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The relationship between excess body weight and the risk of death from unnatural causes

Wei Wang [a], Jane C. Obi [b], Selam Engida [b], Elizabeth R. Carter [b], Fei Yan [a], Jian Zhang [b,*]

[a] Department of Social Medicine, School of Public Health, Fudan University, Shanghai 200032, China
[b] Department of Epidemiology, Jiann-Ping Hsu College of Public Health, Georgia Southern University, Statesboro, GA 30460, USA

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ABSTRACT

Objective: The purpose is to exam whether excess body weight is associated with an increased risk of death from unnatural causes, particularly, injury.
Method: We analyzed nationally representative data of 14,453 adults (19 and older) who participated in the third National Health and Nutrition Examination Survey, 1988–1994, and were followed up with vital statuses through December 31, 2006. We used Cox proportional hazard regression to estimate the hazard ratio (HR) of death from all unnatural causes combined and specific ones. Gray's test was performed to assess the equality of cumulative incidence functions between body mass index (BMI) levels.
Results: A total of 128 unnatural deaths were recorded during an 18-year follow-up with 193,019 person-years accumulated. Compared with healthy weight participants, a person with excess body weight had a low hazard of death from unnatural causes [HR = 1.00 (reference), 0.58 (0.39–0.87), and 0.50 (0.30–0.82) for healthy weight, overweight and obese participants, respectively]. Injuries, including motor vehicle accidents and falls, were the major types of unnatural deaths (n = 91, 71% of all unnatural deaths), and the risk of death from injuries was linearly and reversely associated with BMI. The HRs of injury were 1.00 (reference), 0.57 (0.36–0.91), and 0.36 (0.19–0.69) for healthy weight, overweight and obese participants, respectively. All these estimates were obtained after adjustment of socio-demographic variables.
Discussion: Excess body weight appears to be associated with a low risk of death from unnatural causes, particularly, injuries. Additional investigations on the mechanism underlying the relationship between BMI and unnatural deaths are warranted.

1. Introduction

Injury and obesity are two major causes of motality and morbidity in modern society. Deaths from injuries rank as the fifth leading cause of mortality, with over 120,000 deaths occurring each year in the U.S. (Johnson et al., 2014). Meanwhile, more than one-third of U.S. adults are obese (Ogden et al., 2013). Several lines of evidence have been reported to link these two health issues, but the conclusions are far from consistent, some observed an increased injury risk among overweight and obese persons (Jones et al., 1993; van et al., 1996; Bazelmans et al., 2004; Xiang et al., 2005; Matter et al., 2007; Hu et al., 2009) but not all (Wearing et al., 2006a,b; Himes and Reynolds, 2012). Presumably, more evidence supports the link between an increased risk of injuries and excess body weight. Sleep apnea, prevalent among obese peoples, may explain the elevated risk of road injury among obese individuals. The likelihood of falling, and resulted musculoskeletal injury may also increases along with the body weight. However, it has hypothezied that elevated risk of falls among obese individuals may be counter produced by the cushioning effects from fat mass and protective effects from increased bone density in weight-bearing joints. On the other hand, the methodological limitations of previous studies may also contribute to the inconsistency of the findings. Lumping all types of injuries together might be a part of the explanation of the inconsistency. Additionally, the places of residence (rural vs. urban) and alcohol consumption are all major risk factors for injury (Parks et al., 2014), but were insufficiently controlled in most previous investigations.

In addition to injury, suicide is a major unnatural cause of deaths, accounting for over 30,000 deaths annually and

* Corresponding author at: Department of Epidemiology, Jiann-Ping Hsu College of Public Health, Georgia Southern University, PO Box 8015, Statesboro, GA 30460, USA. Tel.: +1 912 478 2290; fax: +1 912 478 2479.
E-mail address: jianzhang@georgiasouthern.edu (J. Zhang).

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representing the 3rd leading cause of death among young adults in the U.S., and more young adults died of suicide than from cancer, heart disease, AIDS, birth defects, stroke, pneumonia and influenza, and chronic lung disease combined (Zhang et al., 2005). An increasing number of robust prospective studies consistently suggested a significant reverse association between body mass index (BMI) and the risk of death from suicide, among Swedish conscripts (Magnusson et al., 2006), US health professionals (Mukamal et al., 2007), dwell-living men and women of Norway (Bjerkeset et al., 2008), and US cohorts of general population (Carpenter et al., 2000; Zhang, 2006; Kaplan et al., 2007; Mukamal et al., 2010). However, major limitations among these studies, such as using self-reported body weight and height and failure to control for cigarette smoking, have clouded the findings severely (Zhang et al., 2005).

In light of the urgency of obesity, suicide, and injury prevention and the limitations of previous investigations, we conducted the current study to examine the prospective relationship between body weight and the death from unnatural causes, including fall, motor vehicle accident, and suicide, among a nationally representative cohort. We also assessed the time-dependence of the risk pattern. The body weight and height used in the current analysis were directly measured rather self-reported.

2. Methods

2.1. Study population

The study populations are the adults 19 years or older who participated in the third National Health and Nutrition Examination Survey (NHANES III), conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC), 1988–1994. The NHANES consists of a nationwide probability sample of non-institutionalized civilians. The protocol for NHANES III was approved by the Institutional Review Board of the CDC, and all participants gave written informed consent. We restricted our analyses to 17,375 adults whose vital statuses were available by the end of a roughly 18-year follow-up. We excluded 62 participants who had missing values for anthropometric data, 1,666 with no data for family income, 478 with no data on educational attainment, and 716 with no data for other covariates, including smoking and marital status at the baseline survey. After these exclusions, a total of 14,453 participants were retained for the present analyses (Fig. 1).

2.2. Baseline data collection

As parts of the NHANES III, the baseline data were collected during an in-home interview and a subsequent visit to a mobile examination center. The demographic and health-related information was collected using a standardized questionnaire/protocol.

2.2.1. Body mass index

Weight was measured in the mobile examination center using a digital Toledo scale (Mettler-Toledo International, Inc., Columbus, OH), and participants wore only underwear, gown and foam slippers. A fixed stadiometer was used to measure height. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2), and study participants were grouped into four BMI categories, underweight ($\leq 18.4\ kg/m^2$), healthy weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), or obese ($\geq 30\ kg/m^2$).

2.2.2. Socio-demographics

Ethnicity was coded as whites, blacks, or Mexican Americans. Educational attainment was measured as the highest completed grade of school regardless of age, and categorized as three categories: high school/equivalent or below, some college years, and college graduate or above. Poverty status was assessed using the poverty income ratio (PIR), calculated from the previous year's family income and the family size, and compared with the federal poverty line (PIR = 1) (Housing and Household Economic Statistics Division, U.S.C.B, 2009). The current analysis categorized family income into four levels: poor ($PIR < 1.0$), near poor ($1 \leq PIR < 2$), middle-income ($2 \leq PIR < 4$) and high-income ($PIR \geq 4$) (Bloom et al., 2009). Marital status was collapsed into two categories: married or living as married and other, including never married and widowed, divorced or separated. Rural/urban classification was based on USDA rural-urban codes that describe metro and non-metro counties by the degree of urbanization and nearness to metro areas (Zhang et al., 2005).

2.2.3. Health risk factors and the history of medical and psychiatric illnesses

Current alcohol drinkers were defined as "heavy" if the respondents reported that, in the last 12 months, more than 10 days on which five drinks or more were consumed and "moderate" if the number of days on which five drinks or more were consumed was ≤10 days. Current smokers were defined as "heavy" if the respondents reported that, in the past five days, 40 cigarettes or

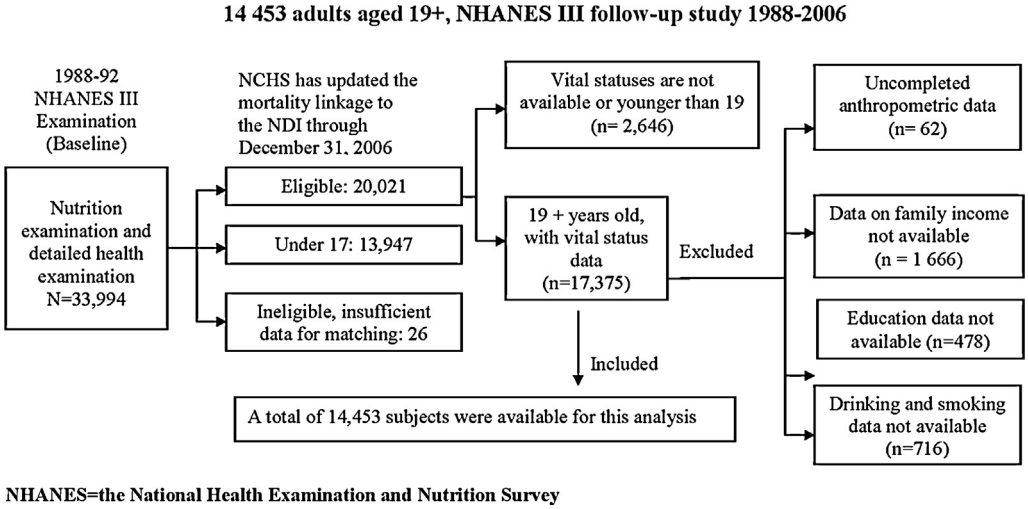

Fig. 1. Flow chart of the study population included 14,453 adults aged 19+, NHANES III follow-up study 1988–2006. NHANES: the National Health Examination and Nutrition Survey.