# Obesity and Subjective Survival Expectations in a Developing Country: Costa Rica* 

Beatriz Novak*

Palabras-clave: Obesity, Subjective Survival

## Resumen

Latin America and the Caribbean are witnessing an increasing obesity trend that is accompanied by an increasing prevalence of obesity-related comorbidities, while diseases that traditionally burdened the region are still present. Although the relationship between obesity and mortality has mainly been studied for developed countries, there is also evidence of this relationship for developing countries as well. The literature on individuals' knowledge of the health risks associated with obesity is, by far, less abundant than is the literature that investigates the health consequences of excess body weight. Even so, results point clearly towards deficient knowledge of the risks associated with obesity. Individuals appear to underestimate the mortality risks of their excessive body weight. Our results show that in general, the determinants of subjective survival behave as expected in the literature for developed countries. We also found that subjective survival expectations are an important mortality predictor, especially for men. Individuals at higher levels of body weight/risky fat distribution are surprisingly unaware of deleterious effects of obesity on future survival. This result should be taken into account for any intervention oriented to reduce the burdens associated with obesity. Unexpected findings may be revealing lack of health education/information and/or "defensive optimism."

[^0]
# Obesity and Subjective Survival Expectations in a Developing Country: Costa Rica* 


#### Abstract

Beatriz Novak*

With very few exceptions, there is no research done on subjective survival expectations related to excess body weight in developed countries; for developing countries, the body of research on this topic is scant. The main objectives of this paper is to investigate whether older adults are aware of the deleterious effects that excessive body weight (fat) may have on their future survival in a developing country. In order to so, this paper first investigates whether the relationship between individuals' characteristics and their subjective survival expectations differ across body weight levels; and second, it assesses whether subjective survival predicts mortality (controlling for sociodemographic and health-related variables including self-reported health).


## Introduction

During the last decades, obesity prevalence has been increasing worldwide. In developing countries, the increment in obesity prevalence is not only accompanied by an increment of noncommunicable diseases (Worley 2006), but also by diseases that traditionally burdened them are still present, as are infectious diseases like TB and malaria (Prentice 2006).

The Costa Rican Ministry of Public Health, based on the Costa Rican National Nutrition Survey, found that between 1982 and 1996 among women aged 20 to 44 the increment in overweight and obesity prevalence was between $34.6 \%$ and $45.9 \%$. For women aged 45 to 59 the increment was between 56\% and $75 \%$. The Community Nutrition and Alimentation Surveillance Survey 19992000 show for the district of Damas de Desamparados, that $56.4 \%$ females aged 19-44 were at least overweight ( $17.6 \%$ presented obesity type 1 and $2.5 \%$ type 2 ). ${ }^{1}$ This prevalence was $42.7 \%$ according to the 1996 round of the same survey. The 1999-2000 round of the mentioned survey showed that $58.8 \%$ of males aged $19-59$ were at least overweight, $14.7 \%$ presented type 1 obesity and $1 \%$ type 2 (Ministerio de Salud 1996, 2003).

The relationship between obesity and mortality has mainly been studied for developed countries. However, there is also evidence of this relationship for Latin American countries as well. Higher levels of BMI were found to be associated with excess mortality among older adults in Mexico. A study conducted by Monteverde et al. (2010), using the Mexican Health and Aging Study (MHAS), found that at age 60 the relative difference in the probability of dying between

[^1]individuals in the third quintile of the BMI distribution and individuals in the forth and fifth quintiles of this distribution is more than $60 \%$. The same study shows that at age 60 the loss of life expectancy in Mexico due to excess BMI (fifth quintile) would be 2 years while for the US it will be 0.55 years. ${ }^{2}$ The authors suggested that the higher mortality among the Mexican elderly may respond to two factors. On the one hand, it may be due to inferior access to health services. This inferior access could be highly affecting the obese (who suffer from chronic conditions more often). On the other hand, it may be due to forces that could be operating without an increment in the incidence of chronic conditions. For instance, to the double exposure to parasitic and infectious diseases that may negatively influence the natural course of the chronic conditions (Monteverde et al. 2010). The CRELES study also offers evidence of the relationship between obesity and mortality (Rosero-Bixby, Brenes-Camacho, and Méndez-Chacón 2009).

## Data and Measures

## Data

Data for this study is drawn from the CRELES ${ }^{3}$ study. The CRELES study is a Costa Rican national representative longitudinal survey of individuals born before 1946 designed to study older Costa Rican adults' longevity and quality of life as well as its determinant factors. The original study sample consisted of 3,000 individuals living in households. By design, this study over-sampled older individuals age 90 and older. ${ }^{4}$ The present study analyzes data from the first CRELES wave (2004-2006). A total of 2,827 respondents 60 years old and over were interviewed in the first CRELES wave. Until June 2007, there were registered 246 deaths. CRELES respondents' vital status was followed by linking the dataset to the Costa Rican Civil Registry. In total 2,515 individuals provided anthropometric measures that were taken by trained professionals; these measures include height, weight, and waist and hip circumferences. The CRELES study provides information over a set of 22 biomarkers of different kinds including cholesterol measures and handgrip strength, among others.

## Subjective Survival Expectations

The question regarding subjective survival expectations in the CRELES study takes the following form:

- "How likely do you think it is you will live until age ...

80 (if the respondent's age is less than 69 years old)?

[^2]85 (if the respondent's age is between 70 and 74 years old)? 90 (if the respondent's age is between 75 and 79 years old)?
95 (if the respondent's age is between 80 and 84 years old)?
100 (if the respondent's age is between 85 and 90 years old)?"
(1: Very Likely; 2: Likely; 3: Unlikely; 4: Very Unlikely)

## Relevant Measures

## Body Mass Index

For this study, the levels of body weight (fat) are defined according to the WHO cut-off points for BMI. They are Normal Weight ( $18.5 \leq \mathrm{BMI}<25$ ), Overweight ( $25 \leq \mathrm{BMI}<30$ ), and Obese ( $\mathrm{BMI} \geq 30$ ). Despite the limitations of BMI as a measure of body fat and of the standard WHO cut-off points to determine overweight levels, both of them are widely used (Hubbard 2000). As mentioned before, the CRELES study provides height and weight measures obtained by trained professionals; these are the measures used in the present paper for calculating individuals' BMI.

## Waist Circumference (WC) and Waist to Hip Ratio (WHR)

Other measures like WC and WHR were shown to be better than BMI to capture abdominal fat (Snijder, van Dam, and Seidell 2006). In addition, WHR was found to be a better anthropometric predictor of total mortality than BMI and WC. It was also found to be associated with mortality from coronary heart disease and other cardiovascular (CV) diseases (Folsom et al. 2000). Although some studies suggest that central obesity may be a stronger mortality predictor than BMI the issue is still controversial (Solomon and Mason 1997). WC levels were defined according to the cut-off points proposed by Lean, Han, and Morrison (1995) who suggested two levels of action for determining the need of weight management. These levels are Action Level 1 ( $94 \mathrm{~cm} \leq \mathrm{WC} \leq 101 \mathrm{~cm}$ for males and $80 \mathrm{~cm} \leq \mathrm{WC} \leq 87 \mathrm{~cm}$ for males) and Action Level 2 (defined as having a WC over the upper limit of WC at Action Level 1). Han et al. (1995) found that, compared with individuals classified as being below Action Level 1, those at Action Level 1 are 1.5-2.0 as likely while those at Action Level 2 are 2.5-4.5 as likely to have one or more major CV risk factors. The categories defined for WHR, according with the NIH (1998) cut-off points, were Safe (WHR $\leq 90$ for males and WHR $\leq 80$ for females), Unsafe ( $90<\mathrm{WHR}<1$ for males and $80<\mathrm{WHR}<1$ for females), and finally the Danger zone (WHR $\geq 1$ for males and females) where the risk of heart disease and other obesity-related diseases is greater.

## Methods and Results

The analysis is divided in two sections. The first section is dedicated to analyze the determinants of subjective survival expectations and possible differences across body weight/body fat distribution levels. The second section of the analysis is focused on the properties of subjective survival expectations as mortality predictors. In both sections, we analyze two age groups, 60-69 and 70-90. This age stratification was done for two reasons. First, because individuals aged less than 70 were asked to estimate an event that may occur as far as 20 years ahead; while for individuals older than 70 the event may happen as far as 15 years ahead. Second, because even though for younger adults the association of obesity with mortality is well established (Thorpe and Ferraro 2004), for older adults this relationship is controversial (Oreopoulos et al. 2009).

However, evidence from longitudinal studies show that despite the fact that the association of greater BMI with all cause and CV mortality decreases with age it remains significant for both men and women up until age 75 (Prospective Studies Collaboration 2009).

## First Section: Determinants of Subjective Survival Expectations

## Methods

Following Nelson and Honnold (1980), the determinants of subjective survival were divided into four different dimensions adding two more dimensions to their basic model that included only the sociodemographic and death experience dimensions. The two dimensions added are the physical and mental health dimension and the health-related behaviors dimension. Each of these dimensions consists of a set of explanatory variables.

## 1. Sociodemographic Dimension

The factors included in this dimension are age, gender, education, a measure of income and wealth, marital status, and number of living children. Age was found to have a positive relationship with both subjective probability of surviving to a target age and subjective life expectancy. While some studies showed that income and wealth do not have a strong influence in the assessment of subjective survival, current economic hardships were found to decrease survival expectations (Benítez-Silva and Ni 2005; Hurd and McGarry 1995; Mirowsky and Ross 2000). The indicators of income and wealth included in this dimension are representative of possible economic hardships. They are an indicator of whether the respondent's income is below the median of the income distribution and an indicator of the conditions of the respondent's house (a self-assessment on whether the respondent's house is in good conditions). Education, as an indicator of economic status showed that those individuals with poor educational attainment were more pessimistic regarding their future survival (Popham and Michell 2007). The measure for educational attainment used here states whether the respondent had completed elementary education because in most Latin American countries, including Costa Rica, for older adults this is the highest educational attainment they have reached. Some research has shown that married individuals enjoy economic and health advantages that are not enjoyed by other groups (Lillard and Waite 1995); therefore it could be reasonable to expect that married individuals express higher survival prospects than those expressed by individuals that are not married. For marital status, the sociodemographic dimension includes an indicator stating whether the respondent is currently married or in consensual union. Ross and Mirowsky (2002) hypothesized that having living children may foster a sense of security about the future thus contributing positively to the assessment of subjective survival. For this reason, this dimension also includes an indicator of the number of the respondent's living children.

## 2. Physical and Mental Health Dimension

Two self-assessed measures of health status are part of this dimension, self-assessed general health status (going from excellent to poor) and self-assessed health status compared with others the same age (stating better, equal, or worse). In addition, there are three indexes of chronic conditions. These indexes are first, an index of the number of major obesity-related diseases
(heart disease, infarction, stroke, and diabetes). Second, an index of general diseases (usually perceived as life threatening but not related with obesity: cancer and lung disease). Third, an index of minor obesity-related diseases, diseases that although may be considered as obesityrelated they are not perceived as life threatening as the diseases included in the other two indexes are (arthritis, hypertension, and hypercholesterolemia). Two more objective health indicators are included in this dimension. One of them states whether the respondent has been hospitalized any time during the previous year and the other one whether the respondent is actually taking prescription medicines. The health dimension also counts with two measures of physical limitations, the Activities of Daily Living (ADL) and the Instrumental Activities of Daily Living (IADL) indexes. Mental health is taking into consideration by means of the 15 -item short form of the Geriatric Depression Scale (GDS). Different health conditions and self-assessed health status have shown to be not only mortality predictors but also predictors of self-assessed probabilities of surviving to a target age (Hamermesh and Hamermesh 1983). With data from the first six waves of the HRS study, Benítez-Silva and Ni (2005) found that both health stocks and health flows, as well as having more diseases that are chronic or more ADLs limitations decreased expected longevity probabilities.

## 3. Health-related Behaviors Dimension

The health-related behaviors dimension includes first, an indicator of the respondent's status as a smoker (is or not a current smoker). Second, an indicator stating whether the respondent currently drinks alcoholic beverages. Third, an indicator reporting whether the respondent have been practicing vigorous physical activities more than three times per week during the last year. Smoking is consistently found to be negatively associated with subjective survival estimations (Hurd and McGarry 1995). Moderate alcohol drinking was found to be associated with higher survival probabilities to ages 75 and 85 compared with the survival probabilities for complete abstinence. The opposite was true for heavy drinking relative to complete abstinence (Hurd and McGarry 1995). Having physical activities seem also to be important to respondents for estimating their own probabilities of surviving to a given age (Ross and Mirowsky 2002).

## 4. Death Experience Dimension

This dimension includes information regarding the survival status of the respondent's mother as well as the age of the mother if alive or if not, the age at death. Different studies have shown that longevity of parents, used by respondents as a marker of their genetic makeup, has a great influence on the assessment of individuals' survival expectations, particularly longevity of the same-sex parent (Hurd and McGarry 1995; Ross and Mirowsky 2002). The CRELES study only provides survival status of the respondent's mother.

Each of the aforementioned dimensions is added into the model, an ordered logistic regression model, in a nested way. The dependent variable of the ordered logistic regression model is the subjective probability of surviving to a given age, which is a four-point Likert Scale variable. The ordinal regression model is commonly approached as a latent variable model. If $y^{*}$ is a latent variable ranging from $-\infty$ to $+\infty$ then the structural model is:

$$
\begin{equation*}
y^{*}=X \beta+\varepsilon \tag{1}
\end{equation*}
$$

Using (2), we can relate the latent observation to the ordinal response variable and express the model in terms of probabilities. In (2), $J$ is the number of categories of the response variable, and $\tau_{i}$ are cut-off points to be estimated. It is assumed that $\tau_{0}=-\infty$, and that $\tau_{J}=+\infty$.

$$
\begin{equation*}
y=i \quad \text { if } \tau_{i-1} \leq y^{*}<\tau_{i} \quad \text { for } i=1 . . J \tag{2}
\end{equation*}
$$

As mentioned before, each dimension is added to a basic model in a nested way (leading to five models in total). The basic model has only two variables. Each of these variables represents the body weight categories of overweight and obese as measured by BMI, with the normal weight category as the residual one. The same exercise was repeated two more times. The first time the basic model used the categories of WC (with Not at Risk as the reference category), and a second time using the categories WHR (with Unsafe as the reference category).

## Descriptive Analysis

There are 2,549 individuals aged 60-90 in the original CRELES sample. Individuals over 90 years old ( $9.83 \%$ ) were not asked the subjective survival question. Individuals with serious communication problems answered the interview with help of a proxy ( $19.03 \%$ ) and were not asked the survival question either. There were also excluded from the analytical sample individuals for whom there is no BMI information (8.56\%), underweight individuals (3.30\%), and those for whom there is no information on variables that comprise the different previously mentioned dimensions. The analytical sample is therefore composed of 1,209 individuals that were divided into two age groups 60-69 (42.68\%) and 70-90. ${ }^{5}$

Among individuals in the younger age group, $45.69 \%$ are classified as overweight and $27.71 \%$ as obese; $39.38 \%$ and $22.31 \%$ as overweight and obese respectively among individuals in the older age group. When the classification is done according to WC, the proportion of individuals classified as being at action Level 2 doubles the proportion classified as obese. For both age groups the great majority is classified as being in the WHR Unsafe zone with only less than $10 \%$ classified as in the WHR Safe zone. In general, there are almost no differences across body weight/body composition groups in the proportion of individuals giving any of the possible subjective survival answers or to the self-assessed health question. This is true for both age groups. The sample composition for the rest of the health variables is as expected, with higher proportions of obesity-related diseases among individuals classified as obese, overweight, being at WC Levels 1 and 2, and being in the WHR Danger zone (compared with individuals with normal weight, in the WC Not at Risk zone, and in the WHR Unsafe zone respectively).

## Results

As mentioned earlier, the basic model (Model 1) consists of the BMI categories overweight and obese where normal weight is the reference category. In the younger age group, the odds of

[^3]stating that it is Very Unlikely to survive to age 80 versus stating any other of the options combined are 1.7 times higher among obese individuals than among normal weight ones ( 1.5 times higher in the older age group). Including in Model 1 the sociodemographic dimension (Model 2) slightly reduces these odds in magnitude and significance among individuals in the younger age group. On the contrary, it increases these odds among individuals in the older age group. Regarding the variables of the sociodemographic dimension, the coefficients associated with them do not suffer much change neither in magnitude nor in significance from Model 2 on. The same is true for the variables included in Models 3 to Model 5, once in the model the inclusion of other dimension do not change substantively the coefficients of the previously included variables neither in magnitude nor in significance. The only exception is the variable associated with obesity in the younger age group. In Model 3 (Sociodemographic+Health dimensions), the coefficient associated with obesity loses significance and decreases its value; however, thereafter it does not suffer any more changes. This result shows that the variables in the health dimension are mediating the relationship between obesity and subjective survival expectations among individuals in the younger age group. Because adding into the model the health-related behaviors and death experience dimensions do not substantively modify in magnitude nor in significance the coefficients of the variables already in the model, we will only analyze Model 5, the complete model for both age groups (Table 1).

We found that education, self-assessed health, and health compared with others are the predictors of subjective survival that both age groups have in common. In addition, gender, number of children alive, minor obesity-related diseases, hospital stays, currently taking prescription medicines, depression, practicing physical activities, and the information pertaining to the survival status of the mother are also determinants of subjective survival among individuals in the younger age group. Age, being obese, having major obesity-related diseases, and having IADLs limitations are subjective survival predictors only among in the older age group. Similar results were obtained using WC and WHR levels instead of BMI levels.

Among individuals in both age groups, the worsening of both self-reported health (compared with excellent) and health compared with others (versus better) increases the odds of stating that survival to the target age is Very Unlikely. Major obesity-related and general diseases variables do not seem to have any influence in determining the levels of the dependent variable among individuals in the younger age group. However, one unit increment in minor obesity-related diseases variable unexpectedly decreases the odds of reporting the Very Unlikely option (although at the 0.1 level significance level). On the contrary, among individuals in the older age group, for each unit increment in the variable counting major obesity-related diseases the odds of reporting the Very Unlikely option versus the combination of the other categories is 1.4 times as higher. Among individuals in the older age group, except for the index of IADL none of the other variables in the health dimension is significantly related with subjective survival expectations. In the younger age group, however, symptoms of mild and severe depression increase 1.7 times the odds of stating that surviving to the target age is Very Unlikely. Surprisingly, for individuals in the younger age group for both having been hospitalized any time during the previous year and currently taking prescription medicines the odds of reporting it is Very Unlikely to survive to the target age are around 0.5 times as high as the odds of the
combination of the other categories. Also unexpectedly, females in the younger age group are less optimistic regarding their future survival than men are.

Table 1. CRELES 2004-2006 - Ordered Logistic Regression - Dependent Variable: Subjective Survival

| Variables | Age 60-69 |  | Age 70-89 |  |
| :---: | :---: | :---: | :---: | :---: |
|  | OR | SE | OR | SE |
| BMI (vs. Normal) |  |  |  |  |
| Overweight ( $\mathbf{1}=\mathbf{Y e s}$ ) | 1.142 | 0.196 | 0.883 | 0.171 |
| Obese (1-Yes) | 1.164 | 0.228 | $1.697^{*}$ | 0.390 |
| Age | 0.993 | 0.026 | 1.042* | 0.020 |
| Female (1=Yes) | $1.516^{* *}$ | 0.237 | 0.978 | 0.183 |
| Married or Cohabiting ( $1=$ Yes) | 0.778 | 0.122 | 0.955 | 0.173 |
| Elementary Education or More ( $1=$ Yes) | $0.721^{*}$ | 0.107 | $0.733^{\dagger}$ | 0.133 |
| Children Alive (1-Yes) | 1.076** | 0.030 | 0.987 | 0.027 |
| Low Income ( $1=$ Yes) | 1.184 | 0.188 | 1.058 | 0.195 |
| Condition of the House (1=Yes) | 1.017 | 0.150 | 0.758 | 0.132 |
| Self-Assessed Health | $1.598 * * *$ | 0.131 | $1.799^{* * *}$ | 0.178 |
| Health Compared with Others | 1.550 *** | 0.187 | $1.524^{* *}$ | 0.246 |
| Major Obesity-Related | 0.835 | 0.104 | $1.383 *$ | 0.191 |
| General Diseases | 1.021 | 0.161 | 1.047 | 0.184 |
| Minor Obesity-Related | $0.858^{\dagger}$ | 0.076 | 0.937 | 0.102 |
| Hospital Stays (1=Yes) | $0.455^{* *}$ | 0.133 | 1.249 | 0.349 |
| Taking Medicines ( $1=Y \mathrm{Yes}$ ) | $0.520^{* * *}$ | 0.094 | 0.990 | 0.249 |
| ADL | 0.997 | 0.057 | 0.927 | 0.059 |
| IADL | 1.027 | 0.175 | $1.443{ }^{*}$ | 0.239 |
| Depression | $1.732^{* * *}$ | 0.220 | 1.031 | 0.165 |
| Current Smoker (1-Yes) | 0.908 | 0.204 | 1.169 | 0.415 |
| Current Drinker (1=Yes) | 0.971 | 0.145 | 1.130 | 0.209 |
| Physical Activities (1=Yes) | $0.723^{*}$ | 0.104 | 1.225 | 0.222 |
| Mother Alive ( $1=$ Yes) | $0.626{ }^{*}$ | 0.114 | 0.768 | 0.300 |
| Mother's Age | $1.00{ }^{*}$ | 0.005 | 1.003 | 0.005 |
| N | 51 |  |  |  |

${ }^{\dagger}$ : p-value $<0.1 ;{ }^{*}$ : p-value $<0.05 ;{ }^{* *}:$ p-value $<0.01 ;{ }^{* * *}:$ p-value $<0.001$

Only among individuals in the younger age group, vigorously exercising decreases ( 0.7 times) the odds of stating that survival to the target age is Very Unlikely. Importantly enough, among individuals in both age groups neither smoking nor drinking alcoholic beverages seem to be related with subjective survival estimations. For individuals in the younger age group, the coefficients of both variables that constitute the death experience dimension are statistically significant. The odds of stating that survival to the target age is Very Unlikely, as compared with the other options combined, are 0.6 times lower among those having their mothers still alive, also given that all of the other variables in the model are held constant. For one-year increment in the highest age reached by the mother, the odds of selecting the Very Unlikely category versus the
other categories combined are 1.01 times greater, which is not in the expected direction. Taking into account WC and WHR levels, we obtained in general the same results as for BMI. ${ }^{6}$

Table 1 shows that some coefficients are not statistically significant in neither age group and for none of the body composition measures. These coefficients are associated with the variables marital status, income below the median, condition of the house, ADLs, currently smoker, and currently drinker of alcoholic beverages. As mentioned earlier, evidence of the influence of income, wealth, and marital status on subjective survival is not consistent throughout the literature. Therefore, this result is not surprising. One possible explanation for this result may be related to the universalism of the Costa Rican health system. The Costa Rican Social Security Fund is responsible for offering health insurance to the whole population. This comprehensive type of health coverage may be diluting the negative influence that economic hardships may have on subjective survival estimates. Regarding marital status, evidence from the literature is also unclear (Hurd and McGarry 1995; Ross and Mirowsky 2002). Perhaps, here again, the economic advantages that married people may have that affects in a positive manner their health are less important for influencing future survival estimations under a universal health care system.

Regarding the ADLs, even though there is some evidence of the negative relationship between number of ADLs and subjective survival expectations (Benitez-Silva and Ni 2005) some research did not find any significant association between them (Karagiannaki 2009). On the contrary, research on subjective survival expectations consistently showed a negative association with smoking (Hamermesh and Hamermesh 1983; Hurd and McGarry 1995; Ross and Mirowsky 2002). It could be said that the lack of influence of smoking on subjective survival expectations found here may be due to lack of awareness of the damaging effects of smoking, even though smoking is a serious health issue in Costa Rica (Esquivel 2005). With data drawn form the Italian SHARE, Balia (2007) identified a group of smokers that seemed to attribute less damaging effects of smoking on health and mortality. Because this group was composed of heavy smokers, who were in general older than the non-heavy smokers were, Balia suggested that individuals in this group might have believed that they were too old for smoking to increase their mortality risk beyond what could be expected given their age. This type of reasoning may be operating here as well. Heavy drinking is not a minor issue in Costa Rica either. A survey conducted by the Costa Rican Social Security Fund in 2001 found that the leading reason for psychiatric consultations by both sexes was anxiety, followed by alcoholism and depression (PAHO, 2007). Hurd (2009) stated that smokers, as well as heavy drinkers, seem to be optimistic regarding their survival chances relative to observed mortality outcomes.

[^4]Taking globally, in general the (Chow) test shows for both age groups that there are no statistical differences in the coefficients across subgroups as defined by body weight/composition levels. Results do not change in a significant manner when the stratification was done by WC or WHR levels. Therefore, results show that there are no differences across body weight/body composition subgroups in the relationship between individuals' characteristics and their subjective survival expectations; that is to say, the parameters of the complete model (Table 1) do not differ across body weight/body composition levels. Testing the hypothesis of equality of the coefficients associated with major obesity-related and general diseases within each body weight/composition subgroup we found that it could not be rejected in any case. However, testing across body weight levels, for the younger age group the hypothesis of equality of coefficients was rejected only for the coefficients associated with major obesity-related diseases (at a 0.05 level) when comparing the overweight and obese subgroups. This result shows a greater negative impact of major obesity-related diseases on subjective survival estimations among individuals in the overweight subgroup than among those in the obese one. For the older age group, the hypothesis was rejected for the same coefficient when comparing the normal weight and overweight subgroups as well as between the overweight and obese subgroups (in both cases at a 0.1 significance level). Among individuals in the older age group, the negative impact of major obesity-related diseases is felt more among those in the normal weight and obese subgroups than among those in the overweight one. The global test (Chow test) for equality of coefficients between the younger and the older subsamples shows that the null hypothesis is rejected (at a 0.05 level) when using BMI as a measure of body fat. Similar results were obtained for WC and WHR.

## Second Section: Subjective Survival Expectations as Mortality Predictors

## Methods

The interest of this section is to evaluate whether subjective survival expectations in the CRELES study has one the most important properties that subjective survival expectations have shown in other contexts, namely to predict mortality. The CRELES study provides information regarding the exact date of entry into the study and the date of exit from the study, which is either the date at death or the final date of the follow-up period. This information allows conducting a survival analysis. We estimate a parametric Gompertz model, which expressed in the proportional hazard metric assumes the following form:

$$
h\left(t / x_{j}\right)=\exp (\gamma t) \exp \left(\beta_{0}+x_{j} \beta_{x}\right)
$$

Where $\gamma$ is the parameter to be estimated and $x$ is a vector of variables containing information of each individual $j$. Vector $x$ includes a set of sociodemographic variables (age, gender, education, an indicator of marital status, income and wealth indicators, and an indicator of residence area, urban or rural). Vector $x$ also includes a set of health-related variables (chronic diseases, ${ }^{7}$ a dichotomous indicator of unintentional weight loss, hospital stays, prescription

[^5]medications, depression, ADL, and IADL), and a set of health-related behavior variables (smoking condition, drinking habits, exercising, BMI, BMI squared, and WC ${ }^{8}$ ). The analytical samples do not exclude underweight individuals. Six models were estimated, the first one includes in vector $x$ the variable associated with subjective survival to a target age (more than ten years more than current age). The second model does not include the variable associated with subjective survival, but includes the variable associated with self-assessed physical health status. The third model includes both, the variable associated with subjective survival expectations and the variable associated with self-assessed health status. The last three models are similar to the first three previously described, but in these cases vector $x$ also contains a set of four physical functioning biomarkers. These biomarkers are handgrip strength, peak expiratory flow, speed lifting an object from the floor, and walking speed, which have been shown to be mortality predictors among the elderly (Al Snih et al. 2002; Cook et al. 1991; Rolland et al. 2006). ${ }^{9}$

## Descriptive Analysis

The younger age group analytical sample is composed of 550 individuals ( $44 \%$ males) while the older age group analytical sample of 768 individuals ( $49.48 \%$ males). Among individuals in the younger age group there were 76 deaths ( $51.32 \%$ males) registered in the period under observation (until June 2007) and among individuals in the older age group the number of deaths was 119 ( $44.54 \%$ males). In general, the set of individuals that were lost for analysis is the same as for the previous section.

## Results

The upper part of Table 2 shows that among males in the younger age group, in models that may or not include biomarkers, but include subjective survival, and do not include self-assessed health status as independent variables (Model 1 and Model $1+$ Biomarkers), the worsening of subjective survival expectations significantly increases the mortality risk. The inclusion of biomarkers in Model 1 results in an increment of $7 \%$ in the mortality hazard associated with subjective survival (and an enhancement in its significance) with respect to its value in the model without biomarkers. In models that may or not include biomarkers, but include self-assessed health status, and do not include subjective survival expectations (Model 2 and Model $2+$ Biomarkers), the worsening of health status also significantly increases the mortality risk. Including biomarkers in Model 2 results in a decrement of $2 \%$ in the mortality hazard associated with self-assessed health status. In addition, among males in the younger age group, in the model that includes both subjective survival expectations and self-reported health status and does not include biomarkers (Model 3), subjective survival expectations do not show any significant relationship with mortality, however the association between self-assessed health and mortality remains significant. Including biomarkers in the model results in regaining statistical significance and a $9 \%$ increment in the hazard associated with subjective survival, with respect to its value in

[^6]the model without biomarkers. It also results in a $4 \%$ decrement in the hazard associated with self-assessed health status and its loss of statistical significance. Therefore, for males in the younger age group, subjective survival is an independent mortality predictor with and without the presence of self-assessed health status in a model including objective measures of health. This result is suggesting that subjective survival may not just be mediating the effects of selfassessed health on mortality, as the literature usually states, but instead it may be mediating the effects of objective measures of health status on mortality. ${ }^{10}$

Table 2. CRELES 2004-2006 - Deaths 2007 - Estimated Hazard Rates (Gompertz)

| Age 60-69 |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Males- Models Not | Model 1 |  | Model 2 |  | Model 3 |  |
| Including Biomarkers | HR | SE | HR | SE | HR | SE |
| Self-Assessed Survival | $1.346{ }^{+}$ | 0.241 |  |  | 1.276 | 0.223 |
| Self- Assessed Health |  |  | $1.534^{\dagger}$ | 0.351 | $1.449^{+}$ | 0.322 |
| Males - Models Including | Model 1+ Bio |  | Model $2+$ Bio |  | Model $3+$ Bio |  |
| Biomarkers | HR | SE | HR | SE | HR | SE |
| Self- Assessed Survival | $1.443^{*}$ | 0.269 |  |  | $1.388^{\dagger}$ | 0.251 |
| Self- Assessed Health |  |  | $1.491^{\dagger}$ | 0.358 | 1.397 | 0.317 |
| N |  |  |  |  |  |  |
|  | Model 1 |  | Model 2 |  | Model 3 |  |
| Females - Models Not Including Biomarkers | HR | SE | HR | HR | SE | HR |
| Self- Assessed Survival | 1.051 | 0.167 |  |  | 1.093 | 0.174 |
| Self- Assessed Health |  |  | 0.759 | 0.169 | 0.740 | 0.166 |
| Females - Models Not | Model 1+ Bio |  | Model $2+$ Bio |  | Model 3 + Bio |  |
| Including Biomarkers | HR | SE | HR | HR | SE | HR |
| Self- Assessed Survival | 1.067 | 0.169 |  |  | 1.110 | 0.175 |
| Self- Assessed Health |  |  | 0.741 | 0.174 | 0.720 | 0.170 |
| N |  |  |  |  |  |  |

Note: Regressions adjusted by age, gender, education, marital status, income, condition of the house, urban residence, index of chronic conditions, BMI, BMI squared, WC, ADL, IADL, depression, hospital stays, currently taking medicines, currently smoking, currently drinking alcoholic beverages
${ }^{\dagger}$ : p-value $<0.1 ;{ }^{*}$ : p-value $<0.05 ;{ }^{* *}: \mathrm{p}$-value $<0.01 ;{ }^{* * *}: \mathrm{p}$-value<0.001

[^7]Among females in the younger age group (Table 2) as well as among males and females in the older age group (results not shown), no association was found between subjective survival expectations and mortality in any case, independently of the presence of biomarkers in the model. ${ }^{11}$ The same is true among males in the older age group for the association between selfassessed health and mortality. Interestingly, among older females the worsening of self-reported health status significantly (at a 0.1 level) reduces their mortality risk by $30 \%$ (results not shown). ${ }^{12}$

Several comments are in place regarding these results. Except for the models including biomarkers, the analysis using data from Costa Rica intended to replicate Siegel, Bradly, and Kasi (2003) study. Siegel et al. with data drawn from the 1992 HRS (individuals aged 51-61) and the 1993 Asset and Health Dynamics Among the Oldest Old (AHEAD) (individuals over 70 years old) studies analyzed subjective survival expectations as mortality predictors for a window period between two (AHEAD) and three (HRS) years. They found that among individuals in the HRS both males and females, subjective survival was not related with mortality risk independently of the inclusion of self-rated health in the model. However, among both females and males in the AHEAD study, the relationship between both subjective survival expectations and self-assessed health and mortality was statistically significant when one or both measures were in the model. When both measures were in the model neither of them lost statistical significance and the risk associated with subjective survival expectations increased, although slightly, and the risk associated with self-assessed health decreased. Van Doorn and Kasl (1998) obtained the same result for males, but not for females, when studying parental longevity and self-rated life expectancy as mortality predictors among individuals aged 70 or more using data from the Australian Longitudinal Study of Aging (ALSA). For this reason, Siegel et al. in agreement with van Doorn and Kasl suggested that perhaps estimating future survival was less meaningful among individuals that were many years from dying than for the others, the older ones. On the contrary, findings of the present research show that among males in the older age group ( 70 or more) neither subjective survival nor self-assessed health were related to mortality. However, among females in the older age group, self-assessed health status was a morality predictor but not in the expected direction. In fact, the coefficient associated with self-assessed health has the opposite sign among women in the younger age group as well, although it was not significant. That is to say, the worsening of self-assessed health decreases the mortality hazard. Perhaps this result is suggesting that older women in Costa Rica are what van Doorn called

[^8]health optimists. These individuals make use of different techniques, like positively compare themselves to others or minimize health issues thinking them natural, given their advanced age, to have a positive view of their health in spite of having more than one important health problem (van Dorn, 1999). As for self-assessed health in the younger age group, results of the present study are in agreement with results obtained by Siegel and colleagues. However, self-rated global health status is associated with mortality among males, but not among females. This gender difference in the relationship between self-assessed health and mortality is abundantly found in the literature (Deeg and Kriegsman 2003).

## Conclusions

Findings suggest that, in general, the determinants of subjective survival among individuals in the CRELES study show the characteristics that were expected based on the literature for developed countries. Among males in the younger age group, subjective survival was found to be a mortality predictor with and without the presence of biomarkers in a model adjusted for other objective (albeit self-reported) measures of health. Results also suggest that subjective survival may be mediating the effects of objective measures of health status on mortality, and not just mediating the effects of self-reported health on mortality. This study also showed that individuals aged 60-69 do not take into consideration their higher levels of body weight and/or risky fat distribution when estimating the likelihood of their future survival. The relationship between body weight/composition levels and future survival estimates is mediated by health status. In addition, results showed that there is no difference in the impact that major obesity-related diseases has on future survival estimates between individuals in the normal weight and obese subgroups. Furthermore, no difference was found among individuals in the younger age group between the coefficients associated with major obesity-related and general diseases within body weight/composition subgroups. However, unexpectedly among individuals in the older age group obese ones were less optimistic regarding their future survival than normal weight individuals were, although the impact of major obesity-related diseases was greater among those in the latter group than among obese ones.

It was surprising to find in the Costa Rican study that among individuals in the younger age group having been hospitalized during the previous year and being currently taking prescription medicines both increases the odds of selecting the Very Likely to survive option (as opposed to all other options combined and holding all other variables constant). This finding may be revealing lack of health education/information and/or "defensive optimism." Defensive optimism, according to Hahn and Renner (1998), is not very far from reality but represents a differential bias. Even though individuals realize that they are at an increased risk of certain type of diseases, they are optimistic with regard to the magnitude of this risk. Probably this finding is pointing out to the need of more health information in general. Jiménez-Herrera and FernándezRojas (2008) found that among individuals in the CRELES study consumption of medicines is mainly related to having hypertension, diabetes, and cardiopathies that do not have a previous history of infarction. It is possible that individuals that have been diagnosed with any of these diseases and are actually under treatment feel they can do as well as any other person does. If individuals are unrealistically optimistic regarding the health risks at which they are exposed
they are more prone, for example, to noncompliance with treatments. Among individuals in the younger age group, neither the major obesity-related nor the general diseases seem to be related with subjective survival estimations. It is possible that results are reflecting unawareness of some conditions and therefore they are not influencing subjective survival expectations among younger individuals in the Costa Rican study. Some evidence of this hypothesis may be offered by a research done with data drawn from the CRELES study finding that $25 \%$ of the participants, whom according with measured blood pressure were in fact hypertensive, did not report previous hypertension diagnosis (Méndez-Chacón, Santamaría-Ulloa, and Rosero-Bixby 2008). It is also possible that here again is operating the defensive optimism; another possibility being, of course, lack of understanding of the subjective survival question.

That individuals in the younger age group of the CRELES study are surprisingly unaware of the deleterious effects of excessive body weight/fat on their future survival is a result that should be considered for any intervention oriented to reduce the burdens associated with obesity. RosellóAraya and Guzmán-Padilla (2004) showed that according with the international literature, CVD mortality, the first cause of death in Costa Rica (IDESPO 2004), is remaining stable and even decreasing, despite increases in its prevalence, probably because of scientific advances. However, the high prevalence of risk factors, such as hypertension, diabetes, overweight and obesity, may in part explain the mortality increment of specific causes such as ischemic heart disease and acute myocardial infarction in Costa Rica (Roselló-Araya and Guzmán-Padilla 2004). Research on Costa Rica already has shown that smoking and abdominal obesity have the strongest population-attributable risk for major myocardial infarction among individuals without history of diabetes, hypertension, or regularly using medications for chronic conditions (Kabagambe, Baylin, and Campos 2007). This also increases the importance of the unexpected finding obtained regarding the lack of association of smoking with subjective survival expectations.

## References

Al Snih, Soham; Markides, Kyriakos S.; Ray, Laura; Ostir, Glenn V.; Goodwin, James S. "Handgrip Strength and Mortality in Older Mexican American." Journal of the American Geriatric Society 50, no. 7 (2002): 1250-1256
Balia, Silvia "Reporting Expected Longevity and Smoking Evidence from the SHARE." CRENOS Working Paper 2007/05. (2007) Centro Ricerche Economiche Nord Sud Università de Caligliari and Università de Sassari. Italy. Available at: www.crenos.it
Benítez-Silva, Hugo and Ni, Huan "Health Status and Health Dynamics in an Empirical Model of Expected Longevity." Journal of Health Economics 27, no. 3 (2008): 564
Cook, Nancy R.; Evans, Denis A.; Scherr, Paul A.; Speizer, Frank E.; Taylor, James O.; Hennekens, Charles H. "Peak Expiratory Flow Rate and 5-Year Mortality in an Elderly Population." American Journal of Epidemiology 133, no. 8 (1991): 784-794
Deeg, Dorly J. H. and Kriegsman, Didi M. W. "Concepts of Self-Rated Health : Specifying the Gender Difference in Mortality Risk." The Gerontologist 43, no. 3 (2003): 376-386
Esquivel, Luis Sandi "Access to Smoking Cessation Treatment in Costa Rica." World Health Organization. Tobacco Free Initiative. (2005) Available at:
http://www.who.int/tobacco/training/success_stories/TfiR3hrCR.pdf
Fernández Rojas, Xinia and Méndez Chacón, Ericka. Estilos de Vida y Factores de Riesgo para la Salud de las Personas Adultas Mayores del Proyecto CRELES - Costa Rica 2004-2006. Technical Report. Población y Salud en Mesoamérica 5, no. 1 (2007) Electronic Journal.Available at: http://ccp.ucr.ac.cr/revista/volumenes/5/5-1/5-1-1t/index.htm
Folsom, Aaron R.; Kushi, Lawrence H.; Anderson, Kristin E.; Mink, Pamela J.; Olson, Janet E.; Hong, Ching-Ping; Sellers, Thomas A.; Lazovich, DeAnn; Prineas, Ronald J. "Associations of General and Abdominal Obesity with Multiple Health Outcomes in Older Women." Archives of Internal Medicine 160 (2000): 2117-2128
Hahn, André and Renner, Britta "Perception of Health Risks: How Smoker Status Affects Defensive Optimism." Anxiety, Stress, and Coping 11 (1998): 93-112
Hamermesh, Daniel S. and Hamermesh, Frances W. "Does Perception of Life Expectancy Reflect Health Knowledge?" American Journal of Public Health 73, no. 8 (1983): 911-914
Han, T.S.; van Leer, E.M.; Seidell, J.C.; Lean, M.E.J "Waist Circumference Action Levels in the Identification of Cardiovascular Risk Factors: Prevalence Study in a Random Sample." British Medical Journal 311 (1995): 1401-405
Hubbard, V.S. "Defining Overweight and Obesity: What are the Issues?" American Journal of Clinical Nutrition 72 (2000): 1067-68.
Hurd, Michael D. and McGarry, Kathleen "Evaluation of the Subjective Probabilities of Survival in the Health and Retirement Study." The Journal of Human Resources 30, no. 0 Special Issue on the Health and Retirement Study: Data Quality and Early Results (1995): S268-S292
IDESPO. 2004. "Percepción de la Ciudadanía Costarricense sobre Estilas de Vida Saludable y los Servicios de Salud del País." Pulso Nacional OP'S 35 Agosto 2004. Instituto de Estudios Sociales en Población. Universidad Nacional de Costa Rica. Available at: http://www.una.ac.cr/idespo
Jiménez Herrera, Luis Guillermo and Fernández Rojas, Xinia "Características del Uso de Medicamentos en Personas Adultas Mayores, Costa Rica 2007." Revista Costarricense de Salud Pública 17, no. 33 (2008): 1409-1429
Kabagambe, Edmond K.; Baylin, Ana; Campos, Hannia "Nonfatal Acute Myocardial Infarction in Costa Rica. Modifiable Risk Factors, Population-Attributable Risks, and Adherence to Dietary Guidelines." Circulation 115 (2007): 1075-1081
Lean MEJ, Han TS, Morrison CE. "Waist circumference indicates the need for weight management." British Medical Journal 311 (1995):158-161
Lillard, Lee and Waite, Linda J. "'Til Death Do Us Apart: Marital Disruption and Mortality." The American Journal of Sociology 100, no. 5(1995): 1131-1156
Liu, Jin-Tan; Tsou, Meng-Wen; Hammit, James "Health Information and Subjective Survival Probability: Evidence form Taiwan." NBER Working Paper 12864. (2007) NBER Working Paper Series. National Bureau of Economic Research (NBER), Cambridge, MA. Available at: http://www.nber.org/papers/w12684
Méndez-Chacón, Ericka; Santamaría-Ulloa, Carolina; Rosero-Bixby, Luis "Factors Associated with Hypertension Prevalence, Unawareness and Treatment among Costa Rican Elderly." BMC Public Health 8 (2008): 275. doi: 10.1186/1471-2458-8-275. Available at: http://www.biomedcentral.com/1471-2458/8/275

Ministerio de Salud. 2003. "Encuesta Basal. Comunidades Centinela en Alimentación y Nutrición 1999-2000. Resultados Damas de Desamparados." Costa Rica. Ministerio de Salud; Instituto Costarricence de Investigación y Enseñanza en Nutrición y Salud; Caja Costarricense de Seguro Social; Ministerio de Educación Pública
1996. "Encuesta Nacional de Nutrición. 1. Fascículo: Antropometría." Costa Rica. Ministerio de Salud; Instituto de Nutrición de Centro América y Panamá; Instituto Costarricense de Investigación y Enseñanza en Salud y Nutrición; Costa Rica.
Monteverde, Malena; Noronha, Kenya; Palloni, Alberto; Novak, Beatriz "Obesity and Excess Mortality among the Elderly in the United States and Mexico." Demography 47, no. 1 (2010): 79-96

NIH (National Institutes of Health). 1998. "Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults. The Evidence Report." NIH Publication No. 98-4083. September 1998
Nelson, Lynn D. and Honnold, Julie A. "Socialization and Demographic Determinants of Mortality Expectations." Population and Environment 3, no. 1(1980): 10-22.
Oreopoulos, Antigone; Kalantar-Zadeh, Kamyar; Sharma, Arya M.; Fonarow, Gregg C. "The Obesity Paradox in the Elderly: Potential Mechanisms and Clinical Implications." Clinics in Geriatric Medicine 25 (2009): 643-659
PAHO (Pan American Health Organization). 2007. "Health in the Americas 2007 - Costa Rica." Scientific and Technical Publications No. 622. Volume II. Pan American Health Organization/World Health Organization. Washington D.C. 2007.
Popham, Frank and Mitchell, Richard "Self-Rated Life Expectancy and Lifetime SocioEconomic Position: Cross-Sectional Analysis of the British Household" International Journal of Epidemiology 36 (2007): 58-65
Prentice, Andrew M. "The Emerging Epidemic of Obesity in Developing Countries." International Journal of Epidemiology 35 (2006): 93-99
Prospective Studies Collaboration "Body-mass index and cause-specific mortality in 900000 adults: collaborative analyses of 57 prospective studies." The Lancet 373, no. 9669 (2009): 1083-1096
Rolland, Yves; Lauwers-Cances, Valerie; Cesari, Matteo; Vellas, Bruno; Pahor, Marco; Grandjean, Hélène "Physical Performance Measures as Predictors of Mortality in a Cohort of Community-Dwelling Older French Women." European Journal of Epidemiology 21 (2006): 113-122
Roselló-Araya, Marlene and Guzmán-Padilla, Sonia "Evolución de la Mortalidad por Enfermedad del Corazón e Infarto Agudo del Miocardio en Costa Rica." Panamerican Journal of Public Health 16, no. 5(2004): 295-301
Rosero-Bixby, Luis; Brenes-Camacho, Gilbert; Méndez-Chacón, Ericka "Obesity, Disability and Aging in Costa Rica." Paper presented at the XXVI International Union for Scientific Studies of Population (IUSSP),„Marrakech, Morocco, 27 September - 2 October 2009
Ross, Catherine E. and Mirowsky, John "Family Relationships, Social Support and Subjective Life Expectancy." Journal of Health and Behavior 43 (2002): 469-489
Siegel, Michele; Bradley, Elizabeth H; Kasi, Stanislav V. Self-Rated Life Expectancy as a Predictor of Mortality: Evidence from the HRS and AHEAD Surveys. Gerontology 49 (2003): 265-271

Snijder, M.B.; van Dam, R.M.; Seidell, J.C. "What Aspects of Body Fat are Particularly Hazardous and How Do We Measure Them?" International Journal of Epidemiology 35 (2006): 82-92.

Solomon, Caren G. and Mason JoAnn E. "Obesity and Mortality: A Review of the Epidemiologic Data." The American Journal of Clinical Nutrition 66, no. Suppl (1997): 1044S-050S
Thorpe,, Roland J. Jr. and Ferraro, Kenneth F. "Aging, Obesity and Mortality: Misplaced Concern about Obese Older People?" Research on Aging 26, no. 1 (2004): 108-129
van Doorn, Carol and Kasl, Stanislav V. "Can Parental Longevity and Self-Rated Life Expectancy Predict Mortality Among Older Persons? Results from an Australian Cohort." Journal of Gerontology 53B, no. 1 (1998): S28-S34
Worley, Heidi "Chronic Diseases Beleaguer Developing Countries." Population Referece Bureau. Articles 2006. Available at:
http://www.prb.org/Articles/2006/ChronicDiseasesBeleaguerDevelopingCountries.aspx


[^0]:    * Trabajo presentado en el IV Congreso de la Asociación Latinoamericana de Población, ALAP, realizado en La Habana, Cuba, del 16 al 19 de Noviembre de 2010.
    * University of Wisconsin-Madison.
    bnovak@ssc.wisc.edu

[^1]:    * Trabajo presentado en el IV Congreso de la Asociación Latinoamericana de Población, ALAP, realizado en La Habana, Cuba, del 16 al 19 de Noviembre de 2010.
    * University of Wisconsin-Madison. bnovak@ssc.wisc.edu
    ${ }^{1}$ Type 1 Obesity: $30 \leq \mathrm{BMI}<40$; Type 2 Obesity: $\mathrm{BMI} \geq 40$

[^2]:    ${ }^{2}$ Data from 2001 wave of the MHAS study. Third quintile of the BMI distribution: $24.7 \leq$ BMI $<27.3$; Fourth quintile: $27.3 \leq$ BMI $<30.5$; Fifth quintile: $30.5 \leq$ BMI. Data from 2000 round of the Health and Retirement Study (HRS). Third quintile of the BMI distribution: $25.1 \leq \mathrm{BMI}<27.4$. Fifth quintile: $30.3 \leq \mathrm{BMI}$.
    ${ }^{3}$ Costa Rica: Estudio de Longevidad y Envejecimiento Saludable. Rosero-Bixby, Luis , Xinia Fernández, and William H. Dow. CRELES: Costa Rican Longevity and Healthy Aging Study, 2005 (Costa Rica Estudio de Longevidad y Envejecimiento Saludable) [Computer file]. ICPSR26681-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2010-07-21. doi:10.3886/ICPSR26681. Available at: : http://ccp.ucr.ac.cr/creles/index.htm
    ${ }^{4}$ More detailed description at: http://www.ccp.ucr.ac.cr/creles/descripc.htm,

[^3]:    ${ }^{5}$ For both age groups on average the analytical samples are composed of younger as well as subjectively and objectively healthier individuals than those lost for analysis. For the younger age group there are no differences between samples in the proportion of obese individuals. However, for the older age group the proportion of obese individuals in the analytical sample is higher than it is in the sample lost for analysis.

[^4]:    ${ }^{6}$ In order to study the influence of missing data on the results, the method of imputations by chained equations was used to impute the missing data (STATA 11, ICE procedure). The imputation method included all variables in the model generating 5 datasets. Among individuals in the younger age group, the coefficients associated with hospital stays and minor obesity-related diseases lose significance when using the imputed sample. Among individuals in the older age group, the ones associated with being obese and with major obesity-related diseases lose significance when data is drawn from the imputed sample. On the contrary, the coefficient associated with depression symptoms, which was not statistically significant among older individuals gains statistical significance at a 0.05 level using data from the imputed dataset.

[^5]:    ${ }^{7}$ The index of chronic diseases is the sum of the values of the indexes of major obesity-related diseases, general diseases, and minor obesity-related diseases previously described.

[^6]:    ${ }^{8}$ For the survival analysis both BMI and WC are continuous variables. As underweight individuals are included in the sample so is BMI square in the model because of the $U$ shape relationship between BMI and mortality.
    ${ }^{9}$ The variables associated with the biomarkers consider quartiles of the corresponding distribution for each sex.

[^7]:    ${ }^{10}$ Using the missing data imputed dataset, subjective survival expectations lost significance in all cases. The same occurs with the only biomarker that predicted mortality among males in this age group. Education that was not significantly related with mortality in none of the models among males in this age group, resulted in being a mortality predictor, but not in the expected direction; having more than elementary education increased the mortality risk. Education showed a significant protective effect among females in this age group; this result persisted when analyzing the imputed dataset. Therefore, this topic deserves further investigation.

[^8]:    ${ }^{11}$ Only among females in the younger age group, the variables related with body weight (BMI, BMI squared, and the indicator of weight loss) were statistically significant. BMI significantly decreases the mortality risk among females in the younger age group while BMI squared significantly increases it even controlling for unintentional weight loss, which also significantly increases the mortality risk among individuals in this subsample. When models were evaluated using data drawn from the imputed missing data dataset, BMI, BMI squared and unintentional weight loss were not significantly related with the mortality risk. Further investigation is needed regarding these differences between results using the analytical samples and the samples were missing data was imputed.
    ${ }^{12}$ Results are similar using a model that only adjusts for age and has self-assessed health as independent variable: the worsening of self-assessed health significantly decreases (at a 0.05 level) the mortality risk among older females in the analytical sample (and in the whole sample as well). However, in the imputed missing data dataset selfassessed health status among older females is not significantly related with the risk of death.

