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Why are women slimmer than men in developed countries?

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ABSTRACT

Women have a lower BMI than men in developed countries, yet the opposite is true in developing countries. We call this the gender BMI puzzle and investigate its underlying cause. We begin by studying time trends in Japan, where, consistent with the cross-country puzzle, the BMI of adult women has steadily decreased since the 1950s, whereas the BMI of adult men has steadily increased. We study how changes in energy intake and energy expenditure account for the over-time gender BMI puzzle using the Japanese National Nutrition Survey from 1975 to 2010, which provides nurse-measured height and weight and nutritionist-assisted food records. Because long-term data on energy expenditure do not exist, we calculate energy expenditure using a steady-state body weight model. We then conduct cross-country regression analysis to corroborate what we learn from the Japanese data.

We find that both energy intake and energy expenditure have significantly decreased for Japanese adult men and women and that a larger reduction in energy expenditure among men than women accounts for the increasing male-to-female BMI gap. Trends in BMI and energy expenditure vary greatly by occupation, suggesting that a relatively large decrease in physical activity in the workplace among men underlies the gender BMI puzzle.

The cross-country analysis supports the generalizability of the findings beyond the Japanese data. Furthermore, the analysis suggests the increasing male-to-female BMI gap is driven not only by a reduction in the energy requirements of physically demanding work but also by weakening occupational gender segregation. No support is found for other explanations, such as increasing female labor force participation, greater female susceptibility to malnutrition in utero, and gender inequality in nutrition in early life.

1. Introduction

Cross-country analysis shows that the obesity rate is higher among women than among men in low-income countries (Wells et al., 2012). Similarly, women have a higher risk of obesity than men do among minority groups (Wardle et al., 2002; Thorburn, 2005; Katzmarzyk, 2008; Flegal et al., 2010) and among individuals with a low socioeconomic background (Case and Menendez, 2009; Robinson, 2012). We find that this pattern holds more generally. Fig. 1 shows the body mass index (BMI) of men and women across selected countries (BMI is defined as [weight in kilograms]/[height in meters]^2). Regardless of the average BMI level of each country, the average female BMI is higher than the average male BMI in developing countries, and the opposite is true in developed countries. We call this phenomenon the gender BMI puzzle.

The literature offers a number of potential explanations for this puzzle. The conventional explanation posits that early-life malnutrition leads to adult obesity and that the obesity prevalence is higher for women than for men due to greater female exposure to malnutrition (Wells et al., 2012) and greater female susceptibility to perinatal nutritional restriction (the fetal origin hypothesis) (Robinson, 2012). The marriage market might be relevant because physical attractiveness is more important in the male choice for women than in the female choice for men (Averett and Korenman, 1996; Fisman et al., 2006) and because men in high-income groups/countries tend to prefer women with a low BMI compared to men in low-income groups/countries (Swami, 2006). Women in lower-income countries might gain more weight from more frequent childbirth than women in higher-income countries do. Finally, the fact that physically demanding jobs, especially blue-collar jobs, are traditionally held by men (occupational gender

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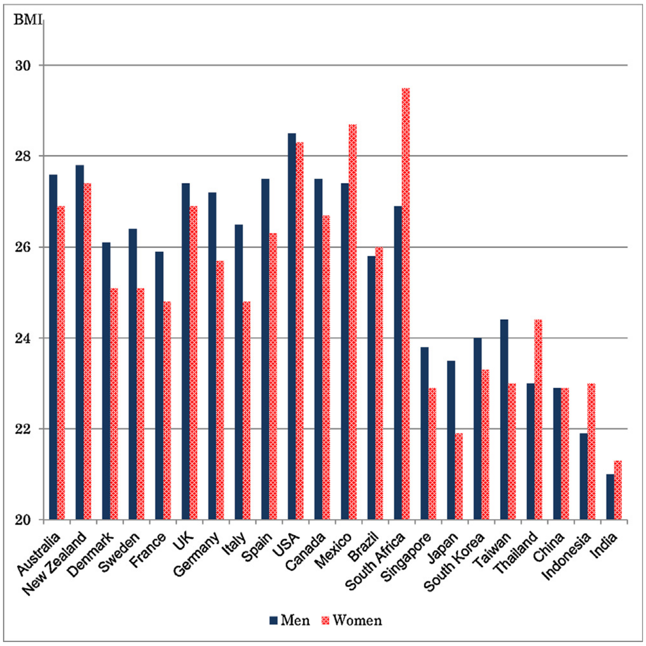

Fig. 1. Mean Age-Adjusted BMI in 2008 by Gender for Selected Countries.
Notes: The countries are ordered by region: Oceania, Europe, America, Africa, and Asia. Within each region, they are ordered in 2008 GDP per capita taken from the IMF's World Economic Outlook database, October 2017 edition. The BMI data are from the Web appendix to Finucane et al. (2011).

segregation) might also explain the gender BMI puzzle in two ways. First, if technological development reduces the energy requirement in physically demanding jobs more than in other jobs, male energy expenditure decreases relative to female energy expenditure. Second, if social development weakens occupational gender segregation, women's energy expenditure at work increases relative to men.

We provide new insights into the mechanism behind the gender BMI puzzle by studying individual-level data drawn from the 1975–2010 Japanese National Nutrition Survey (NNS) and cross-country data. The time-series dataset in Japan offers a unique opportunity to identify the main intertemporal driver behind the gender BMI puzzle: the age-specific BMI of adult women in Japan has steadily decreased since the 1950s, whereas the BMI of adult men has consistently increased (Funatogawa et al., 2009; Maruyama and Nakamura, 2015). A large body of nutrition science literature agrees that the long-term BMI trend is due to energy imbalance (i.e., an excess of energy intake over energy expenditure) (e.g., Bleich et al., 2008). Hence, we studied how changes in energy intake and energy expenditure over time account for the gender difference in BMI trends. To the best of our knowledge, this is the first such undertaking. Previous studies have focused on cross-country variation in female excess in obesity (Wells et al., 2012).

The NNS is presumably one of the best available data sources for height, weight, and food intake in terms of sample representativeness, accuracy, and duration of the survey. The height and weight measurements are recorded by health professionals, and energy intake data are based on nutritionist-assisted food records (Smil and Kobayashi, 2012). To address the lack of reliable long-term data on energy expenditure, we calculated energy expenditure using a steady-state body weight model in which body weight self-adjusts so that energy imbalance resolves. This framework was used to quantify how changes in energy intake and energy expenditure over time contribute to trends in BMI. Furthermore, we examined how trends in energy intake and energy expenditure differ across various subpopulations to explore how lifestyle and socioeconomic environments underlie the gender BMI puzzle. We then conducted a cross-country analysis to corroborate the generalizability of our findings beyond the Japanese data and to obtain further insights into the cause of the gender BMI puzzle.

The analysis of the NNS reveals that the direct cause of the increasing male-to-female BMI gap is differential changes in physical activity levels between men and women. In Japan, energy intake and energy expenditure have steadily decreased among adults in all gender and age groups. The reason the average male BMI has increased and the average female BMI has decreased is that although the decrease in energy intake is similar for both men and women, the decrease in energy expenditure is greater among men than among women.

Why did men's physical activity level decline faster than that of women? We find that trends in energy expenditure differ significantly by occupation, suggesting the substantial role of occupational gender segregation. The results from the cross-country analysis indicate that male BMI is higher than female BMI in countries with smaller occupational gender segregation and that economic development makes men heavier than women only in countries where more men than women work in physically demanding occupations. Overall, our findings suggest two mechanisms behind the gender BMI puzzle: weakening occupational gender segregation and a reduction in energy requirements at work. No support is found for other explanations, such as increasing female labor force participation, marriage market and fertility hypotheses, greater female susceptibility to malnutrition in utero, and gender inequality in nutrition in early life.

2. Framework for energy accounting analysis

Using individual-level data drawn from the 1975–2010 Japanese National Nutrition Survey (NNS), we construct the time-series data of energy intake and energy expenditure. We compare trends in energy intake and energy expenditure between men and women to identify the main driver behind the gender BMI puzzle. As a more formal, mathematical description, we also derive a decomposition of the gender difference in BMI trends into the gender differences in energy intake and energy expenditure trends.

2.1. Data

The NNS is a nationally representative annual cross-sectional survey conducted by the Ministry of Health, Labour and Welfare. This survey was renamed the National Health and Nutrition Survey in 2003, but we use the abbreviation NNS throughout the paper. Further details of the NNS and the data construction are provided in Appendix 1. We restricted our attention to individuals aged 18–59. Pregnant and lactating women and children were excluded from the main analysis because our steady-state model may not hold for them, although we conducted the analysis for children aged 10–17 to compare the results. We excluded the elderly because BMI and mortality may be related, and longevity trends in the sample may have confounded BMI trends. The total sample size over our study period was 245,880.

Our main dataset consisted of age, gender, height, weight, and food intake. Overall, the NNS data are reliable; reporting bias and misreporting are of limited concern. Height and weight were measured without shoes by health professionals with adjustments for the weight of clothes. Nutritional intake data were compiled from a nutritionist-assisted food intake questionnaire. "The person in charge of cooking" in the household was instructed to use scales for measurement and to record the food items and the amounts consumed by the household during the survey period. A certified nutritionist visited each participating household to provide further guidance and to correct for misreporting. We examined the validity