Published in final edited form as:

Ageing Int. 2011 December 8; 37(1): 104–117. doi:10.1007/s12126-011-9135-y.

Coexistence of Obesity and Anemia in Older Mexican Adults

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Abstract

Introduction—Developing countries in Latin America (LA) are experiencing rapid aging as a result of advances in medical interventions. This rapid aging has not occurred with comparable improvements in standards of living. Chronic conditions are becoming highly prevalent while exposure to infectious communicable diseases is very common. This unique situation where communicable and non-communicable diseases coexist in the presence of low socioeconomic status place countries in LA in a unique epidemiological situation. Mexico presents a very good example where the impact of this situation on health warrants further analysis.

Methods—We use data from the Mexican National Health and Nutrition Survey (ENSANut 2006), a cross-sectional study representative of all urban and rural areas of Mexico. A total of 5,605 adults older than 60 years of age with valid values for Body Mass Index and Hemoglobin were analyzed. We first included a descriptive analysis of the coexistence of anemia and obesity by age, gender and characteristics of the living environment. We reported the weighted percentages for each covariate by each of four nutritional condition categories (obese and anemic, only-obese, only-anemic, not obese and not anemic). We used multinomial logit regressions to determine the association of socioeconomic characteristics, health status and the living environment with the presence of the three nutritional condition categories.

Results—In the ENSANut cohort 10.3% of older adults are anemic, 25.0% are obese and 2.6% are both anemic and obese. Approximately 62% has neither anemia nor obesity. Within the 38% that fall in the three nutritional condition categories, the co-existence of obesity & anemia appears to be associated with metropolitan area residence, living alone, being male, having relatively high wealth, and reporting two or more chronic health conditions. Analyzing the effect of the covariates to distinguish between outcome categories, living environment, age, gender, wealth, and smoking show a significant effect when comparing across the three nutritional categories.

Conclusions—Older Mexican adults with both obesity & anemia have a different profile compared to that of adults with only one of the conditions. Future studies need to do a careful clinical evaluation of this group and design clinical interventions to avoid complications. Additionally, social support initiatives that target specific groups of older adults according to their health and social needs must be established.

Keywords

Anemia; Obesity; Latin America; Mexico; Mixed Epidemiological Regime

Introduction

Aging in Latin America is occurring much faster compared to developed countries (Wong R & Palloni A, 2009). In the last two decades the world percentage of adults 65 and older living in developing countries, including Latin America, grew from 56% to 63%; this number is expected to reach more than 70% by the year 2030 (Ham-Chande R, Palloni A & Wong R, 2009; Kinsella K & Wan H, 2009). Using data from the US Census Bureau, the growth rate in the percentage of older adults between 2000 and 2010 in Latin America (0.38) is more than twice the rate of the developed countries (0.15); this rate is even larger for Mexico (0.46) (US CENSUS BUREAU, 2011). In fact, it will take countries in Latin America (LA) less than half the time to double their population over 65 compared to developed countries like the United States (Kinsella K & Wan H, 2009).

Furthermore, birth cohorts reaching age 60 and older in LA are unique in that they are largely the product of advances in medical interventions in the absence of significant improvements in standards of living (Ham-Chande R et al., 2009; Kinsella K & Wan H, 2009). Compared to developed countries, most countries in LA are experiencing population aging while challenges to significant population sub-groups, such as limited access to healthcare, malnutrition, and low income still need resolution (Palloni, Pinto-Aguirre & Pelaez, 2002). Malnutrition affects a large number of older adults and includes a variety of disorders: undernutrition, nutrient imbalances and obesity. Both obesity and anemia can be caused by malnutrition and increase the risk of disability and mortality among older adults (Al Snih, Ottenbacher, Markides, Kuo, Eschbach & Goodwin, 2007; Eisenstaedt, Penninx & Woodman, 2006; Izaks, Westendorp & Knook, 1999). The coexistence of obesity & anemia illustrates the “double burden” of health that developing countries like Mexico are facing at the same time that they experience rapid population aging (Frenk, 2006).

Obesity is a growing phenomenon worldwide. Once considered highly prevalent only in developed countries, obesity is dramatically increasing in developing countries as well. This is a considerable concern for the well being of the population given that obese people are at increased risk for medical comorbidities, functional decline, impaired quality of life, increased use of health care resources, and mortality (Ledikwe, Smiciklas-Wright, Mitchell, Jensen, Friedmann & Still, 2003). There is a high prevalence of obesity in Mexico where about 20% of men and 35% of women over 60 years of age are obese (Shamah-Levy, Cuevas-Nasu, Mundo-Rosas, Morales-Ruan, Cervantes-Turrubiates & Villalpando-Hernandez, 2008).

Globally, anemia affects 1.62 billion people, which corresponds to 24.8% of the population (WHO, 2002). Similar to other countries in LA, some Mexican subgroups are exposed to anemia since childhood, additionally, the prevalence of anemia increases with age (Izaks et al., 1999). We focus on anemia during old age because it is associated with a wide range of complications including increased risk for mortality, cardiovascular disease, cognitive dysfunction, longer hospitalization after elective procedures, reduced bone density, falls, and fractures (Eisenstaedt et al., 2006). Furthermore, few studies have analyzed anemia in older populations in LA.

Previous research has shown that older adults with anemia or obesity are significantly different compared to their healthy counterparts. Older adults with anemia or obesity have higher mortality rates, poorer quality of life and poorer overall health compared to their healthy counterparts. However, there is little information available on the overlap of obesity & anemia and its impact for older adults. Older adults in LA countries like Mexico may be at risk for higher rates of obesity and anemia, due to increased rates of poverty and limited access to both preventive and curative health resources and the coexistence of infectious and

chronic diseases. It has been suggested that socioeconomic status (SES) and demographic characteristics play an important role in the development of both obesity and anemia (Garry, Goodwin & Hunt, 1983; Grafova, Freedman, Kumar & Rogowski, 2008; Todhunter & Darby, 1978; Wang, Kim, Gonzalez, MacLeod & Winkleby, 2007). Additionally, both conditions increase the need older adults have of community support and resources.

It is therefore crucial to study both conditions jointly and to typify older adults with anemia, obesity or both, and determine if older adults with both obesity & anemia have unique traits. This information will help design public health initiatives for older Mexicans as well as increase understanding of the phenomenon among sub-groups in other countries that are aging rapidly. In addition to individual characteristics, the living environment may play a major role in the coexistence of both disease conditions in developing countries.

Thus in this study, we analyze the association of individual socioeconomic characteristics and health status, and the living environment including living arrangements and area of residence, on the presence of anemia, obesity, and the coexistence of both nutritional conditions. Our hypothesis is that the group with coexistence of both nutritional conditions is significantly different from those with only one of the conditions. Individuals with both nutritional conditions cannot be managed by combining the interventions used in a person with anemia and a person with obesity because they many times oppose each other. A management tailored specifically to these individuals is required and is more complex requiring more resources (Llanos, Oyarzun, Bonvecchio, Rivera & Uauy, 2008). Additionally individuals with both anemia and obesity are likely to overlap with those with multiple chronic diseases, making management even more difficult (Llanos et al., 2008).

Methods

Data

We use data from the Mexican National Health and Nutrition Survey (ENSANut 2006). The ENSANut 2006 is a cross-sectional study representative of all urban and rural areas of Mexico. A total of 45,241 adults (20 years and older) were interviewed during the study. From a total of 5,927 adults aged 60 and older, we selected a total of 5,605 (Mean 70.3 years, SD 7.8) with valid values for Body Mass Index and Hemoglobin. For the multivariate models of the joint nutritional conditions, we use 2,194 cases because they reported anemia, obesity, or both, which are our conditions of interest. We used sampling weights to make the sample representative of the Mexican older population.

Variables

Socioeconomic measures

Education: A large portion of the older adult sample has low education (mean 3.6 years, SD 4.1); 63% of the population has fewer than 3 years of education, 24% has between 4 and 6 years of education and only 13% has more than 7 years of education. We therefore constructed a categorical variable for education for the descriptive analysis using four categories: less than one year of education, one to five years of education, six years of education and more than seven years of education. For the multivariate analysis however, the continuous variable was used to facilitate the interpretation.

Wealth: Since 50% of the older adults in Mexico do not receive income from salaries, benefits or public transfers, income is not a reliable measure of economic well-being (Wong & Espinoza Higgins, 2003). We used an alternative measure using principal component analysis (PCA) to construct an asset-based wealth index (United Nations, 2005). We integrated a mix of asset variables – such as ownership of homes, vehicles, and appliances –

and dwelling characteristics. We used a total of 28 variables and obtained eight factors with an eigenvalue greater than one. With these results we created three wealth categories: low, medium and high.

Obesity and anemia—To measure obesity and anemia we established valid values of Body Mass Index (BMI) and Hemoglobin (Hb). Hb was measured in (g/dl) (mean 14.5, SD 3.1). We used the World Health Organization (WHO) cut-off points for valid values (WHO, 2008); only Hb values within 2 standard deviations of the mean were included. BMI, defined as the total weight in kilograms divided by the square of height in meters, is also used based on the WHO cut-off points to construct underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese categories (≥ 30) for both males and females (WHO, 2006). Only BMI values within 3 standard deviations (mean 27.4, SD 4.8) were included.

We constructed three categories for the nutritional conditions as follows: *only-anemic (no obesity)*, *only-obese (no anemia)*, *anemic and obese*. We used those in the only-anemic group as the reference category in multivariate analyses.

Living Environment—Two variables were used to capture characteristics of the living environment of older adults: living arrangements and residential location. Living arrangements were categorized in three groups: alone (if living alone at the time of interview), with spouse (if the respondent reported living with their spouse or partner, regardless of who else lived in the household) and other (if the respondent lived without a spouse, but lived with either a family member, a caregiver or a friend). Residential location was divided in three categories depending on the population size: rural (locations with less than 2,500 inhabitants), urban (locations with 2,500–99,999 inhabitants) and metropolitan (locations with more than 100,000 inhabitants).

Chronic Diseases and Health Behaviors—We used an index for the number of self-reported chronic diseases. Subjects were asked “Has a doctor ever told you that you had ...?”. The diseases included were diabetes, hypertension, cardiovascular diseases, and stroke. We used a count of diseases to create three categories: zero, one and two or more of these diseases.

Additionally, we included smoking status to analyze the effect of health behaviors. We included three categories: current smoker, former smoker, never smoked.

Statistical Analysis

We first included a descriptive analysis of the coexistence of anemia and obesity by age, gender and characteristics of the living environment. We reported the weighted percentages for each covariate by each of four categories (obese and anemic, only-obese, only-anemic, not obese and not anemic). We then performed chi square tests to analyze differences in each covariate by the three nutritional condition categories to establish independence between each covariate and nutritional status.

Multivariate Analysis—We performed multivariate analyses using multinomial logit regressions to determine the association of socioeconomic characteristics, health status (diseases and health behaviors) and the living environment with the presence of the three nutritional condition categories. We used the relative risk ratio (RRR) to estimate the effect of each covariate across nutritional categories, which is interpreted as the relative risk of one category compared to a base category (Long & Freese, 2006).

Results from the multinomial logit model are not shown. Instead, to facilitate interpretation of our analysis, probabilities were calculated based on the full model and are used and shown in Figure 1. The full model included residential location (rural, urban and metropolitan; rural served as reference category), living arrangements (alone, with spouse and with other; alone served as reference category), age (continuous), gender (male, served as reference), years of education (continuous), wealth (low, medium and high with low as the reference), number of conditions (as a count) and smoking status (dichotomized as current smoker yes vs. no).

To facilitate the interpretation of results, we used the estimated coefficients from the multivariate model and calculate the probabilities of being obese & anemic, only-obese, and only-anemic. For presentation purposes, we plotted these probabilities for select covariates keeping all the other explanatory variables at the mean value. In addition, we show the effect and significance of each variable for each pair of nutritional categories. This is a convenient way to easily examine whether each covariate significantly affects the likelihood of one outcome category versus the other (Long & Freese, 2006). We also tested the assumption of independence of irrelevant alternatives in the multinomial logit models. All statistical analyses were performed using STATA 10 and are available upon request (StataCorp. 2007. *Stata Statistical Software: Release 10*. College Station, TX: StataCorp LP.).

Results

Table 1 summarizes the overall characteristics of older adults in our study by nutritional condition category. Four categories are included (obese & anemic, only-anemic, only-obese, and those without anemia or obesity). In the ENSANut cohort 10.3% of older adults are only-anemic, 25.0% are only-obese and 2.6% are both anemic and obese. A total of 62.1% has neither anemia nor obesity. The healthy category (without anemia or obesity) is most common among the oldest (67% of those aged 80+ compared to 60% among those aged 60–69), among males (69% of males compared to 57% of females), and among rural residents (68% compared to 59% of those in metropolitan areas).

Because of our interest in typifying those with coexistence of anemia and obesity, only individuals in the first three columns of Table 1 are used for the subsequent multivariate analysis. Table 2 shows weighted percentages of adults by the nutritional condition categories. Chi square tests show statistically significant differences in age, gender, education, residential location, and wealth between the three nutritional condition categories. Prevalence of only-anemia is associated with older age, while prevalence of only-obesity and coexistence of obesity & anemia is associated with younger age. Women have higher prevalence of anemia, while men have higher prevalence of obesity and coexistence of both nutritional conditions. Lower education is associated with higher rates of only-anemia, while higher education is associated with higher rates of obesity & anemia and only-obesity. Anemia is more prevalent in rural areas, while obesity is more prevalent in metropolitan areas, and the coexistence of both is more common in medium-size communities. Higher number of medical conditions is associated with higher coexistence of obesity & anemia. Finally, higher prevalence of anemia is observed among those who currently smoke compared to those that are former smokers and those that never smoked.

Regression coefficients from the multinomial logit regressions are not shown due to the complexity and length of the results. Estimated probabilities based on the multinomial regressions are presented in Table 3. Controlling for all covariates, the probabilities convey the direction and magnitude of the difference in the propensity to have each of the three nutritional conditions across each covariate. For example, within the population aged 60 and older in Mexico that fall into one of the nutritional condition categories (approximately

38%), 9.4% of those in the highest tertile of wealth are obese & anemic, compared to 7.9% of those in the lowest tertile. Thus the co-existence of obesity & anemia appears to be associated with metropolitan area residence, living alone, being male, having relatively high wealth, and reporting two or more chronic health conditions.

Table 3 also shows the effect of the covariates to distinguish between outcome categories. Living in a metropolitan area has a significant effect in the contrast between only-obesity and only-anemia. This implies that living in metropolitan areas has a significantly different association for individuals between these two categories. Indeed, metropolitan residence has a positive association with having only-obesity. Conversely, metropolitan residence has a negative association with having only-anemia. Similarly, living with someone other than a spouse/partner has an opposite effect in the comparison to only-anemia and obesity & anemia. The same holds true for those with only-anemia compared to only-obese. Higher number of chronic diseases has a significant opposite effect across all pairs of outcome categories. Other covariates also show a significant effect when comparing across the three nutritional categories: gender has a significant effect when comparing across all categories; age and wealth have a significant effect when comparing only-anemia with only-obese, and only-anemia with obese & anemic; smoking has a significant opposite effect when comparing only-obese and obesity & anemia.

To illustrate the predicted probabilities associated with main covariates, Figure 1 shows the probabilities of being obese & anemic, only-obese, and only-anemic by residential location, living arrangements and number of medical conditions. The estimated probabilities follow similar patterns for those with obesity & anemia and those with only-obesity. In other words, living in more urban areas (urban and metropolitan) is associated with higher probability of being only-obese and both obese & anemic, but with lower probability of being only-anemic. Similarly, living with someone other than a spouse/partner is associated with higher probability of having only-anemia but lower probability of having only-obesity or coexistence of obesity & anemia. Living with a spouse or alone does not have a significant effect when comparing across nutritional condition categories. Finally, a higher number of chronic diseases is associated with higher probability of being only-obese or having obesity & anemia, but with lower likelihood of having only-anemia.

Discussion

Older Mexican adults with coexistence of obesity and anemia have a distinct profile compared to those that have only-anemia and only-obesity. However, this profile seems to be more comparable to that of older adults with only-obesity. Characteristics of the living environment and chronic diseases significantly differentiate those who have only-anemia, only-obesity or the coexistence of both.

This manuscript touches on three important issues related to the aging experience of older adults in developing countries like Mexico: 1) Where older adults are aging; 2) Who older adults are aging with; and 3) What health issues older adults face. These issues are very important for developing countries because the epidemiological transition with a rapidly growing number of chronic diseases is posing important challenges for policy makers and healthcare providers. Where older adults age, who they age with and what health issues they face, determines where resources need to be allocated and how policies need to be designed to ensure quality of life for older adults.

Where older adults age has been a central issue for healthcare providers and policy makers. In the past decade, the term “aging in place” has gained support and attention. The premise behind “aging in place” is that older adults can do better when they remain in the place

where they spent most of their adult life; for many older adults, remaining in their home for as long as possible is not only desirable but also an indicator of control. However, aging in place is not always possible or desirable. The characteristics of the context of residence and the presence of different health conditions largely influence the decision of whether or not an older adult can remain at home. In countries like Mexico, where there are vast differences between the urban and rural settings, the place where older adults age is likely to impact their quality of life and dictate the health care available to them (Salinas, Al, Markides, Ray & Angel, 2010). Urban residents usually have access to better healthcare; however, living in urban settings also poses additional risks related to lifestyles. In our study, older adults with coexistence of obesity and anemia have a higher probability of residing in urbanized areas. Moreover, some authors have suggested that social networks available in rural settings are stronger and can impact positively on quality of life of older adults. (Mair & Thivierge-Rikard, 2010; Wanless, Mitchell & Wister, 2010). Our results show that where older adults live modifies the probability of being in the different nutritional condition categories.

Who an older adult lives with, also affects several aspects of their quality of life. Community resources available for older adults in many LA countries, including Mexico, modify their aging experience (Smith & Goldman, 2007; Wong R & Palloni A, 2009). Nursing homes, assisted care facilities and home health care are rare in most LA countries, making family members and friends the main sources of support (Mendez-Luck, Kennedy & Wallace, 2009). Thus social support and social networks available for older adults determine the amount and quality of care they receive when needed. Our study shows that among older adults, the likelihood of having both obesity & anemia is higher if they are living alone. Thus our results are consistent with other research that has shown the protective effect of family support for the health of older adults (Hagedoorn, Van Yperen, Coyne, van Jaarsveld, Ranchor, van Sonderen et al. 2006; Waite, 1995).

Finally, as stated before, the “double burden” of disease that older adults in countries in Mexico and other LA countries are exposed to raises important health policy questions. In our study, older adults with two or more chronic diseases were more likely to have coexistence of obesity & anemia or only-obesity compared to those with fewer chronic diseases. In contrast, those reporting no chronic diseases were more likely to report only-anemia. It is well known that obesity and anemia increase the risk of developing other medical conditions (Al Snih et al., 2007; Alley & Chang, 2007; Eisenstaedt et al., 2006; Ferrucci & Alley, 2007; Kaplan & Opie, 2006). Similarly, many medical conditions are associated with higher risk of developing obesity and anemia (Eisenstaedt et al., 2006; Harris, Flegal, Cowie, Eberhardt, Goldstein, Little et al. 1998; Kuri-Morales, Emberson, Alegre-Diaz, Tapia-Conyer, Collins, Peto et al. 2009). What our results indicate, however, is that only-anemia is not associated with higher number of diseases while the joint presence of anemia and obesity is. It therefore makes sense that the health profile of those with both conditions will be different to that of those with only-anemia or only-obesity. Thus, the healthcare needs and the overall approach to this group of older adults will require specific interventions and preventive measures.

Our study has several strengths. We used a nationally representative cohort of Mexican older adults. Also, we used validated and widely used cut-off points to identify adults with anemia, obesity and both. Additionally, we analyzed the association of socioeconomic status, living environment, chronic diseases and health behaviors with these nutritional conditions. However, our study has some limitations. First, we are using cross-sectional data, limiting our ability to establish causation. Second, diagnosis of obesity and anemia was based on single criteria: hemoglobin levels for anemia and BMI for obesity. It is well known that there are sub-types of obesity and anemia that have different clinical implications; we are not able to use these sub-types and determine how they affect older adults differently.

Third, information on chronic diseases is self-reported, we have no information that indicates the severity of the disease and how well or poorly controlled these conditions are. Despite these limitations we have documented and produced a basic profile of older adults with anemia, obesity and both conditions, and examined how SES, the living context and chronic diseases modify the simultaneous presentation of these high-risk nutritional conditions.

In summary, older Mexican adults with both obesity & anemia have a different profile compared to that of adults with only one of the conditions. Adults in this group seem to have better socioeconomic status, poorer overall health and living environments that impose additional risk, compared to those with only-anemia and only-obesity. Future studies need to carefully evaluate this group and design interventions to help avoid complications. Additionally, social support initiatives that target specific groups of older adults and establish their health and social needs should be implemented. A better understanding of these issues will help other countries in LA face the epidemiological transition more effectively.

Acknowledgments

This work was partly supported by grant **R01HD051764-03** (PI A. Pebley) of the National Institute on Aging and the National Institute of Child Health and Human Development. Infrastructure support was provided by the Sealy Center on Aging at the University of Texas Medical Branch.

References

- Al Snih S, Ottenbacher KJ, Markides KS, Kuo YF, Eschbach K, Goodwin JS. The effect of obesity on disability vs mortality in older Americans. *Archives of Internal Medicine*. 2007; 167(8):774–780. [PubMed: 17452539]
- Alley DE, Chang VW. The changing relationship of obesity and disability, 1988–2004. *JAMA*. 2007; 298(17):2020–2027. [PubMed: 17986695]
- Eisenstaedt R, Penninx BW, Woodman RC. Anemia in the elderly: current understanding and emerging concepts. *Blood Reviews*. 2006; 20(4):213–226. [PubMed: 16472893]
- Ferrucci L, Alley D. Obesity, disability, and mortality: a puzzling link. *Archives of Internal Medicine*. 2007; 167(8):750–751. [PubMed: 17452535]
- Frenk J. Bridging the divide: global lessons from evidence-based health policy in Mexico. *Lancet*. 2006; 368(9539):954–961. [PubMed: 16962886]
- Garry PJ, Goodwin JS, Hunt WC. Iron status and anemia in the elderly: new findings and a review of previous studies. *J Am Geriatr Soc*. 1983; 31(7):389–399. [PubMed: 6863789]
- Grafova IB, Freedman VA, Kumar R, Rogowski J. Neighborhoods and obesity in later life. *Am J Public Health*. 2008; 98(11):2065–2071. [PubMed: 18799770]
- Hagedoorn M, Van Yperen NW, Coyne JC, van Jaarsveld CHA, Ranchor AV, van Sonderen E, Sanderman R. Does marriage protect older people from distress? The role of equity and recency of bereavement. *Psychology and Aging*. 2006; 21(3):611–620. [PubMed: 16953722]
- Ham-Chande, R.; Palloni, A.; Wong, R. Aging in developing countries: building bridges for integrated research agendas. van Nimwegen, N., editor. Paris, France: IUSSP; 2009.
- Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, Wiedmeyer HM, Byrd-Holt DD. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988–1994. *Diabetes Care*. 1998; 21(4):518–524. [PubMed: 9571335]
- Izaks GJ, Westendorp RG, Knook DL. The definition of anemia in older persons. *JAMA*. 1999; 281(18):1714–1717. [PubMed: 10328071]
- Kaplan NM, Opie LH. Controversies in hypertension. *Lancet*. 2006; 367(9505):168–176. [PubMed: 16413880]

- Kinsella, K.; Wan, H. *An Aging World: 2008 - International Population Reports*. Washington, DC: U.S. Census Bureau; 2009. p. 1-175.
- Kuri-Morales P, Emberson J, Alegre-Diaz J, Tapia-Conyer R, Collins R, Peto R, Whitlock G. The prevalence of chronic diseases and major disease risk factors at different ages among 150,000 men and women living in Mexico City: cross-sectional analyses of a prospective study. *BMC Public Health*. 2009; 9:9. [PubMed: 19134207]
- Ledikwe JH, Smiciklas-Wright H, Mitchell DC, Jensen GL, Friedmann JM, Still CD. Nutritional risk assessment and obesity in rural older adults: a sex difference. *Am J Clin Nutr*. 2003; 77(3):551–558. [PubMed: 12600842]
- Llanos A, Oyarzun MT, Bonvecchio A, Rivera JA, Uauy R. Are research priorities in Latin America in line with the nutritional problems of the population? *Public Health Nutr*. 2008; 11(5):466–477. [PubMed: 17711613]
- Long, J.; Freese, J. *Regression Models for Categorical Dependent Variables Using Stata*. College Station: Stata Press; 2006.
- Mair CA, Thivierge-Rikard RV. The strength of strong ties for older rural adults: regional distinctions in the relationship between social interaction and subjective well-being. *International Journal of Aging and Human Development*. 2010; 70(2):119–143. [PubMed: 20405586]
- Mendez-Luck CA, Kennedy DP, Wallace SP. Guardians of health: the dimensions of elder caregiving among women in a Mexico City neighborhood. *Social Science and Medicine*. 2009; 68(2):228–234. [PubMed: 19028415]
- Palloni A, Pinto-Aguirre G, Pelaez M. Demographic and health conditions of ageing in Latin America and the Caribbean. *International Journal of Epidemiology*. 2002; 31(4):762–771. [PubMed: 12177016]
- Salinas JJ, Al SS, Markides K, Ray LA, Angel RJ. The rural-urban divide: health services utilization among older Mexicans in Mexico. *J Rural Health*. 2010; 26(4):333–341. [PubMed: 21029168]
- Shamah-Levy T, Cuevas-Nasu L, Mundo-Rosas V, Morales-Ruan C, Cervantes-Turrubiates L, Villalpando-Hernandez S. Health and nutrition status of older adults in Mexico: results of a national probabilistic survey. *Salud Publica de Mexico*. 2008; 50(5):383–389. [PubMed: 18852935]
- Smith KV, Goldman N. Socioeconomic differences in health among older adults in Mexico. *Social Science and Medicine*. 2007; 65(7):1372–1385. [PubMed: 17618717]
- Todhunter EN, Darby WJ. Guidelines for maintaining adequate nutrition in old age. *Geriatrics*. 1978; 33(6):49–6. [PubMed: 648878]
- United Nations. *Household Sample Surveys in Developing and Transition Countries*. New York: Department of Economic and Social Affairs, Statistics Division, Studies in Methods; 2005.
- US CENSUS BUREAU. *Mid-year population by age and sex in 2000 and 2010 for Mexico, Latin America and Developed Countries*. 2011.
- Waite LJ. Does marriage matter? *Demography*. 1995; 32(4):483–507. [PubMed: 8925942]
- Wang MC, Kim S, Gonzalez AA, MacLeod KE, Winkleby MA. Socioeconomic and food-related physical characteristics of the neighbourhood environment are associated with body mass index. *J Epidemiol Community Health*. 2007; 61(6):491–498. [PubMed: 17496257]
- Wanless D, Mitchell BA, Wister AV. Social determinants of health for older women in Canada: does rural-urban residency matter? *Can J Aging*. 2010; 29(2):233–247. [PubMed: 20416123]
- WHO. *The World Health Report 2002: Reducing risks, promoting healthy life*. WHO press; 2002.
- WHO. *Global Database on Body Mass Index*. WHO press; 2006.
- WHO. *Worldwide prevalence of anaemia 1993–2005*. WHO press; 2008.
- Wong, R.; Palloni, A. Aging in Mexico and Latin America. In: Uhlenberg, P., editor. *International Handbook of Population Aging*. Springer; 2009. p. 231-252.
- Wong R, Espinoza Higgins M. Income and assets of the population of middle and old age in Mexico. *Papeles de Población*. 2003; 37:29–166.

Figure 1.

Estimated Probabilities of Obesity & Anemia, Only-Obesity, and Only-Anemia by Residential Location, Living Arrangement, Wealth Index, and Number of Chronic Diseases
 NOTE: Estimated probabilities based on multinomial regression model for Obese & Anemic, Only-Obese, Only-Anemic. Explanatory variables: age, gender, marital status, education, living arrangements, residential location, wealth index, number of chronic diseases, smoking status. Data: Older adults aged 60 and older. ENSANut 2006, Mexico.

Table 1

General Characteristics of Older Adults by Nutritional Condition Category

	Obese & Anemic	Only-obese	Only-anemic	Not Anemic, Not Obese
<i>Age (Mean, SD)</i>	68.08 (6.33)	67.59 (6.48)	73.74 (8.53)	70.02 (7.72)
60–69	2.9%	30.1%	7.1%	59.9%
70–79	2.6%	22.2%	11.3%	63.9%
80+	1.4%	10.3%	21.5%	66.8%
<i>Gender</i>				
Male	2.3%	16.7%	12.3%	68.7%
Female	2.8%	31.7%	8.8%	56.7%
<i>Living Arrangements</i>				
Alone	3.4%	22.9%	10.1%	63.5%
Spouse	2.5%	24.3%	9.6%	63.6%
Others	2.5%	27.0%	12.1%	58.5%
<i>Residential Location</i>				
Rural (<2,500)	2.2%	17.4%	12.0%	68.3%
Urban (2,500–99,999)	3.0%	22.6%	12.8%	61.6%
Metropolitan (100,000 +)	2.6%	30.5%	7.9%	59.0%
Total	2.6%	25.0%	10.3%	62.1%
Weighted	184,952	1,778,936	737,479	4,426,270

Source: Encuesta Nacional de Salud y Nutrición (ENSANut 2006), Mexico, INSP.

Sample of adults aged 60+ are included (n=5,588)

Table 2

Weighted Percentages of Older Adults by the Three Nutritional Condition Categories

	Obese & Anemic	Only-obese	Only-anemic	p-value *
Sample Size (N)	176	1,374	644	
(weighted)	184,952	1,778,936	737,479	
	6.80%	65.90%	27.30%	
Age (Mean, SD)	68.08 (6.33)	67.59 (6.48)	73.74 (8.53)	0.000
60–69	7.20%	75.20%	17.60%	
70–79	7.20%	61.50%	31.40%	
80+	4.20%	31.00%	64.80%	
Gender *				0.000
Male	7.40%	53.30%	39.30%	
Female	6.50%	73.20%	20.20%	
Marital Status				0.395
Married	7.00%	66.80%	26.30%	
Widowed	6.70%	63.50%	29.80%	
Single, Divorced	6.60%	66.50%	26.90%	
Education (Mean, SD)	4.15 (4.09)	3.95 (3.86)	2.76 (3.55)	0.001
0 yrs	5.80%	55.40%	38.80%	
1–5 yrs	7.10%	67.20%	25.70%	
6 yrs	7.50%	73.60%	18.90%	
7 yrs +	7.40%	75.60%	17.00%	
Living Arrangements				0.631
Alone	9.40%	62.80%	27.80%	
Spouse	7.00%	66.70%	26.30%	
Others	6.00%	65.00%	29.10%	
Residential Location				0.000
Rural (<2,500)	6.90%	55.10%	38.00%	
Urban (2,500–99,999)	7.80%	58.90%	33.30%	
Metropolitan (100,000 +)	6.30%	74.30%	19.30%	
Wealth Index				0.000
Low	4.70%	52.20%	43.20%	
Medium	7.00%	64.20%	28.70%	
High	7.80%	73.10%	19.20%	
Number of Chronic Diseases				
Count				0.000
0	5.90%	61.40%	32.60%	
1	6.20%	70.90%	22.90%	
2 or more	10.80%	66.60%	22.60%	
Risk Factors				
Tobacco use				0.125
Current smokers	2.00%	62.70%	35.30%	

	Obese & Anemic	Only-obese	Only-anemic	p-value *
Former smokers	7.90%	66.70%	25.40%	
Never	7.10%	65.90%	27.00%	

* Results from chi square tests comparing the covariates by each nutritional condition category.

Source: Encuesta Nacional de Salud y Nutrición (ENSANut 2006), Mexico, INSP.

Sample of adults aged 60+ are included (n=2,194)

Table 3

Estimated Probabilities (*) of Nutritional Condition Categories, by Selected Covariates

	Obese & Anemic	Only-obese	Only-anemic
<i>Residential Location</i>			
Rural	0.075	0.626	0.300
Urban	0.086	0.630	0.284
Metropolitan	0.084	0.691 (a)	0.226 (a)
<i>Living Arrangements</i>			
Alone	0.092	0.676	0.232
Spouse	0.083	0.672	0.246
Other	0.074 (b)	0.599 (a)	0.327 (a)(b)
<i>Gender</i>			
Male	0.088	0.530	0.382
Female	0.077 (b)(c)	0.717 (a)(c)	0.206 (a)(b)
<i>Wealth Index</i>			
Low	0.079	0.627	0.294
Medium	0.073	0.634	0.293
High	0.094 (b)	0.697 (a)	0.208 (a)(b)
<i>Number of Chronic Diseases</i>			
None	0.073	0.614	0.313
One	0.075 (b)	0.717 (a)	0.208 (a)(b)
Two or More	0.132 (b)(c)	0.622 (c)	0.246 (b)
Multinomial Logistic Regression Goodness of Fit:			
Number of Observations	2,171		
LR Chi2(22)	376.000		
Prob>Chi2	0.000		
Pseudo R2	0.102		
Test for combining outcome categories:			
<i>Alternatives tested</i>	Chi2	P>Chi2	df
Obesity and Anemia & Only Anemia	86.78	0.000	12
Obesity and Anemia & Only Obesity	25.718	0.012	12
Only Anemia & Only Obese	353.588	0.000	12

* Estimated probabilities based on multinomial regression model for Obese & Anemic Only-Obese, Only-Anemic. Explanatory variables: age, gender, marital status, education, living arrangements, residential location, wealth index, number of chronic diseases, smoking status. Data: Older adults aged 60 and older. ENSANut 2006, Mexico.

NOTE:

- $p < 0.05$ for the test of the covariate in comparing the odds of nutritional categories:

- a. only-obese versus only-anemic,
- b. obese & anemic versus only-anemic,
- c. obese & anemic versus only-obese.

- The three nutritional disease categories include approximately 38% of the population over 60 years of age of ENSANut 2006.