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High frequency body mass measurement, feedback, and health behaviors

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ABSTRACT

We analyze weight and fat percentage measurements of respondents in an online general population panel in the Netherlands, collected using wireless scales, with an average frequency of 1.6 measurements per week. First, we document the existence of a weekly cycle; body mass is lowest on Fridays and highest on Mondays, showing significant ($p < 0.01$) differences of, on average, 0.2 kilogram in weight, 0.06 in BMI value, and 0.03 in fat percentage. Second, we find that in the general population fat-based measures of obesity point at a three times larger prevalence of obesity (53%) than BMI-based measures (17%). Third, we find that feedback that includes a recommended weight range increases the temporal variation in individual body mass by almost ten percent (sd for weight increases from 1.13 to 1.22; sd for BMI increases from 0.37 to 0.41; sd for fat percentage increases from 0.55 to 0.61.

1. Introduction

Social science research on health and health behaviors often uses BMI based on self-reports of weight and height as an indicator of health risks. While this is a low cost method, it has serious flaws (Burkhauser and Cawley, 2008; Burkhauser et al., 2009). The first weakness is the self-reported nature of weight measurements. A large literature documents biases in self-reported weight. In their review article Connor Gorber et al. (2007) report that studies comparing self-reported and objectively measured weight usually find under-reporting for weight and BMI, with a great deal of individual variability. A second, major weakness of BMI based on self-reports is that it does not distinguish fat from fat-free mass such as muscle and bone. Johansson et al. (2009), Bozoyan and Wolbring (2011) and von Hinke Kessler Scholder et al. (2012) illustrate the importance of how fatness is measured in analyzing its effects on labor market and educational outcomes. In general, fat is generally a stronger predictor of morbidity (in particular cardiovascular diseases and diabetes), mortality, employment, work disability, and socio-economic variables like marriage and wages, than is total body mass (Burkhauser and Cawley, 2008; Bozoyan and Wolbring, 2011). Another major weakness of weight measurements in social science surveys is its low frequency, typically once a year. This may mask substantial weight cycling within the year. Weight cycling can bring health risks over and above the risk of being overweight or underweight (Jeffery, 1996).[1]

This paper reports on steps toward improved measurement and analysis of body mass in survey research, building on recent technological advances in body mass measurement and wireless information exchange. We provided about 1000 households in the LISS panel – an internet panel based on a true probability sample of the

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[1] A related literature has analyzed obesity trends using height, weight and skinfold thickness information collected by health professionals; see e.g. Burkhauser et al. (2009) and Komlos and Brabec (2011).

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Dutch population – with a device that measures body weight and fat percentage (based on bioelectrical impedance), and that wirelessly sends this information to the LISS database. Since measurement is embedded in the LISS panel, the data are linked to a wealth of socioeconomic variables, including health related behaviors like time use and the use of health care. The procedure minimizes the role of the respondent in transferring information. In addition to being accurate, the measurements can be performed at high frequency. We independently randomized the minimum frequency with which respondents are requested to step on the scale (once a day, once a week, or unspecified) as well as the type of feedback they receive (graphs with own weight measurements only, own weight with own target weight, own weight with recommended norm weight range). The empirical analysis is based on almost 80,000 measurements collected in 2011.

First, we document the existence of a weekly cycle in weight, BMI, and fat percentage in the general population, with weight being lowest on Fridays and largest on Mondays. Second, we find that in the general population self-reported weight provides a reasonably accurate picture of the weight distribution as measured using the scales. However, fat-based measures of obesity point at a substantially larger prevalence of obesity than BMI-based measures. Third, we find that certain types of feedback increase temporal variation in individual body mass. Fourth, we do not find effects of feedback and requested weighing frequency on the use of health care and time spent on sports.

Section 2 provides the motivation for collecting longitudinal, objective measures of body mass. Section 3 describes the LISS panel and provides details on the procedure of collection information on body mass composition using the advanced scales. Section 4 presents the empirical analysis. We analyze weighing behavior (Section 4.1), discrepancies between actual weight and self-reports (Section 4.2), the level of body mass and its temporal variations (Section 4.3), and health behaviors (Section 4.4). Section 5 concludes.

2. The importance of longitudinal studies of weight and body fat

Overweight and obesity can lead to chronic health problems which reduce the overall quality of life, such as respiratory difficulties; chronic musculoskeletal problems; skin problems and infertility. In addition, obesity is associated with life-threatening conditions, such as insulin resistance, as in type 2 diabetes; certain types of cancers; and gallbladder disease. Obesity is also one of the key risk factors for other chronic diseases together with smoking, high blood pressure and high blood cholesterol (World Health Organisation, 2000; World Health Report, 2002). Although the risks are well-known and national prevention programs have been developed in many countries, the BMI distribution is still shifting upwards in most populations. The World Health Organisation (2000) speaks of a worldwide epidemic of obesity and calculates that obesity accounts for at least 2–6% of total health care costs in several developed countries.

Several studies focusing on the societal costs of obesity have shown a decrease in the healthy life expectancy: not only do obese persons die on average at a younger age than normal weight persons, they also live through more years of disease and disability, need more long-term medication and have more sick leave and work disability. Visscher et al. (2004) quantified the number of unhealthy life-years in obese individuals in Finland, using 3 criteria: work disability, coronary heart disease, and need for long-term medication. The study showed that, over a 15 year period, obese men aged 20 to 64 years who never smoked had 0.63 more years of work disability, 0.36 more years of coronary heart disease, and 1.68 more years of long-term medication compared with normal-weight men. Obese women had, respectively, 0.52, 0.46, and 1.49 more years from these conditions than normal weight women. Based on National Health and Nutrition Examination Survey (NHANES III, National Center for Health Statistics) (1996) and Thompson et al. (1999) estimated the total discounted lifetime medical care costs for the treatment of 5 diseases (hypertension, type 2 diabetes mellitus, coronary heart disease, stroke) to differ by $10,000 ($ 29,600 vs $ 19,600) between obese and normal weight persons, at the 1996 price levels. Neovius et al. (2012) calculated that for Swedish men, obesity is associated with almost twice as high productivity losses to society as for normal weight over a lifetime. The direct costs of obesity are now estimated to be around 4–7% of total health care costs in the United States and around 1–5% in Europe (Allison et al., 1999; Visscher and Seidell, 2001). A further increase in the prevalence of overweight and obesity will lead to an increase in obesity-related health care costs due to an increase in number of unhealthy life-years.

Within this perspective, the value of accurate estimation of the prevalence and trends in overweight and obesity is evident. Knowledge of the level and changing distribution of overweight and obesity in different populations can be used to predict health care costs, to allocate resources for health prevention and to monitor the effects of programs of weight control (WHO, 2000). To study the causes and health consequences of the obesity trend, long-term monitoring of nationally representative samples is needed. A pattern of weight gain across the lifespan has become typical in the past decades, and is associated with the increased prevalence of obesity (WHO, 2000). Lappalainena1 et al. (1999) showed that even normal and overweight (not obese) people in the EU are gaining weight. Although the majority of studies of overweight and obesity are single studies of a population at a particular point in time, some more longitudinal studies of weight change in large samples have been done in recent years. Ball and Crawford (2005) review a total of 34 papers about weight gain during adulthood and its relationship with socio-economical status. The longitudinal studies they included used both self-report measures and objective measures. Moreover, some longitudinal studies used retrospective self-reported weight change, which can be particularly unreliable due to memory effects. For the Netherlands, van Lenthe et al. (2000) report change in BMI over a 6-year period among initially 20 ± 49-year-old subjects. The data were collected with a