might expect that less skill and low income (Cowley, 2004) to be associated with a higher prevalence of obesity and lesser health status. On the other hand, socio-economic related cultural contexts limiting individual choice and behavior might lead to the eating calorie-dense industrially produced foods as what is defined as "normal feeding" behavior by some groups does not necessarily coincide with other. For instance, thinness can be a marker of social distinction and physical activity is a product comoditified (e.g., fitness clubs) so that the changes of having the right weight are likely to been associated with socio-economic conditions. Furthermore, obesity is argued to be subject to social stigma and exclusion form certain jobs (Stunkard, 2000).

Following the literature on health inequalities (Wagstaff and van Doorslaer, 2000), one might argue that socio-economic position might proxy the hierarchy one has in society, and accordingly lower socio-economic groups are more likely to suffer from stress and anxiety which might be responsible of higher obesity amongst individuals in the lower quintiles of the income distribution. In some western countries such as the United States, the prevalence of obesity has risen dramatically (Nestle and Kackobsonn, 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's estimated to be responsible of 9.1% of total US medical expenditures (Finkelstein *et al*, 2003). It is also progressively becoming a primary health problem in southern European countries such as Spain given that one out of every two individuals is overweight and 14.5% is obese in Spain according to the Spanish Ministry of Health.[1] The scenario is even more worrying if we bear in mind that after the United Kingdom, Spain ranks among the European Union countries exhibiting the highest increases in obesity rates over the last decade (World Health Report, 2002).[2] On the other hand, Spain is one of the countries where the impact of obesity on avoidable mortality is the highest, approximately responsible of 5.5% of total mortality and about 18.000 yearly deaths (Banegas *et al*, 2003). Nonetheless, the 'obesity epidemic' might enhance

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

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

noteworthy effects over mortality rates given chronic diseases associated with obesity in Spain (Costa-Font and Gil, 2005). This feature results from the fact that cardiovascular diseases are the first cause of death (31% men and 41% women) and digestive system conditions 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) point out that obesity could be responsible as much as for 7% of total health expenditure.

This paper examines the existence of income related inequalities in obesity as measured by the Body Mass Index (BMI) in Spain. The interest of the Spanish application lies in that Spain is a Mediterranean country and thus access to certain healthy food is relatively less expensive. On the other hand, we employ the recently developed methodology to estimate and decompose inequalities and inequities, which allow us to examine the magnitude of the income, related effects as compared to other effects. 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. Significant policy implications derive from these results.

The structure of the paper is the following. Section 2 presents the methodology for the measurement of obesity and the income related obesity inequalities while section 3 discusses the microdata used to performs 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 departing from a health production function: $H_i = H(X_{i,j}, S_{i,j}, Z_{i,j})$ where X refers to different consumption goods and Z to individual's characteristics. The additional of expenditures in health production good in the lack of savings would be individual's income. Thus, we hypothesize a positive and significant relation of individual's income. However, given the existence of some stress S levels, 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 does have economic motivations as well. Empirical studies dealing with obesity, such as those examining the determinants of health suffer from significant unobserved heterogeneity. Accordingly, the effect of certain well-known variables (e.g., education, age, gender, etc.) might be proxying other underpinning effects from unobservable variables.

The socio-economic determinants of obesity are multiple and empirical evidence is still relatively scarce and mostly aimed at explaining the causes of the so-called 'obesogenic environment' (French et al, 2001). This feature is grounded on the economic effects of industrialization and urbanization resulting from an expansion of economic growth that have lead to an increasingly sedentary workforce and lifestyles. Accordingly, the reduction of energy expenditure is accompanied with a dietary shift to the consumption of increasingly caloric diets - with high proportion of fats, saturated fats and sugars food. From an evolutionary perspective, organisms should behave so as to maximize the survival of their genes, which under natural selection and food scarcity survival leads to the reproduction of the fittest individuals. Yet, if the individual preferences are based on such an environment and scarcity periods are rare, it is expectable to find that under food abundance, individuals would gain weight unless an increase in physical activity counteracts such effects (Logue, 1998). This imbalance might become structural due to excess caloric that is in turn reinforced by unhealthy meals and other lifestyles.

Some studies examine a behavioural model of obesity to explain the determinants of calories consumed, such as changes in relative prices and density of fast food restaurants (Chou et al., 2002), reductions in the time costs of preparing meals (Culter *et al.*, 2003), unemployment and job strenuousness (Ruhm, 2000). Ruhm (2000) found that, using time series analysis of US states for 1972 to 1991, obesity increases and physical activity declines during business cycle expansions. Lakadawalla 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 as 'intermediate output' (Kenkel, 1995). Recent data indicates that obesity is found to affect not only current consumption of health services but the future consumption of health care services (Daviglus *et al*, 2004), and the existence of a socio-economic vector implies that those effects are likely to be publicly financed in countries such as Spain through an expansion of NHS expenditures associated with obesity.

In addition to the economics determinants of obesity, the socio-cultural contexts of obesity are recognized as key factors explaining the development of individual's weight. Given that obesity is a household-produced good, individuals' self-image and social interactions are likely to play a role in explaining individual's weight. Indeed, some evidence indicates that the individual's social interactions are not independent of individuals' body mass production significantly (Costa-Font and Gil, 2004). On the other hand, eating and physical activity patterns are likely to be, to some extent, culturally driven behaviour in industrialized nations. Wansink (2004) finds that the eating environment (e.g. environmental factors associated with food intake) is associated with the amount of food intake. In a recent contribution, Kan and Tsai (2004) found evidence using quantile regression that knowledge of obesity risk factors affects individuals' obesity and it is different for males and females. Another variable connected with health knowledge is schooling, which potentially increases the efficiency of health production (Kenkel, 2000; Grossman, 2004), although following the health capital theory, education is likely to influence obesity by influencing individuals' income. Finally, the effect of schooling on obesity might as well result from time preference (Fuchs, 1982). Indeed, individual's consumption intake is shown to depend on the rate at which future health benefits are discounted on the individual's consumption decisions, and individuals fitness is show to be negatively associated with a high rate of time preference measured using country-based aggregate data in Komlos et al. (2004).

2.2 Measurement of obesity

As in previous work, our measure of obesity is derived from respondents' reports of his/her height and weight which allowed us to define 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). According to the World Health Organization classification, a BMI of 25 to 29.9 kg/m^2 is defined as overweight and a BMI of ≥ 30 kg/m^2 is considered as obese. This only one measure of obesity, probably the most extended and it subject to some problems. One of the most frequently cited problems refer to on the one hand unlike alternative measures of fat deposition like waist-hips ratio or waist circumference, the epidemiological significance of central body fat characteristic of males can be underestimated. On the other than, some individuals might suffer from abdomoninal obesity regardless of having a BMI below 30 and might not be captured in our estimates (Koplemann, 2000). However, BMI is still the vastly accepted criteria for measuring obesity. Finally, measuring BMI using self-reported - rather than observed – data might have some problems explaining an additional underestimation, although as some studies (Chou et al, 2004) already find and it has been specifically examine for the context of Spain (Costa-Font and Gil, 2005), there is very limited underestimation of obesity rates.

Unfortunately, measuring obesity is a problematic issue given that self-reported anthropometric variables contain measurement error with heavier persons more likely to underreport their weight, which might have an impact on the total share of obese population in a specific country (Chou *et al.*, 2004).[3] Interestingly enough, Chou *et al.* (2004) find that the correlation between corrected and uncorrected measure of obesity is 0.86 for obesity and 0.99 for BMI. In the Spanish context, previous studies indicate that self-reported body mass suffers from a systematic underreporting (Quiles-Izquierdo and Vioque, 1996). Indeed, Aranceta *et al.*, (1998, 2000) examined the prevalence of obesity in Spanish adult population aged 25-60 using cross-

[3] Additionally, 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.

sectional nutrition surveys performed on regionally representative random samples.[4] The prevalence of obesity in Spanish adults was 13.6% in the 1997 study and 14.5% in the 2000 study, which confirms that the estimation of the obesity rate from self-reported data suffers a slight underestimation (12.43%, edition 2001 of the Spanish National Health Survey).[5] Unlike Chou et al. (2004) though, there is no way that we can estimate a correlation coefficient for the total sample although the self-reported obesity at the regional level is highly correlated –follows the same patterns– as that of observational studies.

Our procedure to measure obesity will consist in transforming a dichotomous obesity measure into a continuous variable by using the predictions of a Linear Probability Model (LPM) of the form,

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

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

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

The option of choosing a LPM is justified 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-Nicolás, 2004). Yet, in examining the determinants of obesisty we should bear in mind that certain determinants are unavoidable such as gender and age. Indeed, women have much more peripheral body fat in the legs and hips than men and obesity is found to be higher at middle age groups (Costa-Font and Gil, 2004).

2.3 Measurement of inequality

As it is standard in the literature, we use the obesity concentration index as our measure of income-related obesity inequality (Van Doorslaer and Koolman, 2004). The concentration index (CI) of obesity on income, which is very similar to the more known Gini coefficient for

[4] Weight and height were measured on each individual by trained observers following standardised procedures and measuring instruments. The samples were pooled together and weighted according to the distribution of Spanish adult population aged 25-60 years.

pure obesity inequality,[6] 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 one enjoys 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*.

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 firstly the adjustment of a 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:

$$CI = \sum_k \left(\beta_k \frac{\bar{x}_k}{\bar{P}}\right) C_k \tag{4}$$

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,

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

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,

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

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[5] Certainly, the prevalence of obesity estimated from the adult population of the SNHS-2001is just 12.43%.

This decomposition, as it 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 into two parts: (i) its impact on obesity, as measured by the 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 obesity inequality 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) standardize 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 total CI as a way 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-section nationally representative survey and is designed for the purpose of gathering data on aspects such as self-perceived health state of population, primary and specialised health care utilization, 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 the second stage units are the main family dwellings, investigating all households who have their habitual residence there. The stratification criteria used was the size of the municipality to which the section belongs. To cover the objectives of the survey to be able to facilitate reliable estimates on a national and regional level, a sample of approximately 22,000 dwellings distributed into 1,844 census sections has been selected.

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

Our investigation is based on the adult questionnaire of the SNHS-2001 which contains 21,067 individuals from all Autonomous Communities aged 16-99. After dropping some individuals with missing values for obesity determinants (mainly those not reporting weight and/or height) the estimated sample contained 18,033 individuals. 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 imputing the midpoint of each income bracket, we opted to impute to each household an income figure based on information retrieved from the *Continuous Household Budget Survey* (CHBS) 2001, taking into account age, gender and level of education of the head of the household as imputation criteria.[7] Once net monthly household income was deduced we divided it by an equivalence factor (equal to number of household members elevated to 0.5), to adjust for differences in household size.

The explanatory variables employed in the estimation of the regression model for obesity are: i) the logarithm of equivalent household income, ii) eight age-sex categories corresponding to groups less than 30, 30-44, 45-64, 65+ for men an women (the omitted categories correspond to individuals younger than 30). These variables constitute what can be considered as the determinants of unavoidable inequalities. On the other hand, our the obesity determination function depends on iii) cohabitation, given that it is shown evidence of the positive inter-household effects appearing within married couples, which we believe can be expected to those cohabiting. Furthermore, we include iv) four education level categories (the omitted category is unschooled/illiterate) to measure alternative effects associated with the generation of health knowledge (Kenkel, 1991). Yet, given that Spain is an heterogeneous country, one might need to control by differences associated with cultural feeding patterns across the country and accordingly we include dummy variables for the v) sixteen Autonomous Communities or regional variables (the omitted category is La Rioja). Recently, there is evidence reporting that smoking is included given that previous studies show that smokers have higher metabolic rates

[7] 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.

than non-smokers and tend to consume fewer calories (Chou et al, 2004), therefore, our functional form includes vi) smoking. However, we should bear in mind that some ore recent evidence questions the finding that falling smoking not necessarily contribute to rising rates of obesity in the US (Gruber and Frakes, 2005), but there is still evidence that, especially between women, there is a resistance to quit smoking because of the fear of weight gain. Moreover, factors associated with dietary habits have show to be important (Boumtje et al, 2005) such as the vii) frequency of consumption of some foods (the omitted category is eggs); viii) breakfast habits. Finally, given that obesity is essentially an imbalance between the caloric intake and expenditure, we include data on physical activity, namely ix) frequency of physical activity both at work and during spare time. This is argues to be relevant in some studies suggesting that post-industrial societies tend to be relatively sedentary which reduces the calories expended on a daily basis (Grueber and Frakes, 2005)[8]. Indeed, its well established that physical activity leads to weight loss because it increases the body metabolism and energy expense and, finally x) the number of hours slept per day. It is useful to remark that this regression model might be interpreted as a reduced form model whose estimates provide an indication of how exogenous changes in obesity covariates can affect the degree of socioeconomic inequality in obesity (Table 1).[9]

[8] About 30% of adult population in the US is found to get no physical activity at their leisure time (Rosenberger, et al, 2005).
[9] This set of obesity determinants has been successfully proven for the case of Spain by the authors (Costa-Font and Gil, 2004 and 2005).

4. Results

According to our adjusted database the overall prevalence of obesity for a sample of Spanish individuals aged 16-99 is 12.4% in 2001 (Table 1). This figure must be interpreted with some caution since its value is certainly lower than the predicted figure based on standard measurement procedures of height and weight (14.5%) and leads to the expected underestimation of total obesity in Spain. The Table 1 also presents the mean and standard errors of the mean for each explanatory variable of the obesity equation. On the other hand, Table 2 presents evidence of the distribution of obesity among income deciles. Indeed, the unambiguously reveals that obesity (absence of obesity) declines (increases) with an increase in the position in the income distribution. While 17.5% are obese at the lower income deciles (10%) only 6% are obese at the highest decile (90%). Now, whilst for female where the inter-quartile ratio is higher that for male respondents (1.18 v 1.10), in the case of male we find a more monotonic increase of obesity as compared to that of female. Interestingly, the rate of obesity at the top income deciles in men (8.4%) is higher than that of median female obesity (roughly 8%).

Following the estimated approach describe in previous sections, we report the coefficients in Table, joint with the elasticity estimates of the LPM are shown in Table 3 (column 2). As previously mentioned, these estimates are used to calculate and decompose the obesity inequality index (Van Doorslaer *et al.*, 2004). As it is expected, income has a negative and statistically significant effect on the prevalence of obesity and this condition is higher among women aged 45 and older. Interestingly, the prevalence of obesity increases with age although this relationship seems to curve at last stages of life just in case of men consistently with previous studies indicating an inverted U-shape (Chou et al, 2004). No surprisingly, the results reveal that higher levels of education are significantly associated with lower weight to height ratio, consistently with previous studies that indicate that obesity declines with knowledge (Kan and Tsai, 2004). Our data also confirm (c.f. Aranceta *et al.*, 2003) the emergence of a regional pattern with comparatively high prevalence rates in Andalucia, Extremadura and Castilla-La Mancha and low rates in Northern Spain (País Vasco and Navarra). This is consistent with findings from previous studies that suggest that inequalities in health follow north-south patterns and is not associated with institutional organisation of the Spanish health system (Costa-Font, 2005). It is also worth noting that smoking and doing physical activities or sports (mainly during spare time) have an inverse effect on obesity as expected form the evidence of previous studies indicating that non-smoking might lead to an increase in the individuals body mass (Chou et al, 2004)[10]. Finally, most of food consumption variables were not statistically significant.

Table 3 also reports the estimation of the obesity elasticities and concentration indices for each explanatory variable on income (columns 3 and 4 respectively). [11] We find that the income elasticity in the probability of obesity to be negative, significant 1.27 and larger than in previous studies (Chou et al, 2004) although the exact magnitude of the income effects might well be overestimated (Cawley, 2004). Other significant elasticity's were that of consumption of sweets (0.18) whilst physician activity both at work (-0.09) and at leisure (0.26) is responsible for a reduction in obesity. Table 3 provides the concentration index of all variables as well as the significance of the variables after bootstrapping. The CI of the log income (0.02684) shows that there exists an unequal income distribution in favour of the richest individuals of the population, with bootstrapped standard errors showing that the index is statistically significant. In terms of age and sex groups, it is striking to observe older population concentrated in low income groups, though for women this condition starts at earlier ages. As it might be suspected higher educated Spanish adults are strongly concentrated amongst the richest, while the opposite is true for low educated individuals.[12]

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 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 even much higher than that experimented by the US adult population (-0.055 as estimated by Zhang and Wang, 2004) although Spain's obesity rate is clearly lower. In the second row of Table 4 we present an estimate of the obesity inequality that is not explained by

[10] However, this does not necessarily mean that individuals substitute "food for cigarettes" as suugested in Chou et al (2004).
[11] Standard errors of the concentration index coefficients have been calculated by bootstrapping methods.
[12] These features have been observed in the EU context, for instance, by Van Doorslaer and Koolman (2004).

age and gender (I*=CI-CI*), which would indicate what has been labelled the degree of potentially avoidable inequality. Thus, the resulting figure (I*=-0.0922) apart from showing the same pattern as its raw counterpart, it points-out that just a modest share in the degree of income related obesity inequality is due to differences in the age-gender structure of population. On the other hand, this result indicates that the vast majority of inequalities in obesity are avoidable.

Some interesting results emerge from the decomposition analysis or the contributions of the explanatory variables to the degree of income related obesity inequalities (Table 4). A striking finding is that income just explains approximately *32% of the income related inequalities* in obesity. This means that if income were equally distributed across the income range or income had zero obesity elasticity, then income-related obesity inequality would still be substantial, ceteris paribus.[13] Without any doubt, this reflects that other factors out of income are even more relevant to explain inequalities in obese adults. Certainly, our results confirm that education accounts for the most sizeable contribution: 43% of the measured obesity inequality. This result poses additional strength to the argument that knowledge might be a key variable in explaining individuals body mass to exceed the obesity threshold. Finally, the other factors have been grouped as cohabitation, region, demographics and lifestyles show comparatively minor contributions to the income related inequalities in obesity. Indeed, demographics explain 13.8% of income related inequality, region of residence 5.9% and the group of lifestyles only 5.8%.

[13] A similar magnitude was found by García-Gómez and López-Nicolás (2004) in their analysis of income related self-assessed health inequalities by Autonomous Communities.

5. Discussion

This paper has reported empirical evidence on the determinants of obesity in Spain. We employ data fro one year 2001 and we employ recently exploited decomposition methods to estimate the income related inequalities in obesity and its decomposition. Interestingly, we find significant evidence of income-related inequalities in obesity in Spain, despite being Spain a Mediterranean country; recent estimates indicate that is one of the countries where the prevalence of obesity is growing faster. The finding that of the existence of income related inequalities in obesity take place amongst white population (Zhang and Wang, 2004), given this is the vast majority of the Spanish population is white. Yet, results from the decomposition analysis indicate that inequalities in obesity are mainly explained by differences in education (43%) rather than income related differences (32%). This result is potentially interesting for health policy decision making as far as it suggests that policies to deal with the onset of inequalities in obesity must not rely, at least exclusively on fiscally promoting healthy products through an indirect redistribution mechanisms, but instead they have to provide information and raise awareness on the benefits of healthy lifestyles and correct feeding. On the other hand, we find that even within Spain there are appreciable differences in the onset of obesity which where already reported in previous studies (Costa-Font and Gil, 2004). In some sense, our findings complement previous results (García-Gómez and López-Nicolás, 2004) indicating that there are significant inequalities in health, which might well indicate that to deal efficiently with the emergence of inequalities in health, governments should deal with the causes of explaining morbidity such as the case of obesity (negative outputs), as a fist step to deal with the emergence of inequalities in outcomes (ill-health).

Our results are relevant in the context of the potential introduction of incentives to be fitted through market and regulatory mechanisms. Although some occasional research indicates that BMI is negatively associated with the real price of groceries (Cawley, 1999), some other evidence questions the effects that would result from changing food relative prices through taxation., Indeed, Leicester and Windmeijer (2005) examine the potential use of new taxes on the quantity of fat existing in different consumption products. Yet, given the existence of significance income related inequalities in obesity in Spain, one might well argue that the introduction of taxes would be regressive and could potentially lead to the expansion of income relate inequalities (Leicester and Windmeijer, 2005). However, some alternative effects cold take place through subsidisation of healthy lifestyles and thus consumption of healthy food instead which could potentially change the behaviour of certain low income groups that are potentially likely to fall to the consumption of junk food.

Nevertheless, the finding that other determinants such as lifestyles, region and cohabitation explain the income related inequalities in obesity in Spain, indicates that health promotion should focus as well in promoting and subsidising lifestyles that lead to physical activity, as well as promoting adequate feeding and sleeping practices. Some evidence form the US (McCrory and colleagues ,1999) demonstrate that, in particular, the consumption of fried chicken and hamburgers were both correlated with body fatness. Therefore, some desirable effects on individual's body weight might well be achieved through prevention of certain unhealthy habits. On the other hand, cultural practices, which are regionally determined, might well explain income related inequalities sin obesity. Cultural difference smith explains the frequency of meals that individuals have at home and in restaurants. Indeed, there is evidence that in purchasing meals in restaurants people follow the market principle of maximizing consumer value (Wansink 1996). Overall, this result suggests that prevention might take place indirectly through education along with the promotion of healthy activities even when taking into account regional specific differences. Lifestyle sat work and at leisure appears to be relevant as well to explain inequalities sin obesity. In particular, we have found consistently with evidence from the US (Rosenberger et al, 2005) higher physical activity at leisure reduce the probability of obesity, and the elasticity was three times higher that physical activity at work .

The main caveats refer to the existence of only one year of data, accordingly some relevant questions that imply time and regional variation have not been taken into account and are left for future research. Furthermore, given that our obesity data is self-reported, some bias in self-reported which expectedly should underestimate obesity rates. However, some studies that compare observation and self-reported data find that a significantly high correlation between self-reported and observational data (Chou et al, 2004) suggesting that would not affect the inequality estimates unless there is a reason for most affluent individuals not to report their true weight and height. Finally, an unavoidable limitation is the presence in all studies looking at income related inequalities sin health is that of an 'endogeneity bias' that would arise if one assumes that obese individuals live with other obese individuals so that obesity might lead to a reduction of individuals' income.

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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
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
Cohabitation	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
Pulse	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 o 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 important physical effort. [d] Up to 4 responses: 1-no activity or sedentary life; 2-unusual physical

activity (less than once a month); 3-ocasional 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. The income distribution of (absence) of obesity (%)

Income quantile	Total (%)	Male (%)	Female (%)
1	82.6	83.50	82.13
2	87.56	88.83	86.56
3	88.53	87.71	88.79
4	88.27	87.27	89.26
5	90.81	88.32	92.17
6	88.28	88.33	88.23
7	91.88	89.17	94.35
8	93.04	91.07	94.86
9	92.47	90.43	94.09
10	94.06	91.60	96.60
Mean	89.72	88.82	90.39
Inter-quartile rank	1.14	1.10	1.18

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

	β_k	$\hat{\eta}_k$	$\hat{C}_k$
Log income	**-0.01371**	-1.27099	**0.02684**
M30-44	**0.05272**	0.06199	**0.14161**
M45-64	**0.08255**	0.09051	**0.05962**
M65+	**0.06612**	0.04466	**-0.14533**
F30-44	**0.01521**	0.01811	**0.03744**
F45-64	**0.11634**	0.12204	**-0.04678**
F65+	**0.13011**	0.09776	**-0.17804**
Cohabitation	**0.01558**	0.07740	0.00643
Education 1	**-0.11253**	-0.13026	**0.36656**
Education 2	**-0.10400**	-0.22770	**0.10938**
Education 3	**-0.06514**	-0.25616	**-0.10371**
Region 1	**0.07123**	0.05195	**-0.18253**
Region 2	0.02931	0.01147	**0.07864**
Region 3	**0.06139**	0.01918	0.36632
Region 4	**0.03734**	0.01140	0.18180
Region 5	**0.04979**	0.01853	-0.10038
Region 6	**0.04546**	0.01396	-0.02841
Region 7	**0.04591**	0.01783	-0.12504
Region 8	0.00776	0.00471	-0.06280
Region 9	0.01340	0.01049	0.06886
Region 10	**0.03815**	0.02308	-0.03064
Region 11	**0.04219**	0.01683	-0.25408
Region 12	0.00314	0.00170	-0.05614
Region 13	**0.03073**	0.02493	0.13997
Region 14	**0.04767**	0.01386	-0.05576
Region 15	-0.00084	-0.00022	0.02763
Region 16	-0.00862	-0.00516	0.07784
Smoking	**-0.02352**	-0.06781	0.03500
Fresh fruits	0.00306	0.04252	-0.00658
Meat	**-0.01140**	-0.21212	-0.01104
Fish	-0.00166	-0.03476	-0.00669
Pasta/rice	0.00261	0.04401	0.00316
Bread/cereals	0.00438	0.04595	0.00229
Vegetables	-0.00135	-0.02291	-0.01422
Pulse	0.00480	0.10323	0.00934
Cold meats	0.00351	0.08156	-0.00526
Dairy products	0.00204	0.02139	-0.01269
Sweets	**0.00874**	0.17942	0.00320
Breakfast habits	0.00199	0.04052	0.00027
Physical ex. at work	**-0.00643**	-0.09673	-0.00657
Physical ex. at leisure	**-0.01859**	-0.26683	0.03350
Sleep	-0.00382	-0.22963	-0.00330
Constant	**0.19765**		

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)	-0.0922	
Contributions of obesity determinants:		
Income	-0.0341	31.89%
Demographics	0.0147	13.79%
Cohabitation	0.0005	-0.46%
Education	-0.0461	43.08%
Region	-0.0063	5.90%
Lifestyles	-0.0062	5.80%