The effect of obesity and related chronic diseases on mortality among older adults in Mexico: Is it a different phenomenon than in the US?

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I. Introduction

In developing countries, particularly in Latin America and the Caribbean, obesity rates are growing steadily reaching levels similar or even greater than those of the US. According to the World Health Organization (WHO, 2006), the prevalence of obesity in Mexico (in 2000) for people over 15 years old was 28.1% for women and 18.6% for men. In Chile (in 2003) obesity prevalence was 25.0% for women and 19.0% for men; while in the US (in 2003) for people of the same age group was 21.4% for women and 19.7% for men.

The increasing trend in the prevalence of obesity and overweight in Latin America and the Caribbean may be the result of changes in lifestyle and diet that are similar to those occurring in industrialized countries (Popkin, 1994; Uauy et al., 2001). Obesity is indisputably associated with a high disease burden (Caballero and Wang, 2006). As Caballero (2001) stated, concern over increments in obesity rates in developing countries is amplified by the overall rise in the rates of non-communicable diseases for which, in many cases, obesity is a major risk factor.

Although the association between socioeconomic status and obesity is positive in countries that are at the initial steps of their economic development, several studies show that the bulk of obesity quickly shifts to the less economic advantaged sectors of the population (PAHO/OPS, 2006). At present in Latin American countries, in general, the association between socioeconomic status and obesity is negative (Drewnowski and Specter, 2004; PAHO/OPS, 2006; Zhang and Wang, 2004). Particularly for Mexico, obesity and overweight are concentrated in the poorest sectors of population, and this phenomenon is greater than for other Latin American countries (Ferald et al., 2004).

Compared to people with normal body weight ($18.5 \leq BMI^{1} < 25$) obesity increases the risk of heart disease, hypertension and osteoarthritis (in the knees) by two to three times, doubles the risk of cancer and triples the risk of type 2 diabetes (WHO, 1999).

Worldwide, excess mortality that can be attributed to diabetes in 2000 was estimated as 5.2% (from 6% to 27% for people 35 to 64 years old); estimates ranged from 2% to 3% in poor countries to more than 8% in the US, Canada, and the Middle East (Roglic et al., 2005). In general, an increment in the average values of BMI is expected to result in increments in the prevalence of diabetes, which in turn highly increases the mortality risk due to heart disease and hypertension (WHO, 1999).

Valiente and colleagues (1988) stated that it is in Latin American cities where the concept of malnutrition is really understood. The interaction of undernourishment with a sedentary life and excessive consumption of fat and cheap food experienced by "the survivors of undernourishment" is responsible for diseases like obesity, diabetes, and atherosclerosis. Changes in the environment that produced the metabolic adaptation of the body to work under conditions of low energy intake and low fat diets may result in higher sensitivity to obesity and overweight (Baschetti, 1998; 1999). In Brazil, for example, obesity is replacing undernourishment in certain strata of the adult population. Monteiro et al. (2004) showed differentials in the prevalence of obesity by socioeconomic status for Brazil, with the less advantaged groups having a greater obesity risk. Obesity among the poorest strata of a population is of a different nature than obesity among the highest strata of the same population. In the latter case it is a result of an excessive intake of animal fats and refined sugars accompanied by a low intake of fibers, while in the former it presents itself together with a lack of essential nutrients, particularly the proteins obtained from meat consumption. The conditions in Latin America regarding nutrition are changing from a situation characterized by low stature and below-normal body weight to one with a growing prevalence of chronic diseases like cancer, CVD and diabetes (Albala et al., 2001).

[1] Body Mass Index: $BMI = (\text{weight in kg}) / (\text{height in meters})^2$

Because obesity and overweight are related to an increase in the risk of hypertension, diabetes, heart disease, and some kinds of cancer, among other diseases, it is possible that the observed trend may be influencing the mortality patterns.

An almost linear relationship was found between body mass index and mortality, once weight loss and smoking behavior are taken into account (WHO, 1999). Even though in countries where prevalence of obesity (BMI $\geq$ 30) and incidence of diabetes are increasing, there is also evidence that mortality rates are decreasing. In the US, the decrease is mainly due to a decrease in the mortality rate due to cardiovascular disease (CVD), but is not clear whether in the future these improvements will compensate for an increase in the prevalence of all the obesity-related diseases, particularly for the population at the bottom of the income distribution -- the group mainly affected by obesity.

II. Objective

In the US, excess mortality due to obesity has been acknowledged and investigated and the debate it generates is increasing (Allison et al., 1999; Flegal et al., 2005; Mokdad et al., 2004; Olshansky et al., 2005). This phenomenon needs to be carefully analyzed in Latin America due to the frequent combination of obesity and overweight with frail conditions among those populations and because of the high prevalence and the rapid growth of obesity and diabetes in the region. Therefore, the aim of the present study is to measure mortality differentials in Mexico and produce comparable estimations for the US. The novelty of this study is to evaluate the effect of obesity on mortality in these two countries measured in terms of years of life expectancy lost, as well as the relative effect of the main non-communicable diseases related to the excess of weight.

III. Data and Methods

We used data from the Mexican Health and Aging Study (MHAS) and the Health and Retirement Study (HRS). The MHAS is a longitudinal survey of Mexican people 50 years old and older. The present study is focused on older adults (60 years and over).[2] In 2001, 16,071 individuals were interviewed, including targets and spouses (7,880 aged 59 or more). Follow-up interviews were completed in 2003 with 15,150 individuals (MHAS 2001 and MHAS 2003). During the interviewing period a total of 465 people aged 59 years or older died. The richness of this survey offers the opportunity to study mortality differentials for BMI adjusting by demographic and health factors such as sex, age, smoking behavior and various chronic conditions.

The HRS is a longitudinal survey that was designed to gather information on persons from pre-retirement into retirement in the US. The first wave (1992) includes individuals aged 51-61 living in households. A total of 15,497 individuals, including spouses or partners regardless of their age, were eligible for interviews in 1992 from whom 12,654 respondents were finally interviewed. In 2004 a new sample cohort of individuals aged 51-56 was introduced (from 4,420 eligible individuals, 3,340 interviews were completed). The survey consists of a total of seven waves with interviews conducted every two years. A total of 7,066 deaths were registered over the whole period. In order to have a similar periods for the two countries, the present study analyzes mortality differentials taking as a baseline the sixth (2000) wave of the survey. The sample size for people 59 years and older includes 7,880 individuals, from whom a total of 4,395 died between 2000 and 2004.

MHAS provides self-reported data regarding height and weight, as well as on chronic conditions. Anthropometric measures were taken for a selected subsample. The present study used the self-reported data in order to calculate BMI, but the corresponding anthropometric values were used in the case that the self-reported ones were missing. According to these data we observed that, among people aged 59 years or more, 38% had a normal body weight ($18.5 \leq BMI < 25$), 37% were overweight ($25 \leq BMI < 30$), and 16% were obese ($BMI \geq 30$). In the HRS study height and weight, as well as the rest of the variables, are self-reported. In 2000, the HRS study observed that 32% of the respondents 59 years old or more had a normal body weight according to WHO standards, while 42% were overweight, and 26% were obese.

[2] To take into account people who died at 60 years and older between 2001 and 2003, we consider people 59 years and older and we assume that death occurs in the middle of the interval.

With regard to self-reported obesity-related non-communicable diseases, a 17% prevalence of diabetes was observed in Mexicans over 59 years old (MHAS, 2001), and the same prevalence (17%) observed for the US population of the same age (HRS, 2000). 42% of respondents reported hypertension in Mexico compared to 53% in the US. For heart attack, the US prevalence was 12% compared to 4% in Mexico. 27% of US individuals reported heart disease; MHAS does not have information on this condition.

Figure 1 - The model used for estimating mortality differentials

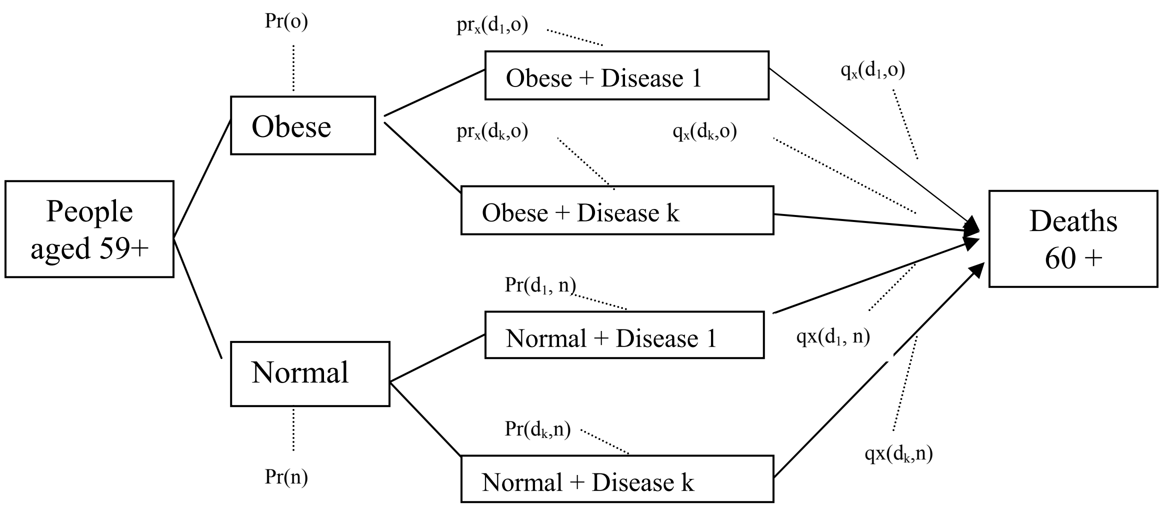


Figure 1 shows that we can decompose the probability of dying being obese as:

$$\mathbf{q_x(o) = q_x(d_1,o) * pr_x(d_1,o) + \ldots\ldots + q_x(d_k,o) * pr_x(d_k,o),} \qquad \mathbf{(1)}$$

Where:

$q_x(o)$ = probability of dying between age x and x +1, conditional on being obese;

$q_x(d_1,o)$ = death probability conditional on being obese and suffering from disease 1;

$pr_x(d_1,o)$ = probability of suffering from disease 1 conditional on being obese;

$q_x(d_k,o)$ = death probability conditional on being obese and suffering from disease k;

$pr_x(d_k,o)$= probability of suffering from diseases k conditional on being obese.

The subscript 1 to k refers not only to the obesity-related chronic conditions such as diabetes, hypertension and cardiovascular diseases but also to all possible combinations of those diseases including not suffering any of them.

In a similar way we can decompose the death probability of people with normal body weight as:

$$\mathbf{q_x(n) = q_x(d_1,n) * pr_x(d_1,n) + ... + q_x(d_k,n) * pr_x(d_k,n).} \qquad \mathbf{(2)}$$

Comparing the left term of expressions (1) and (2) we can evaluate the relative risk of dying for an obese individual (compared to someone of normal weight).

In order to get a detailed understanding of the differences in mortality risks between obese people and people with normal weight we decompose the expressions (1) and (2) into the effect due to each obesity-related disease (each product of right side). The effect by disease is composed of two terms: the first one is the risk of dying for people who suffer from each of the "k" diseases among obese individuals ($qx(d_k,o)$) in expression (1) and people of normal weight ($qx(d_k,n)$) in expression (2); the second term is the probability of suffering from each of the "k" diseases among obese individuals ($pr_x(d_k,o)$) in expression (1) and for normal weight persons ($pr_x(d_k,n)$) in expression (2). This decomposition evaluates the importance of the probability of suffering from each disease and the importance of the risk of dying from each one of those diseases, allowing the comparison of these components between Mexico and the US.

The conditional probabilities are estimated by means of two groups of logistic regressions using STATA 9.2. The first group of logistic models evaluates the probabilities of dying conditional on suffering each disease and having the weight condition "i" (obese or normal weight). The dependent variable is a dummy one equal to 1 if the individual died during the period analyzed (2000 and 2004 for HRS and 2001 and 2003 for MHAS). The second group evaluates the probabilities of experiencing each disease conditional on weight status. The dependent variables are constructed through the interaction of the variables indicating if the individual suffers from each obesity-related chronic disease and their possible combinations. These logistic regressions are adjusted for demographic factors, like age and sex, behavioral factors, like smoking status, and the presence of other confounding effects. The product of the mean probability of dying and the mean probability of suffering from each disease conditional on the respective BMI gives us the relative risk of dying for obese individuals compared to the individuals with normal weight.

In order to evaluate the effect in terms of lost of life expectancy due to obesity we construct period life tables for obese individuals using the probability of dying between age x and x +1 conditional on being obese ($q_x(o)$), and period life tables for individuals with normal weight using the respective probabilities ($q_x(n)$). The life expectancy forgone due to obesity will be the result of subtracting the life expectancy for obese individuals from the life expectancy for individuals of normal weight.

IV. Results

The results of the regression analysis show that death probabilities are highly sensitive to variations in the cutting points used to define obesity and overweight. We compared the estimation obtained using the standard definition given by the WHO with those obtained using relative values of BMI as cutting points (quintiles) for defining obesity and overweight. Using the latter definition the results reflect the effect of obesity and overweight in a way that was more consistent with the existing literature than the ones obtained using the WHO definition. Fixed cutting points, as a general measure of the amount of body fat, have been criticized due to differences in body composition among different populations and age groups. For specific populations it has been founded that the cutting points reflecting higher risk of suffering obesity-related diseases are different than the ones proposed by the WHO. For example, among some Asiatic populations those cutoff points were found to be lower than the fixed ones, while for Asian-Pacific Islanders they were higher (Hubbard, 2000). It has also been shown that individuals with short stature may be consider "obese" at lower levels of BMI because those with short stature have higher levels of body fat at each level of BMI (Lopez-Alvarenga et al. 2003). On the other hand, among the elderly we may find higher levels of BMI (that do not reflect higher levels of body fat) due to changes in height because of vertebral compression, lost of muscular tone and postural changes (WHO, 1995).

For both Mexico and the US, we observed that the effect of higher levels of obesity (BMI≥35) is not statistically significant for the WHO cutting points of BMI even when we are controlling for confounding effects such as low weight and smoke (Table 1 and Table 2). Also, for the obesity (30≤BMI<35) and overweight (25 ≤ BMI < 30) coefficients, the direction is not the expected one.

On the other hand, using the relative cutting points criteria we observe that for the highest BMI quintiles (4th quintile and 5th quintile), compared with people with BMI in the 3rd quintile, the effect of obesity on mortality is not only in the expected direction, but also statically significant for both Mexico and the US. With regard to the variable years of education, we obtained the inverse effect on mortality in all cases (as expected), but it is only statically significant for the US logistic regression.

Table 1
Logistic Regression – Independent Variable: Death between 2001 and 2003
(MHAS 2001, MHAS 2003)

	WHO		Quintiles (1)	
Variable	**Coeff.**	**P value**	**Coeff.**	**P value**
Age	0.08**	0.000	0.08**	0.000
Sex	-0.28**	0.016	-0.32**	0.007
Education	-0.02	0.218	-0.01	0.354
Obese_high (or 5th quintile)	0.21	0.392	0.47**	0.028
Obese (or 4th quintile)	-0.44**	0.023	0.54**	0.009
Overweight (or 2nd quintile)	-0.34**	0.011	0.40*	0.050
Low Weight (or 1st quintile)	0.23	0.346	0.99**	0.000
Smoker	0.17	0.269	0.13	0.394
Constant	-7.81**	0.000	-8.34**	0.000

* p-value < 0.10 ** p-value < 0.05

(1) 1st quintile: BMI<21.9; 2nd quintile: 21.9≤BMI<24.7; 3rd quintile 24.7≤BMI<27.3; 4th quintile: 27.3≤BMI<30.5 and 5th quintile: BMI≥30.5.

Table 2
Logistic Regression – Independent Variable: Deaths between 2000 and 2004 (HRS 2000, HRS 2004)[3]

	WHO		Quintiles (1)	
Variable	**Coeff.**	**P value**	**Coeff.**	**P value**
Age	0.10**	0.000	0.10**	0.000
Sex	-0.57**	0.000	-0.54**	0.000
Education	-0.05**	0.000	-0.05**	0.000
Obese_high (or 5th quintile)	0.18	0.197	0.33**	0.007
Obese (or 4th quintile)	-0.29**	0.009	0.19	0.108
Overweight (or 2nd quintile)	-0.29**	0.001	0.23**	0.044
Low Weight (or 1st quintile)	1.69	0.000	0.72**	0.000
Smoker	0.65*	0.000	0.65**	0.000
Constant	-7.46**	0.000	-7.94**	0.000

* p-value < 0.10 ** p-value < 0.05

(1) 1st quintile: BMI<23.42; 2nd quintile: 23.42≤BMI<25.77; 3rd quintile 25.77≤BMI<28.00; 4th quintile: 28.00≤BMI<31.12 and 5th quintile: BMI≥31.12.

In order to compare differentials in mortality due to obesity in the US and Mexico, we estimated the annualized probabilities of dying (by BMI group) through the previous coefficients. Using the annualized probabilities of dying we construct period life tables and we estimate life expectancies for people belonging to the 3rd quintile of BMI (individuals belonging to the middle group of weight) and for the 4th and 5th quintiles. Note that the 3rd quintile is the group of reference in our analysis.

The life expectancy forgone due to overweight or obesity is evaluated through the differential of life expectancies among people in the two last quintiles of BMI compared to people in the 3rd quintile of BMI. In Figure 2, in the graph on the left side, we show life expectancies adjusting for the mean value of the three control variables (smoker, sex and level of education) in each dataset (MHAS and HRS). As there is an acute difference between the level of education for elderly Mexicans and those in the US, we also selected several sub-samples for different levels of education in search of more "homogeneous" (in terms of education) sub-populations for comparing the US and Mexico. Mean years of education for elderly cohorts in Mexico is 3.6 years (with 4 years of standard deviation) whereas in the US this value is 11.8 years (3.5 sd). In Appendix 1 we present the distribution of quintiles of BMI for different groups of levels of education. For

[3] There is no substantial difference between the coefficients calculated for the period 1998-2004 and the ones obtained for the period 2000-2004. The latter period was preferred because it is closer in time than the MHAS period and for being a conservative one regarding mortality differentials in Mexico.

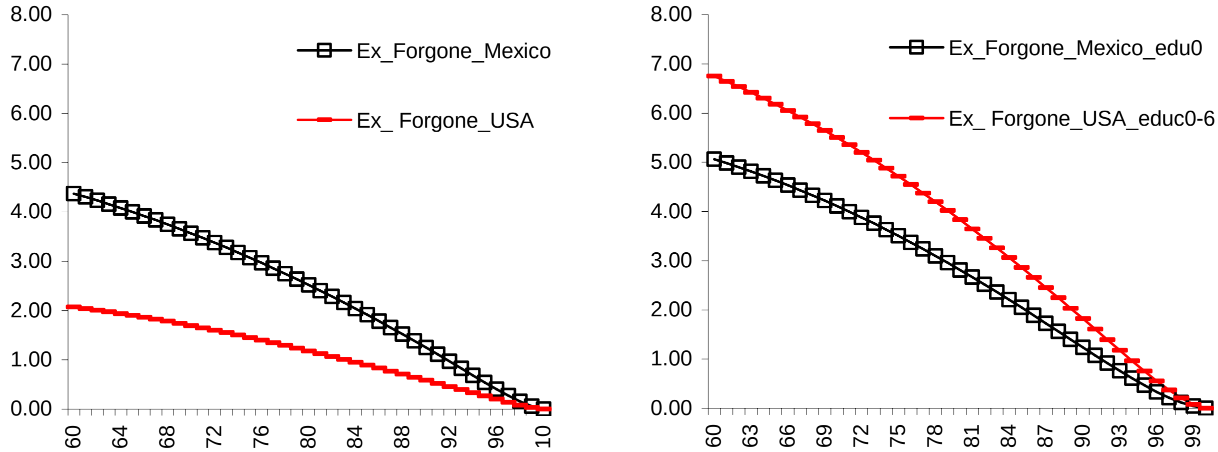
individuals with no formal education or lower levels of education (0-6 years) there are larger proportions of people concentrated in the two last quintiles of BMI (4th and 5th quintiles) in the US than in Mexico.

In Figure 2 (graph on the right side) we also show the life expectancy forgone for populations with the lowest levels of education in the US and Mexico. For the US we selected people with 6 years of education or lower (elementary school or less). For Mexico we considered people with no formal education (zero years of school). Selecting exactly the same number of years of education was not possible in all cases due to the sharp differences in levels of education in these countries[4]. For example, considering people with no education in the US reduces the sample from 10,032 individuals to 90 individuals (and logistic analysis produces results which are statistically not significant). On the other hand, working with people from 0 to 6 years of education in Mexico produces results equivalent to the entire population (people in this range of education represent around 85% of the total sample of elderly Mexicans in MHAS). In Appendix 2 we show the parameters for the logistic regression for different sub-groups of education in Mexico and in the US (including the coefficients that produce the results showed in the right side of the figure 2).

We observe that, for the entire population, the lost of life expectancy due to obesity in Mexico is much higher than for the US (Figure 2) despite the fact that the prevalence of obesity and chronic diseases among the elderly are higher in the United States. For 60 year-old individuals, the life expectancy forgone due to obesity in Mexico would be 4.4 years whereas in the US it would be 2.1 years (graph on the left side). But when we evaluate this effect among the individuals with the lowest levels of education in those countries we obtain the reverse result: for 60 year-old individuals with no formal education in Mexico the loss in life expectancy due to obesity would be 5 years whereas in the US for individuals from 0 to 6 years of formal education the loss reaches 6.75 years.

[4] In the US, over 70% of the elderly population has 11+ years of formal education. In contrast, in Mexico, 70% of elderly have 0-5 years of education.

Figure 2
Life Expectancy Forgone Due to Obesity
For Elderly in Mexico and in the US*



All Levels of Education **Lowest Levels of Education**

*** Note: Difference between Ex 5th - 4th quintile of BMI and Ex 3rd quintile.**
Source: MHAS (2001-2003) and HRS (2000-2004).

As our results point out, despite the fact that the prevalence of obesity and chronic diseases are higher among elderly in the United States, differentials in mortality among obese individuals are higher in Mexico than in the US. The previous result also shows that the higher amount of lost life expectancy in Mexico than in the US seems to be associated with poorer socio-economic conditions among elderly Mexicans. In order to investigate the mechanism underlying the connection between poor socio-economic conditions and higher effect of obesity on mortality we carried out a decomposition analysis. Such analysis, as specified in the methodology section, has two components that allow us to verify whether the higher risk of dying among obese individuals is associated with either a higher probability of suffering obesity-related chronic diseases or with a higher risk of dying conditional on suffering obesity-related chronic diseases (distinguishing each one of these diseases).

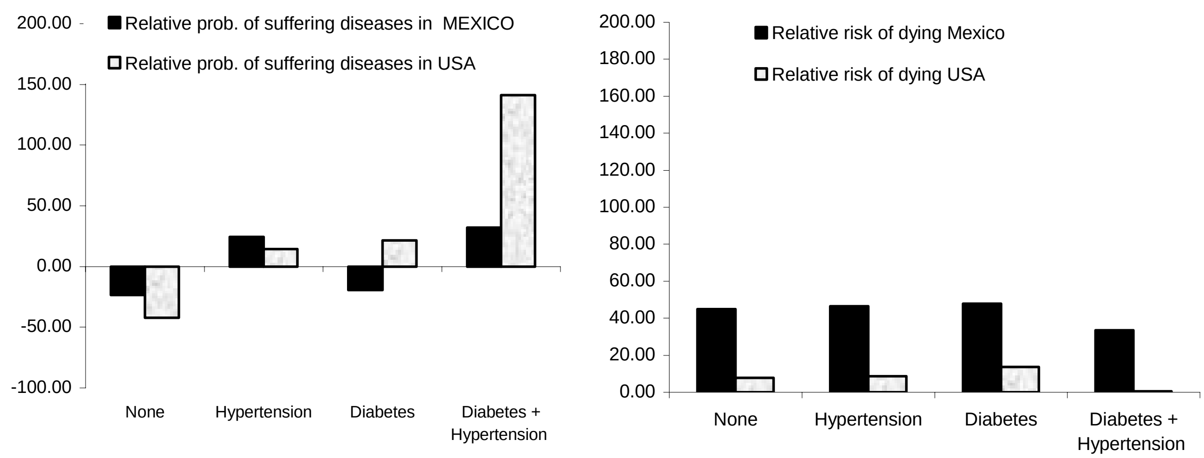
The chronic diseases were selected according to the aforementioned evidence about the effect of obesity on the probability of experiencing chronic diseases. Diabetes, heart diseases and hypertension stand out among them. Additionally, for both countries analyzed, we verify a strong effect of obesity on the probability of suffering diabetes, hypertension and heart attack.[5] Since the effect of obesity on the probability of suffering a heart attack disappears after controlling for hypertension, we only consider diabetes and hypertension in the decomposition analysis.[6] Based on the interaction of these two variables, we get the following groups: suffering neither hypertension nor diabetes; suffering hypertension and not diabetes; suffering diabetes and not hypertension; and suffering both. To avoid compositional differences such analysis is carried out for several groups defined by sex and age. Figure 3 shows the results for the largest homogeneous group found in the samples: females between 59 and 69 years old. This group is around 23% of the total valid data of each sample (excluding missing values).

The graph on the left side of Figure 3 shows the probability of experiencing each chronic condition (none, hypertension, diabetes or both conditions) for obese people (belonging to the fifth quintile of the BMI distribution) relative to the individuals with normal weight (belonging to the third quintile of the BMI distribution). As we can observe, the relative probability is higher for elderly individuals in the US than for Mexicans. For example, in the US the probability of experiencing diabetes and hypertension together is 141.14% higher for obese individuals relative to those with normal weight. This percentage is much lower among Mexicans, whose relative probability is equal to 31.98% (two last bars in the left graph of Figure 3).

The reverse results are observed when we analyze the graph on the right side of Figure 3. This graph displays the relative risk of dying conditional on experiencing each chronic disease. According to it, the probability of dying is higher among obese people than among individuals with normal weight. Clearly this differential is stronger for Mexican elderly. In Mexico, the relative risk probability of dying for people experiencing both hypertension and diabetes is 33.5%, whereas in the US this percentage is 0.54%.

[5] Appendix 3 shows the results of the regression analysis performed in order to evaluate the effect of obesity on the probability of suffering from each disease.
[6] Another important obesity-related factor of risk is heart disease. This variable is available only for United States (HRS). Since we want to compare results for Mexico and United States, we consider only heart attack. Despite the fact that this variable measures only one type of cardiovascular disease, it is the only one available in both datasets used in this paper.

Figure 3
Decomposition Analysis of the Relative Risk of Death for Obese People*
Women aged 60-70
Comparison for Mexico and the US



Relative probability of suffering obesity-related diseases | **Relative risk of dying among those who suffer each disease**

*** Note: The relative risk refers the risk for people in 5th quintile of BMI compared to people in the 3rd quintile of BMI.**
Source: MHAS (2001-2003) and HRS (2000-2004).

V. Discussion

The main contribution of this paper is to produce comparable estimations of the effects of obesity on mortality for elderly people in Mexico and in the US, as well as identifying the main mechanism underlying such effects.

The increase in the prevalence of obesity and its related chronic diseases under frail socio-economic conditions in Mexico suggests that effects on mortality in less-developed countries may be more acute than in more developed countries. These frail socio-economic conditions are related not only to more difficult access to health care but also to greater exposure to infectious diseases and worse nutrition early in life. The distinctive conditions in countries of Latin America and the Caribbean define a profile of obese individuals characterized by having suffered a lack of essential nutrients, particularly the proteins obtained from meat consumption early in life.

Our results show that despite the fact that obesity and related chronic diseases are more prevalent among US elderly, the effect of obesity on lost life expectancy is much more acute in Mexico (over twice that of the US). Analyzing the effects among different socio-economic strata, we can observe a greater effect among lower-educated individuals compared to the population as a whole. For the US, life expectancy lost due to obesity for the entire population is 2.1 years (for individuals 60 years old and over) and 6.75 years for individuals having 0 to 6 years of education. For Mexico, forgone life expectancy for all obese individuals in the same age group is 4.4 years whereas for individuals with no formal education, the loss reaches 5 years.

These findings are in accordance with the hypothesis that suggests that the effect of obesity on mortality is inversely related to the socio-economic level of the population. When we analyze more homogeneous groups (in terms of education) the gap in the effects of obesity on mortality decreases and even reverses the results between the countries.

Is the higher relative risk of mortality observed in Mexico due to the higher probability of suffering obesity-related diseases? Or it is a consequence of the higher relative risk of mortality conditional on having these chronic diseases? The decomposition analysis carried out was useful for answering these questions and helping us to better understand the mechanism underlying the connection between poor SES and the effect of obesity on mortality. According to our analysis, despite the fact that the probability of suffering obesity-related chronic diseases among obese individuals (as compared to people of normal weight) is much higher for US elderly, the relative risk of dying conditional on experiencing these diseases is higher in Mexico.

Evaluating these results for females from 60 to 69 years old we can note that in the US, the probability of experiencing diabetes and hypertension together is 141.14% higher for obese individuals relative to those with normal weight, while it is only 31.98% higher in Mexico. We found only one condition, hypertension, for which the relative probability is higher for Mexicans than for Americans (24% and 14%, respectively).

On the other hand, for Mexican elderly the relative risk of dying for people suffering both hypertension and diabetes is 33.5%, whereas in the US this percentage is

0.54%. For the other conditions the relative risk of dying is: diabetes 48% in Mexico and 14% in the US; hypertension 47% for Mexico and 9% for the US.

The higher probability of suffering chronic conditions in the US could be associated with a larger risk of becoming ill due to the higher prevalence of obesity (or other causes) or it could be the result of a selection effect, that implies a premature mortality in Mexico among obese people that does not allow us to observe people with these conditions at older ages. The previous hypotheses could be operating simultaneously; in fact there is evidence for both scenarios. On the one hand, there is a higher prevalence of obesity among the US elderly; on the other, we observe a larger risk of mortality among obese Mexicans.

Higher mortality among obese Mexicans could be due to a combination of factors. First, inferior access to health services would proportionally affect people who suffer chronic conditions more often (obese more than non–obese individuals). The proportion of elderly people in Mexico (MHAS, 2001) who do not have any health insurance is 32% (52% for people with no formal education), whereas in the US (HRS, 2000) this proportion is equal to 4% (9% for people with 0-6 years of education). Second, the higher mortality among elderly obese in Mexico could be the result of a combination of infectious diseases, undernutrition and poor conditions, in general, early in life. These findings lead us to ask what will happen in Mexico if the prevalence of obesity among the elderly reaches current US levels. A future increase in obesity prevalence for Mexico seems to be the most probable scenario if we observe the prevalence of obesity at younger ages in Mexico (which already is higher than for the US).

The next steps of this work will be simulating the effect on chronic diseases and losses in life expectancy associated with different scenarios of prevalence of obesity. In addition, these scenarios will take into account the role of early conditions on this process: the risk of being obese, suffering chronic conditions and dying.

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Appendix 1

Distribution of Individuals by Quintile of BMI and by Level of Education in Mexico (2001) and in the US (2000)

Years of Education	BMI – Quintiles %				
MHAS	**1st Q**	**2nd Q**	**3rd Q**	**4th Q**	**5th Q**
0	26.04	20.40	16.25	18.63	18.68
0 – 6	20.07	20.01	19.34	19.93	20.66
7 – 12	13.45	21.79	23.16	21.67	19.93
12 and more	13.79	26.60	22.91	20.20	16.50
12 – 15	14.13	27.72	20.65	16.85	20.65
14 and more	13.46	26.15	25.38	21.92	13.08
15 and more	13.39	25.94	24.69	23.01	12.97
HRS 2000					
0	11.96	21.74	19.57	25.00	21.74
0 – 6	14.78	19.10	19.40	25.07	21.64
7 – 12	19.47	19.35	20.24	20.72	20.22
12 and more	20.98	21.56	20.64	19.70	17.11
12 – 15	20.54	19.96	20.63	20.54	18.34
14 and more	21.71	24.03	21.52	18.11	14.63
15 and more	22.24	25.64	20.72	17.54	13.87

Appendix 2

Table A1
Logistic Regression – Independent Variable: Death between 2001 and 2003
Mexican with no Formal Education

N = 1,747	Quintiles	
Variable	**Coeff.**	**P value**
Age	0.07**	0.00
Sex	-0.33*	0.08
5th quintile	0.76**	0.05
4th quintile	0.65*	0.09
2nd quintile	0.77**	0.04
1st quintile	1.02**	0.00
Smoker	-0.20	0.47
Constant	-7.98**	0.00

* p-value < 0.10 ** p-value < 0.05

1st quintile: BMI<21.9; 2nd quintile: 21.9≤BMI<24.7; 3rd quintile 24.7≤BMI<27.3; 4th quintile: 27.3≤BMI<30.5 and 5th quintile: BMI≥30.5.

Table A2
Logistic Regression – Independent Variable: Deaths between 2000 and 2004
US population from 0 to 6 years of formal education

N = 656	Quintiles	
Variable	**Coeff.**	**P value**
Age	0.08**	0.00
Sex	-0.53*	0.05
Education	0.03	0.47
5th quintile	0.96*	0.05
4th quintile	0.70	0.15
2nd quintile	1.35**	0.00
1st quintile	1.46**	0.00
Smoker	0.31	0.315
Constant	-8.03**	0.00

* p-value < 0.10 ** p-value < 0.05

1st quintile: BMI<23.42; 2nd quintile: 23.42≤BMI<25.77; 3rd quintile 25.77≤BMI<28.00; 4th quintile: 28.00≤BMI<31.12 and 5th quintile: BMI≥31.12.

Table A3
Logistic Regression – Independent Variable:
Deaths between 2000 and 2004
US population over 14 years of formal education

N = 3,067	Quintiles	
Variable	**Coeff.**	**P value**
Age	0.11**	0.00
Sex	-0.59**	0.00
Education	-0.08	0.19
5th quintile	0.23	0.38
4th quintile	0.33	0.15
2nd quintile	0.24	0.26
1st quintile	0.45**	0.04
Smoker	0.99**	0.00
Constant	-8.21**	0.00

* p-value < 0.10 ** p-value < 0.05

1st quintile: BMI<23.42; 2nd quintile: 23.42≤BMI<25.77; 3rd quintile 25.77≤BMI<28.00; 4th quintile: 28.00≤BMI<31.12 and 5th quintile: BMI≥31.12.

For Mexico it was not possible to estimate the effect for people with 6 years of education or higher (secondary school finished) because the sample comes down to 300 individuals and of those there are only 20 deaths.

Appendix 3

Results of the Decomposition Analysis

a. Logistic Regression – Independent Variable: Deaths between 2000 and 2004 (HRS) and between 2001 and 2003 (MHAS)

Variable	HRS		MHAS	
	Coeff.	**P value**	**Coeff.**	**P value**
Age	0.10	0.000	0.08	0.000
Sex	-0.54	0.000	-0.40	0.001
Education	-0.04	0.000	-0.02	0.263
Obese_high (or 5th quintile)	0.15	0.241	0.41	0.054
Obese (or 4th quintile)	0.11	0.370	0.49	0.017
Overweight (or 2nd quintile)	0.31	0.008	0.40	0.051
Low Weight (or 1st quintile)	0.85	0.000	1.05	0.000
Smoker	0.70	0.000	0.25	0.107
Hypertension	0.25	0.003	0.26	0.068
Diabetes	0.55	0.000	0.79	0.000
Hypertension and Diabetes	1.21	0.000	1.02	0.000
Constant	-8.24	0.000	-8.69	0.000

b. Multinomial Logistic Regression – Independent Variable: Groups of diseases (Reference Category: Suffer neither hypertension nor Diabetes)

Variable	HRS		MHAS	
Hypertension	**Coeff.**	**P value**	**Coeff.**	**P value**
Age	0.02	0.000	0.01	0.029
Sex	0.08	0.079	0.59	0.000
Education	-0.02	0.001	0.01	0.062
Obese_high (or 5th quintile)	0.67	0.000	0.48	0.000
Obese (or 4th quintile)	0.34	0.000	0.26	0.007
Overweight (or 2nd quintile)	-0.17	0.010	-0.17	0.071
Low Weight (or 1st quintile)	-0.54	0.000	-0.31	0.002
Smoker	-0.18	0.005	-0.56	0.000
Constant	-1.45	0.000	-1.98	0.000
Diabetes	**Coeff.**	**P value**	**Coeff.**	**P value**
Age	0.01	0.197	-0.02	0.038
Sex	-0.44	0.000	0.23	0.027
Education	-0.07	0.000	0.00	0.857
Obese_high (or 5th quintile)	0.70	0.000	0.04	0.800
Obese (or 4th quintile)	0.25	0.085	0.00	0.976
Overweight (or 2nd quintile)	-0.37	0.017	-0.08	0.605
Low Weight (or 1st quintile)	-0.60	0.000	-0.36	0.035
Smoker	-0.29	0.052	-0.23	0.099
Constant	-1.60	0.037	-1.09	0.044
Hypertension and Diabetes	**Coeff.**	**P value**	**Coeff.**	**P value**
Age	0.04	0.000	0.00	0.804
Sex	-0.04	0.545	0.69	0.000
Education	-0.09	0.000	0.01	0.203
Obese_high (or 5th quintile)	1.38	0.000	0.53	0.000
Obese (or 4th quintile)	0.71	0.000	0.38	0.008
Overweight (or 2nd quintile)	-0.57	0.000	-0.20	0.199
Low Weight (or 1st quintile)	-1.04	0.000	-0.18	0.251
Smoker	-0.22	0.031	-0.82	0.000
Constant	-3.01	0.000	-2.83	0.000

c. LOGISTIC REGRESSION – EFFECT OF OBSESITY ON CHRONIC DISEASES

C.1. HRS

Variables	Heart Attack (1)		Heart Attack (2)		Hypertension		Diabetes	
	Coeff.	P Value	Coeff.	P Value	Coeff.	P Value	Coeff.	P Value
Age	0.02	0.036	0.02	0.081	0.02	0.000	0.02	0.000
Sex	-0.75	0.000	-0.79	0.000	0.11	0.011	-0.19	0.001
Education	-0.05	0.001	-0.05	0.003	-0.03	0.000	-0.07	0.000
Obese_high (or 5th quintile)	**0.29**	**0.146**	**0.14**	**0.475**	**0.76**	**0.000**	**0.83**	**0.000**
Obese (or 4th quintile)	**0.03**	**0.884**	**-0.06**	**0.768**	**0.40**	**0.000**	**0.42**	**0.000**
Overweight (or 2nd quintile)	-0.02	0.920	0.02	0.914	-0.21	0.001	-0.41	0.000
Low Weight (or 1st quintile)	-0.07	0.738	0.04	0.845	-0.58	0.000	-0.67	0.000
Smoker	0.14	0.410	0.19	0.281	-0.17	0.004	-0.16	0.049
Hypertension	-	-	0.96	0.000	-	-	-	-
Constant	-3.71	0.000	-4.05	0.000	-1.41	0.000	-1.94	0.000

C.2. MHAS

Variables	Heart Attack (1)		Heart Attack (2)		Hypertension		Diabetes	
	Coeff.	P Value	Coeff.	P Value	Coeff.	P Value	Coeff.	P Value
Age	0.03	0.000	0.03	0.000	0.01	0.010	-0.01	0.069
Sex	-0.58	0.000	-0.79	0.000	0.58	0.000	0.22	0.001
Education	0.02	0.114	0.02	0.237	0.01	0.051	0.00	0.957
Obese_high (or 5th quintile)	**0.36**	**0.059**	**0.22**	**0.259**	**0.51**	**0.000**	**0.12**	**0.241**
Obese (or 4th quintile)	**0.14**	**0.461**	**0.05**	**0.814**	**0.29**	**0.001**	**0.12**	**0.258**
Overweight (or 2nd quintile)	-0.05	0.819	0.00	0.986	-0.16	0.065	-0.08	0.470
Low Weight (or 1st quintile)	0.06	0.768	0.17	0.423	-0.23	0.009	-0.12	0.301
Smoker	-0.81	0.000	-0.60	0.007	-0.59	0.000	-0.30	0.003
Hypertension	-	-	1.48	0.000	-	-	-	-
Constant	-4.29	0.000	-4.71	0.000	-1.89	0.000	-1.29	0.000