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Nonresponse Bias Analysis of Body Mass Index Data in the Eating and Health Module

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August 2012

Nonresponse Bias Analysis of Body Mass Index Data in the Eating and Health Module

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Abstract

The ERS Eating and Health Module, a supplement to the American Time Use Survey (ATUS), included questions on height and weight so that respondents' Body Mass Index (BMI—a measure of body fat based on height and weight) could be calculated and analyzed with ATUS time-use data in obesity research. Some respondents did not report height and/or weight, and BMIs could not be calculated for them. Analyses focusing on correlations between BMIs and time use could be biased if respondents who did not report height and/or weight differ significantly in other observable characteristics from the rest of the survey respondents. However, findings reveal that any nonresponse bias associated with the height and weight data appears to be small and would not affect future analyses of BMIs and time-use pattern correlations.

Keywords: time use, American Time Use Survey, Eating and Health Module, nonresponse bias, item nonresponse, Body Mass Index, BMI, dissimilarity index, paradata

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Contents

Summary iii

Introduction 1

Relevant Literature—Item Nonresponse, Time Use, and BMI 4

Missing BMIs—Characteristics of Respondents 7

Missing BMIs—Time-Use Profiles 18

Is a Remedy for Missing BMI Data Needed? 25

Conclusions 26

References 27

Summary

What Is the Issue?

ERS collected data on Americans' time-use patterns and food-related information in its Eating and Health Module (EH Module), a supplement to the American Time Use Survey (ATUS). The EH Module also included questions on height and weight so that respondents' Body Mass Index (BMI—a measure of body fat based on height and weight) could be calculated and analyzed with ATUS time-use information. Though the EH Module had a high rate of cooperation among respondents, just under 5 percent of respondents did not report height and/or weight, and ERS could not calculate BMIs for these individuals. This raises concerns of bias in the data due to the missing BMI observations. In this report, ERS examines the BMI data to determine if the missing values hinder the ability of researchers to use the data in future analyses. If respondents who did not report height and/or weight differed significantly in other observable characteristics from the rest of the survey respondents, then time-use estimates may be higher or lower than they would be if BMIs were available for all respondents.

What Did the Study Find?

- Respondents who did not report height and/or weight had disproportionately higher indicators of being reluctant or uncooperative survey participants than other respondents. For example, it took more phone calls over more weeks to obtain a completed interview from these participants. This suggests that for these respondents, the tendency to not report height and/or weight had less to do with sensitivity to height and weight questions and more to do with negative views toward participating in the survey.
- The time-use profiles of the total population and of men with missing BMIs closely resembled the profiles of respondents who were normal weight ($18.5 \leq \text{BMI} < 25.0$).
- The time-use profiles of women with missing BMIs closely resembled the profiles of women who were overweight ($25.0 \leq \text{BMI} < 30.0$).
- These findings suggest that those who did not report height and weight are unlikely to be at either end of the BMI spectrum—underweight (BMI<18.5) or obese (BMI>30.0)—mitigating any bias in the data.

Based on these findings, any bias in the EH Module height and weight data stemming from nonresponse appears to be small and would not affect future analyses of correlations between BMI and time use.

How Was the Study Conducted?

This study used data from the Bureau of Labor Statistics American Time Use Survey and the ERS Eating and Health Module for 2006-08. Researchers analyzed demographic characteristics, such as gender and age, of respondents who did not provide weight or height information. Data quality measures (e.g., completeness or incompleteness of diary reports recording respondents' activities) served as indicators of respondents' reluctance or

uncooperativeness toward participating in the ATUS. Multivariate analysis was performed on respondents' demographic and survey characteristics. A measure of dissimilarity was used to compare time profiles across BMI groups to determine which BMI group most resembled the respondents with missing BMIs in terms of activities reported in the time diaries.

Introduction

ERS collected data on Americans' time-use patterns and food-related information in its Eating and Health Module (EH Module), a supplement to the American Time Use Survey (ATUS). The module included questions on height and weight so that respondents' Body Mass Index (BMI—a measure of body fat based on height and weight) could be calculated and analyzed with ATUS time-use data in obesity research. Because some survey respondents refused to report their height and/or weight, ERS could not calculate BMIs for these individuals. Does the lack of BMIs for some respondents create bias in the data? Bias would occur if respondents without corresponding BMIs had different time-use patterns than other respondents, resulting in under- or over-estimates of average time spent in various activities. This report presents an examination of the BMI data to determine if the missing values hinder the ability to use the data in other analyses.

In examining the potential for bias, ERS provides technical information in this report that will benefit other researchers using the Eating and Health Module data. In addition, ERS contributes to the literature by investigating nonresponse (i.e., missing information for a survey question) in time use surveys, and the ATUS in particular, and by using paradata (i.e., data about the process of data collection) in the examination of this nonresponse.

Eating and Health Module

The ATUS, sponsored by the Bureau of Labor Statistics (BLS) and conducted by the U.S. Census Bureau, has collected time use data nearly every day since the survey was implemented in 2003. In the survey, one individual age 15 or older from each sampled household is interviewed about his or her activities for the 24-hour period from 4 a.m. the day before the interview to 4 a.m. of the interview day. Survey respondents identify their main activity during any time period for which they were engaged in more than one activity at a time. They also report where they were and whom they were with when the activities occurred. All ATUS respondents also participated in the BLS Current Population Survey (CPS). During the ATUS interview, they were given the opportunity to update information on household labor force participation that they provided to the CPS. Thus, the ATUS data include time diary, demographic, labor force participation, and household information.

The EH Module, a supplement to the ATUS developed by ERS and funded by ERS and the National Cancer Institute, was fielded from January 2006 to December 2008, producing 3 full years of data. The ATUS collected data from over 12,000 respondents each year. From 2006 to 2008, the ATUS and EH Module collected data from 37,832 respondents.[1] Weighting factors calculated by the U.S. Census Bureau and applied to the individual respondent data enabled the ATUS and EH Module to produce nationally representative estimates for an average day over 2006-08.

The EH Module contained questions on eating patterns; height, weight, and health status; USDA Supplemental Nutrition Assistance Program[2] participation and household income; meals obtained at school by household children; and grocery shopping and meal preparation (see box, "ATUS Eating and

[1]A small number of respondents (82, or 0.2 percent of the total sample) completed the ATUS survey but did not complete the EH Module.

[2]As of October 1, 2008, the Food Stamp Program was renamed the Supplemental Nutrition Assistance Program.

Health Module Questions"). Since the ATUS is a time-use survey, it does not include food intake information. Nonetheless, the ATUS data provide important information on eating/drinking duration, frequency, and context that allow for the characterization of eating patterns of different groups.

Data on height and weight collected through the EH Module enable researchers to examine for correlation between BMI and time-use patterns. This may be particularly useful in the design of programs targeted at reducing the incidence of obesity, the most common food and nutrition-related health problem in the United States. Information on patterns of time spent in various activities by those who are obese can help researchers understand how behaviors differ among people of different weight status.

The Eating and Health Module microdata can be downloaded from BLS at http://stats.bls.gov/tus/ehdatafiles.htm; estimates and documentation are available at www.ers.usda.gov/data-products/eating-and-health-module-(atus).aspx

ATUS Eating and Health Module Questions

Eating as a secondary activity

Because many Americans eat while engaged in other activities, such as driving or watching television, information is needed on eating as both a primary and secondary activity. This question records when and during which activities the respondent was eating or drinking beverages.

Question:

We're interested in finding out more about how people fit meals and snacks into their schedules. Yesterday, you reported eating or drinking between [fill times from respondent's time diary]. Were there any other times you were eating yesterday—for example while you were doing something else? About how long would you say you were eating while you were [fill activity]? Not including plain water, were there any other times yesterday when you were drinking any beverages? About how long would you say you were drinking while you were [fill activity]?

Grocery shopping and meal preparation

Question:

I'd like to ask a couple of questions about food preparation. Are you the person who usually does the grocery shopping in your household? Are you the person who usually prepares the meals in your household?

Food Stamp Program participation

This information allows analysis of the time-use patterns of food stamp recipients versus others, and in particular, low-income persons who are not participating in the program.

Question:

In the past 30 days, did you or anyone in your household get food stamp benefits?

Breakfast and lunch obtained at school

Question:

Please think back over the past week starting last Monday up to today, Monday. In the past week, did [fill names of children in the household 18 or under] eat a BREAKFAST that was prepared and served at a school, a paid day care or Head Start Center, or a summer day program? This question refers to ONLY BREAKFASTS prepared at the school or center—not meals brought from home.

What about LUNCH? In the past week, did [fill names of children in the household 18 or under] eat a LUNCH that was prepared and served at a school, a paid day care or Head Start Center, or a summer day program? This question refers to ONLY LUNCHES prepared at the school or center—not meals brought from home.

Height, weight, and general health

From this self-reported information, Body Mass Index (BMI) can be calculated, and time-use patterns, such as activity levels and eating patterns, can be analyzed by BMI levels.

Question:

I'm going to switch topics and ask you a few final questions about your physical health that might affect how you use your time. In general, would you say that your health is Excellent, Very Good, Good, Fair, or Poor? How tall are you without shoes? How much do you weigh without shoes?

Household income

This question asks if total household income before taxes was above or below a certain amount. The ATUS Computer Assisted Telephone Interviewing software automatically calculated the dollar amount of 185 and 130 percent of the poverty threshold based on the respondent's household composition. These income thresholds—185 percent and 130 percent—determine income eligibility for food assistance programs.

Question:

Last month, was your total household income before taxes more or less than [fill 185 percent of poverty threshold] per month?

If answer was LESS:

Was it more or less than [fill 130 percent of poverty threshold] per month?

A text version of the Eating & Health Module questionnaire is available at www.bls.gov/tus/ehmquestionnaire.pdf

Relevant Literature—Item Nonresponse, Time Use, and BMI

Considerable research has been conducted on the effects of *unit nonresponse* in household surveys. Unit nonresponse refers to sampled individuals or households who choose not to participate in a survey. In such cases, the concern is that estimates based on survey data affected by unit nonresponse may have an increased variance and a bias. A bias would result if those who do not participate have different characteristics related to the survey topic than those who do respond to the survey, and so an estimate calculated from survey data would be different than the actual population value. The literature in this area is extensive (see, for example, Groves (2006), Groves et al. (2002), and Bethlehem et al. (2011)).

Abraham et al. (2006, p. 676) investigated unit nonresponse in the ATUS and concluded, "We find little support for the hypothesis that busy people are less likely to respond to the ATUS but find considerable support for the hypothesis that people who are weakly integrated into their communities are less likely to be contacted." However, reweighting the estimates to account for this effect produced only modest differences in time use.

Abraham et al. (2008) also looked at unit nonresponse in the ATUS in relation to estimates of time spent in volunteer work. They investigated whether the social processes that lead one to participate in a survey also lead one to volunteer, which would result in an overrepresentation of volunteers in the ATUS. Their findings reveal an association between the factors that encourage volunteering and those that encourage survey participation, meaning that time-use estimates would contain bias, in this case an overestimate, in time spent in volunteering and other pro-social activities. They do not recommend an adjustment for the bias; however, they suggest strategies to improve sample weighting to account for this nonresponse.

O'Neill and Sincavage (2004) conducted a response analysis survey on ATUS nonrespondents to better understand the differences between respondents and those who refused to respond. One-third of the ATUS nonrespondents cited CPS-related survey fatigue—their decision not to participate in the ATUS was based on their having previously participated in the CPS, which is an 8-month survey over a 16-month period. Several nonrespondents stated that they were tired of the Census Bureau calling them, and they felt that participating in the CPS more than satisfied their requirement.

Item nonresponse occurs when an individual or household participates in a survey but does not provide information for one or more questions. Several factors may account for item nonresponse: The respondent may think that the information requested by a question is too sensitive to reveal, such as income;[3] the respondent may think that a question is not directly related to the survey topic; or the respondent may not know the answer to a question and may not want to spend time researching the answer. It is also possible that the respondent does not know the answer and cannot obtain the answer. The research on item nonresponse is not as extensive as that on unit nonresponse; however, thorough overviews exist (see, for example, Bethlehem et al. (2011, chapter 14), Dixon (2005), and Mason et al. (2002)).

[3]Tourangeau et al. (2000, chapter 9) provide a good discussion of sensitive questions and nonresponse.

Fricker and Tourangeau (2010, p. 941) investigated nonresponse, reluctant respondents, and data quality in the CPS and in the ATUS. Although their focus was unit nonresponse and data quality, they studied item nonresponse as well. Their data quality indicators for ATUS were "(1) total number of diary activities reported; (2) missing diary reports of basic daily activities; (3) round values for activity durations; and (4) item nonresponse on ATUS labor-force questions." They found that respondents with high nonresponse propensity scores had fewer activities reported in their time diaries. In addition, they examined respondents who were *refusal conversions*, that is, they originally refused to participate in the ATUS but later agreed to be interviewed. They found that data quality for refusal conversion respondents was worse than for other nonrespondents.

Other areas of survey-related research include late respondents and data quality. Triplett et al. (1996) studied late respondents (converted-refusal cases) to the 1993-94 time diary study conducted by the U.S. Environmental Protection Agency. They concluded that the converted-refusal respondents consistently provided less information than other respondents. Friedman et al. (2003, p. 992) investigated whether the characteristics of late respondents to the Health Care Survey of Department of Defense Beneficiaries were different from those of other respondents. They used the "continuum of resistance" model that posits that "…individuals who require the most contacts before participating in a survey are also the most resistant to being interviewed, and the more resistant a respondent, the more similar he or she is to the most resistant individuals in the population—the nonrespondents." They studied these late respondents—those who needed the most callbacks before participating—as a way of gaining insight into nonrespondents. They found that late respondents have different characteristics than nonlate respondents and are also more likely to have "don't know," "not applicable," or just blank responses to survey questions. As a consequence, their responses may be less reliable than those of nonlate respondents.

Some survey methodologists recommend that researchers adjust the data to avoid bias from nonresponse. Graham (2009) and Schafer and Graham (2002) provide thorough overviews of dealing with missing data. Both discuss the nature of "missingness" and review various approaches avoiding bias. One such approach is to re-calculate the sampling weights to account for the nonresponse. Estimates using the nonresponse-adjusted weights may be used as population estimates or may be used to estimate the extent of any nonresponse bias. See Abraham et al. (2006) and Dixon (2008) for examples of weight recalculation. Another approach to dealing with missing data is to impute values that are missing due to item nonresponse. Kyureghian et al. (2011) used a parametric Bayesian model for multiple imputation methods, and Andridge and Little (2010) discuss hot deck imputation methods.

The survey methodology literature on BMI focuses on bias of self-reported height and weight measures. Representative research includes Danubio et al. (2008), Kuczmarski et al. (2001), and Hill and Roberts (1998). Research on item nonresponse on BMI is limited, and all of it pertains to children. Wagstaff et al. (2009) imputed BMI values for individuals age 2-15 in the 1999-2000 National Health and Nutrition Examination Survey (NHANES). BMI values are missing for 8 percent of the children/youth sampled. Wagstaff et al. compared active imputation of BMI (imputing BMI directly) with

passive imputation of BMI (imputing height and weight). Using 1999-2000 NHANES data for non-Hispanic White youths age 2-18, they found little difference between the active and passive BMI imputation methods. Nandram and Choi (2010) used the NHANES III data to impute missing values for those respondents age 2-19 with missing BMI. They modeled population means of small domains of age, race, and sex within counties. They focused on analysis of BMI of children/youth and created BMI "growth curves" by age. Tiggemann (2006) studied missing BMI using data from the Flinders University (Australia) survey of teenage boys and girls in South Australia that investigated the role of media and adolescent self-image. Over one-fourth of the sample had missing BMI values. Tiggemann concludes that nonreporting of height and/or weight was not random and consistent with the "motivated nonreporting hypothesis," and, consequently, analysis without the missing values or imputation with a mean BMI would produce biased estimates. She also concludes that "…the current study provides an illustration of how treating missing values as meaningful data can provide some useful information and raise some interesting questions" (p. 349).

Missing BMIs—Characteristics of Respondents

Obesity is the most common food and nutrition-related health problem in America. Data from the ATUS and the EH Module enable researchers to identify the types of activities and eating patterns that are associated with obesity and those that are associated with healthy weight, overall health, and well-being.

As mentioned earlier, researchers used the height and weight information gathered from EH Module respondents to calculate BMIs.[4] They then analyzed BMIs in conjunction with time diary, demographic, and labor force information to better understand associations among BMI status and time-use patterns and demographic and labor force characteristics. Although BMIs were calculated from self-reported height and weight in the ATUS, researchers found that differences between self-reported BMIs and measured BMIs are small and, as a result, self-reported BMIs are acceptable for use in analysis of data on nonelderly adults (see Cawley and Burkhauser, 2006; Kuczmarski et al., 2001; and Danubio et al., 2008). In addition, the expected underreporting of BMIs (through underreporting of weight and overreporting of height) in the EH Module data does not appear to be large (Pinkston and Stewart, 2009). So while the EH Module BMIs should not be used to obtain an official measure of obesity in the United States, the data are suitable for analyzing time-use behavior as it relates to BMI.[5]

Missing values for height and/or weight

EH Module data collected over 2006-08 reveal that only 1,848 respondents, or 4.88 percent of 37,832 completed interviews, did not report height and/or weight, and have missing BMI values (tables 1, 2).[6, 7] ERS did not impute BMIs for any of the missing values. An additional 347 respondents (0.92 percent) told interviewers they were pregnant, and these individuals were not asked about their weight. As a consequence, these respondents have missing BMIs; however, they are not included in this analysis.

Item nonresponse is considered a source of nonsampling error.[8] Respondents who are willing to participate in the ATUS may be unwilling to answer sensitive questions. In response to concerns about sensitivity, ERS placed questions about general health, height, weight, and income at the end of the survey.[9] Respondents with missing BMIs may have declined to report height and/or weight, perceiving this information as irrelevant to a time-use survey.[10] It is also possible that some individuals, such as growing teenagers and elderly individuals with age-related weight loss, may not know their current height and/or weight. Because the ATUS interviews are conducted via computer-assisted telephone calls, respondents may be reluctant to pause the interview to measure themselves.

Because some respondents did not report height, some did not report weight, and some did not report either, the sum of missing height and missing weight is greater than the total number of missing BMI (see table 3). For height and especially for weight, more respondents refused to report values than those who answered that they did not know their height and/or weight. However,

[4]Height and weight are bottom- and top-coded for confidentiality. The EH Module included a screening question for pregnancy as pregnant women were not asked their weight and thus have missing BMIs.

[5]This research does not address whether BMI should be adjusted to correct for underreporting of weight and overreporting of height due to self-reporting as the focus here is on missing BMIs. See Pinkston and Steward (2009) and Danubio et al. (2008) for discussions of BMI bias correction.

[6]All estimates presented in this report were calculated using American Time Use Survey (ATUS) data and Eating and Health Module (EH Module) data for 2006-08. The ATUS Respondent, Activity, Activity Summary, Roster, Who, and ATUS-Current Population Survey files were used, along with the ATUS Methodology Call History and Case History files, and the EH Module Respondent and Replicate Weights files. The dataset used contains 37,832 respondents, with a total of 753,604 activities. Excluding respondents who reported being pregnant results in a total of 37,485 respondents. All estimates and unweighted counts are for individuals age 15 and over. All calculations were done using SAS 9.2. Estimation procedures outlined in the ATUS User's Guide (http://stats.bls.gov/tus/atususersguide.pdf) and the EH Module User's Guide (http://ers.usda.gov/Publications/AP/AP047/) were followed. Averages were calculated as the mean unless otherwise stated. Standard errors were calculated according to Section 7.5 of the ATUS User's Guide. The EH Module Replicate Weights were used to calculate standard errors.

[7]Body mass index is calculated as weight (lb) / [height (in)]^2 x 703. Adult BMI groups are underweight (BMI < 18.5), normal weight (18.5 ≤ BMI < 25), overweight (25 ≤ BMI < 30), and obese (30 ≤ BMI). For purposes of interpreting BMI, the Centers for Disease Control (CDC) defines adults as those age 20 and over and uses a different interpretation for youth and teens. However, here these adult groupings are for convenience of exposition used for all respondents age 15 and

Continued on page 8

Table 1
ATUS/EH Module respondents by Body Mass Index (BMI) status and by sex

Item	Men	Women	Total
		Number	
Missing BMI	389	1,459	1,848
Underweight (BMI<18.5)	148	471	619
Normal weight (18.5≤BMI<25.0)	4,669	8,498	13,167
Overweight (25.0≤BMI<30.0)	6,814	5,649	12,463
Obese (30.0≤BMI)	4,407	4,981	9,388
Total	16,427	21,058	37,485

Note: Cell counts (unweighted), age 15 and over, pregnant women excluded.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health (EH) Module.

Table 2
ATUS/EH Module respondents with missing Body Mass Index (BMI) by year

Item	2006	2007	2008	Total
Respondents missing BMI (number)	588	593	667	1,848
Share of total (%)	4.6	4.9	5.3	4.9
Total respondents	12,764	12,108	12,613	37,485

Note: Cell counts (unweighted), age 15 and over, pregnant women excluded.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health (EH) Module.

Table 3
Missing height and weight respondents by type of nonresponse

Respondent type	Don't know	Refused	Total
		Number	
Missing height	381	478	859
Missing weight	466	1,083	1,549

Note: Cell counts (unweighted), age 15 and over, pregnant women excluded.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health (EH) Module.

whereas a "refusal" is a refusal to answer the question, a "don't know" response may be a soft refusal, so it is unclear how to interpret the "don't know" responses.

Demographic characteristics of BMI nonrespondents

In analyzing BMI nonresponse, it is useful to look at the basic demographic characteristics of those with missing BMI. As shown in table 1, the majority of nonrespondents were women (79 and 75 percent of unweighted and weighted counts, respectively). The share of respondents missing BMIs varies slightly by age group; however, the estimates are not statistically different from each other, so there is essentially no difference in nonresponse across age groups (table 4).

Continued from page 7

older as the focus is on the missing BMIs for the entire dataset and not on analyzing time use patterns of those who are, say, overweight. In analysis by BMI, ERS uses the CDC adult and youth/teen definitions. For more information on BMI, see www.cdc.gov/healthyweight/assessing/bmi/index.html

[8]ERS and the Bureau of Labor Statistics concluded that including height and weight in the EH Module would not lead to unit nonresponse because the ATUS is not a health survey, and individuals would not expect questions about height and weight. For a discussion of nonresponse and sensitive questions, see Tourangeau et al. (2010).

[9]See Vernon (2005) for a discussion of pretesting the EH Module. A text version of the questionnaire is at http://stats.bls.gov/tus/ehmquestionnaire.pdf

[10]Dixon (2002) finds that some respondents in the Current Population Survey respond to labor force questions—indicating that they agree with the purpose of the survey—but not to demographic questions that they may perceive as irrelevant.

Those who were employed at the time of the ATUS interview were more likely to report height and weight, which is reflected by the lower share with missing BMIs for that category of respondents (table 5).

Survey characteristics of BMI nonrespondents

Another way to analyze BMI nonresponse is by looking at ATUS respondent characteristics. Perhaps the respondents with missing BMIs are reluctant to be interviewed (i.e., they are "uncooperative respondents)." An indicator of an uncooperative respondent is the number of phone calls made by the Census Bureau to obtain a completed interview.[11, 12] Based on the ATUS call history data from one of the ATUS survey methodology files, the average number of call attempts appears to be higher for those respondents with missing BMIs (7.1) than for the total population (6.8); however, these averages are not statistically different at the 90-percent level, so the number of call attempts made to those with missing BMIs is about the same as the number of calls made to all others (table 6). A related characteristic of ATUS respondents is the number of weeks (1-8) that were needed to successfully complete the interview. The number of weeks required for respondents with missing BMIs was

[11]Each sampled designated person is assigned a diary day of the week, and the interview is conducted on the next day (e.g., if Monday is the diary day, Tuesday is the interview day). If the designated person is not reached or the interview cannot be completed, call attempts are made on the interview day for up to 8 weeks.

[12]The number of attempted calls also includes times that the respondent's case file was opened. So, an actual call may not have been made if the file was viewed or queued up for a call. Thus, cases with high numbers of call attempts likely have fewer actual calls made. Information from Mary Dorinda Allard, Director, BLS Division of Labor Force Statistics, in a discussion on March 11, 2011.

Table 4
Respondents with missing Body Mass Index (BMI) by age group

	Missing BMI					Total population, nonmissing BMI				
	Un-weighted	Un-weighted	Weighted	Standard error	Weighted, 90% CI	Un-weighted	Un-weighted	Weighted	Standard error	Weighted, 90% CI
	Number	*Percent*				*Number*	*Percent*			
Total population	1,848	4.9	4.9	0.14	±0.24	35,637	95.1	95.1	0.14	±0.24
Age 15-19	129	4.8	4.4	0.46	±0.75	2,588	95.2	95.6	0.46	±0.75
Age 20-39	600	5.2	5.1	0.27	±0.45	11,016	94.8	94.9	0.27	±0.45
Age 40-64	812	4.9	4.9	0.21	±0.34	15,736	96.1	95.1	0.21	±0.34
Age 65+	307	4.6	4.7	0.35	±0.57	6,297	95.4	95.3	0.35	±0.57

Note: Age 15 and over, pregnant women excluded.
Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Table 5
Missing Body Mass Index (BMI) by employment status, population age 15 and over

	Missing BMI					Total population, nonmissing BMI				
	Un-weighted	Un-weighted	Weighted	Standard error	Weighted, 90% CI	Un-weighted	Un-weighted	Weighted	Standard error	Weighted, 90% CI
	Number	*Percent*				*Number*	*Percent*			
Employed	1,112	4.6	4.6	0.18	±0.30	22,988	95.4	95.4	0.18	±0.30
Not employed	736	5.5	5.4	0.26	±0.43	12,649	94.5	94.6	0.26	±0.30

Note: Age 15 and over, pregnant women excluded.
Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Table 6

Call attempts and weeks called by Body Mass Index (BMI) group

Item	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
	Number of call attempts					
Mean (unweighted)	6.7	7.0	6.5	6.8	6.8	6.5
Mean (weighted)	6.8 (0.06) [±0.09]	7.1 (0.20) [±0.33	6.8 (0.44) [±0.72	6.9 (0.09) [±0.15]	6.8 (0.10) [±0.16]	6.6 (0.10) [±0.17]
Median (unweighted)	4	4	4	4	4	4
Median (weighted)	4	5	4	4	4	4
75th percentile (unweighted)	9	9	8	9	9	8
75th percentile (weighted)	9	10	9	9	9	9
Minimum	1	1	1	1	1	1
Maximum	94	72	42	94	78	86
	Number of weeks call attempts made					
Mean (unweighted)	2.2	2.4	2.2	2.2	2.2	2.2
Mean (weighted)	2.2 (0.01) [±0.02]	2.4 (0.05) [±0.09]	2.3 (0.12) [±0.19]	2.2 (0.02) [±0.03]	2.3 (0.02) [±0.04]	2.2 (0.02) [±0.04]
Median (unweighted)	1	2	1	1	1	1
Median (weighted)	1	2	1	1	1	1
75th percentile (unweighted)	3	3	3	3	3	3
75th percentile (weighted)	3	3	3	3	3	3
Minimum	1	1	1	1	1	1
Maximum	8	8	8	8	8	8

Note: Age 15 and over, pregnant women excluded. Variables TUATTMPTNO and TUATTMWEEK from ATUS call history file used. Standard errors are in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health Module

higher (2.4 weeks—weighted mean) and statistically different from that for the total population (2.2 weeks). The median for those with missing BMIs was higher as well—2 weeks versus 1 week for the other groups. The higher average number of weeks needed to complete an interview may indicate that these respondents were reluctant to be interviewed.

Characteristics of late respondents are likely to be similar to those of nonrespondents. Since the 75th percentile for the number of weeks that call attempts were made is 3 weeks, late respondents are defined as those who needed to be called for 4 or more weeks to participate in the ATUS. About 24 percent (weighted) of respondents with missing BMIs were late respondents, a higher share than for late respondents not missing BMI values (20 percent) (table 7). So, the missing BMI group has a higher share of those reluctant to be interviewed than the nonmissing BMI group.

Another indicator of an uncooperative respondent is the number of activities that the respondent reported in the time diary. The mean number of activities reported across the total population was 19.7 (weighted), with a median of 19, a minimum of 5, and a maximum of 91[13] (table 8). Based on the number of activities in the time diaries, the missing BMI group has fewer activities as measured by mean, median, and maximum value than the total population. The figure 1 box plot shows the different distributions of the number of diary activities for the BMI groups. The missing BMI group has a lower box than the other BMI groups, indicating a distribution with fewer diary activities not only for the mean and median but also for the 25th and 75th percentiles. Interestingly, men overall have fewer average reported diary activities than women. This finding suggests that these respondents may have decided to participate in the ATUS but did not report detailed information for their time diaries and were perhaps reluctant to provide answers for the questionnaire portions of the survey as well.

Another indicator of respondent cooperation is the degree to which respondents answered other sensitive questions. The final questions in the survey instrument ask for information on general health, height, weight, and income. General health information is related in content to the height and weight questions. Of the 504 respondents who did not report general health, most (92.5 percent) did not report height and/or weight and had missing BMIs. This

[13]Note that BLS ATUS excludes interviews that have fewer than 5 reported activities and/or reported activities that do not cover at least 21 hours of the diary day. There is no constraint on the maximum number of diary activities. Email correspondence from Rachel Krantz-Kent, Manager, American Time Use Survey, October 7, 2010.

Table 7
Missing Body Mass Index (BMI) by late respondent status—call attempts for 4+ weeks before interview

	Missing BMI					Total population, nonmissing BMI				
	Un-weighted	Un-weighted	Weighted	Standard error	Weighted, 90% CI	Un-weighted	Un-weighted	Weighted	Standard error	Weighted, 90% CI
	Number	*Percent*				*Number*	*Percent*			
Late respondent (4+ weeks)	405	21.9	24.1	1.26	±2.08	6,762	19.0	19.7	0.30	±0.49
Not late respondent	1,443	78.1	75.9	1.26	±2.08	28,875	81.0	80.3	0.30	±0.49

Note: Age 15 and over, pregnant women excluded. CI = confidence interval.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Table 8
Number of diary activities by Body Mass Index (BMI) group

Item	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
	Number of activities in diary					
Mean (unweighted)	19.9	18.6	19.8	20.7	19.7	19.3
Mean (weighted)	19.7 (0.05) [±0.08]	18.7 (0.22) [±0.35]	19.2 (0.46) [±0.76]	20.3 (0.08) [±0.13]	19.5 (0.09) [±0.15]	19.3 (0.10) [±0.17]
Median (unweighted)	19	17	19	19	19	18
Median (weighted)	19	17	18	19	18	18
75th percentile (unweighted)	24	23	24	25	24	23
75th percentile (weighted)	24	23	23	24	24	24
Minimum	5	5	6	5	5	5
Maximum	91	58	91	75	81	85
	Number of activities in diary, men only					
Mean (unweighted)	18.1	15.2	17.0	18.5	18.3	17.8
Mean (weighted)	18.0 (0.06) [±0.10]	15.4 (0.41) [±0.67	17.2 (0.77) [±1.26]	18.2 (0.13) [±0.21]	18.2 (0.10) [±0.17]	17.9 (0.13) [±0.22]
Median (unweighted)	17	14	16	18	17	17
Median (weighted)	17	14	15	17	17	17
75th percentile (unweighted)	22	19	20	22	22	22
75th percentile (weighted)	22	19	20	22	22	22
Minimum	5	5	6	5	5	5
Maximum	64	40	44	64	57	54

—continued

share, however, accounts for only one-fourth of the missing BMI respondents. Perhaps some individuals with missing BMIs are in poor health and may be reluctant to disclose their height and weight. Some respondents may consider this area of questioning to be too intrusive or irrelevant to the survey. The three-fourths of respondents with missing BMIs who did report general health were found to be less likely to report their health as “Excellent” or “Very good,” more likely to report it as “Good “or “Fair,” and equally likely to report it as “Poor” than those with a BMI value (table 9). So, the distribution of

Table 8

Number of diary activities by Body Mass Index (BMI) group—Continued

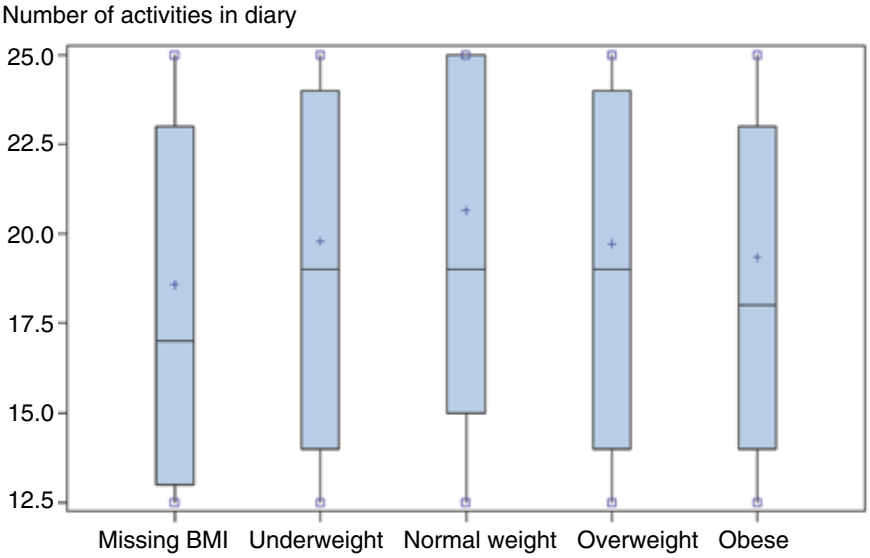
Item	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
	Number of activities in diary, women only					
Mean (unweighted)	21.3	19.5	20.7	21.9	21.4	20.7
Mean (weighted)	21.3 (0.07) [±0.12]	19.8 (0.24) [±0.39]	20.1 (0.47) [±0.78]	21.7 (0.10) [±0.16]	21.4 (0.16) [±0.26]	20.9 (0.15) [±0.25]
Median (unweighted)	20	18	20	20	20	19
Median (weighted)	20	18	19	20	20	20
75th percentile (unweighted)	26	24	25	26	26	25
75th percentile (weighted)	26	24	24	26	26	25
Minimum	5	5	6	5	5	5
Maximum	91	58	91	75	81	85

Note: Age 15 and over, pregnant women excluded. Standard errors are in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Figure 1

Number of diary activities by Body Mass Index group



Note: Extreme values omitted, 1.5 clip factor used. Age 15 and over, pregnant women excluded.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Table 9

Respondents with missing Body Mass Index (BMI) but reported general health

Item	Reported health status					
	Excellent	Very good	Good	Fair	Poor	Total
Missing BMI count (number)	138	409	527	247	61	1,382
Total population, nonmissing BMI count (number)	6,806	12,258	10,566	4,385	1,584	35,599
Missing BMI (row percent unweighted)	10.0	29.6	38.1	17.9	4.4	100
Total population, nonmissing BMI (row percent unweighted)	19.1	34.4	29.7	12.3	4.5	100
Missing BMI (row percent weighted)	10.9 (1.34) [±2.20]	29.2 (1.67) [±2.75]	38.8 (1.78) [±2.93]	17.5 (1.37) [±2.26]	3.6 (0.60) [±0.99]	100
Total population, nonmissing BMI (row percent weighted)	19.1 (0.28) [±0.46]	34.7 (0.33) [±0.55]	30.2 (0.37) [±0.60]	12.0 (0.22) [±0.36]	4.0 (0.13) [±0.22]	100

Note: Age 15 and over, pregnant women excluded. A total of 466 respondents had missing BMI and missing general health, and an additional 38 respondents had BMI but missing general health. Standard errors in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

missing BMI respondents' health status appears slightly different from that of the rest of the respondents.

Questions about income can be problematic in household surveys, as some respondents may be highly sensitive to requests for this information. The EH Module benefited from several rounds of cognitive pre-testing in which ERS was able to craft income questions that produced a high response rate.[14] The first question asked if household income was above or below 185 percent of the poverty threshold for the respondent's household size. If the respondent answered "below" or gave a "don't know" or "refused" answer, then a followup question asked whether the household's income was above or below 130 percent of the poverty threshold for the respondent's household size. Among the respondents who did not report household income for the 185-percent question,[15] 43 percent were missing BMIs (table 10). This share is considerably larger than and statistically different from the 10 percent of respondents who reported height and weight but did not report income.

A final indicator is diary quality. Time diary quality, as reported by the Census interviewer and accessible through the ATUS case history data, can be used to evaluate whether the missing BMI observations were from uncooperative respondents. After each ATUS interview is completed, the Census interviewer answers two data quality questions: "Is there any reason the information from this interview should NOT be used?" and "Why do you think the data should not be used?"[16]

[14]The EH Module income questions had a nonresponse rate of 10 percent, which is lower than the CPS income nonresponse rate of 13 percent. Using household earnings, ERS and BLS imputed income for some respondents, yielding only 6 percent with missing income in the released EH Module data. See Hamrick (2010) for more information.

[15]Used here is the original missing values for variable EEINCOME1; that is, EEINCOME1 without the values that were imputed for those who did not report income. The flag EXINCOME1 was used to remove imputed values. EUINCOME2 (more/less than 130 percent of poverty threshold) was not used here.

[16]See ATUS Questionnaire, June 2010, http://stats.bls.gov/tus/tuquestionnaire.pdf.

Table 10
Respondents with missing Body Mass Index (BMI) by reporting or not reporting income

Item	Income reported	Income not reported
Missing BMI count (number)	1,103	745
Total population, nonmissing BMI count (number)	32,718	2,919
Missing BMI (row percent unweighted)	59.7	40.3
Total population, nonmissing BMI (row percent unweighted)	91.8	8.2
Missing BMI (row percent weighted)	57.2 (1.67), [±2.75]	42.8 (1.67), [±2.75]
Total population, nonmissing BMI (row percent weighted)	89.6 (0.20), [±0.32]	10.4 (0.20), [±0.32]

Note: Age 15 and over, excludes pregnant women. Standard errors are in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

In only 275 of the 37,484 completed interviews did the Census interviewer think that the respondent's time diary was not of good quality (table 11). The unweighted share of those with missing BMIs and no diary quality issues (97.7 percent) is less than the share for those with a BMI value (99.4 percent), as expected. The weighted share of those with missing BMIs and no diary quality issue is 98.2 percent, statistically different from the 99.3 percent for those with a BMI value and no diary quality issue. Although the number and share of respondents with diary quality issues is very small, these results contribute to understanding the factors accounting for the missing BMIs for some respondents.

Multivariate analysis

A probit model was used to systematically analyze the influence that personal characteristics and indicators of uncooperativeness have on the probability that an observation will have missing BMIs (see table 12). In the model, the dependent variable is missing BMI. The model allows for testing the hypothesis that respondents with missing BMIs are uncooperative respondents. Number of diary activities, poor quality time diary, number of weeks that calls were made (1-8), and missing income information were used as indicators of uncooperativeness.[17] Demographic, economic, geographic, and household controls are included to see if respondents with various characteristics are likely to have missing BMIs.

As expected and consistent with the descriptive analysis presented earlier, the probability of missing BMI is higher for female respondents. The probability of missing BMI is also higher for those with less than a high school education, noncitizens, employed persons, and those with household income less than 185 percent of the poverty threshold. Among all respondents, probability of missing BMI was lower for teenagers, Asians, those of mixed race, and those that have any health status except "Good." Region and household composition seem to have little association with missing BMI. Interestingly,

[17]Missing general health could not be included as it is closely correlated with missing income and so resulted in a near singular matrix; likewise for number of call attempts and weeks call was made.

Table 11
Missing Body Mass Index (BMI) respondents by diary quality

Item	No diary quality issue	Diary quality problems				Total
		Intentionally wrong	Could not remember	Deliberately long durations	Other reason	
Missing BMI count (number)	1,806	4	19	11	8	1,848
Total population, nonmissing BMI count (number)	35,404	32	85	77	39	35,637
Missing BMI (row percent unweighted)	97.7	0.2	1.0	0.6	0.5	100
Total population, nonmissing BMI (row percent unweighted)	99.4	0.1	0.2	0.2	0.1	100
Missing BMI (row percent weighted)	98.2 (0.37), [±0.61]	0.2 (0.16), [±0.26]	0.9 (0.26), [±0.43]	0.4 (0.15), [±0.24]	0.3 (0.12), [±0.20]	100
Total population, nonmissing BMI (row percent weighted)	99.3 (0.06), [±0.10]	0.1 (0.02), [±0.03]	0.2 (0.04), [±0.06]	0.3 (0.04), [±0.07]	0.1 (0.03), [±0.05]	100

Note: Age 15 and over, excludes pregnant women. Standard errors are in parentheses, 90-percent confidence intervals in brackets.
Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

in this multivariate analysis that controls for other factors, those who were employed have a higher probability of missing BMI than other respondents, whereas in the descriptive statistics, the same group had a lower share of missing BMI. Employed respondents may have a higher probability of missing BMI because those who are overweight but not obese have, on average, longer paid work hours than other respondent types.[18]

[18]Hamrick et al. (2011), app. table 6.

The general health variables were all negative and significant, indicating that those reporting general health of ”Excellent,” “Very good,” “Fair,” or “Poor” had a lower probability of missing BMI than those reporting general health of “Good.” However, because missing general health cannot be included in the model as it is closely related with missing income, these general health coefficients may also be indicating that these probabilities are less than for those with missing general health.

Among measures of cooperativeness, all coefficients were significant, and coefficient signs were in the expected directions. For all respondents, the more activities reported in the time diary, the lower the probability of a missing BMI. And having a time diary flagged as a poor quality diary increases the probability of having a missing BMI, consistent with the possibility that missing BMI observations are from uncooperative respondents. The more weeks that call attempts were made to interview a respondent, the more likely the respondent’s BMI is missing. Likewise, not reporting household income increased the probability of missing BMI.

Table 12

Probit model, dependent variable = missing Body Mass Index (BMI)

Item	Missing BMI probit coefficient	Marginal probability	Standard error	Significance level
Intercept	-2.0836	-0.1320	0.0824	***
Demographic variables:				
Female	0.6139	0.0389	0.0375	***
Age 15-19	-0.7448	-0.0472	0.0763	***
Age 40-64	0.1029	0.0065	0.0378	***
Age 65 and over	-0.0447	-0.0028	0.0606	
Less than high school education	0.2501	0.0158	0.0502	***
Some college	0.0115	0.0007	0.0421	
College degree	0.0704	0.0045	0.0534	
Advanced degree	0.1094	0.0069	0.0589	*
Noncitizen	0.4787	0.0303	0.0548	***
African American	-0.0362	-0.0023	0.0476	
Asian	-0.3326	-0.0211	0.0950	***
Mixed race	-0.3200	-0.0203	0.1295	**
Labor force and household income:				
Employed	0.0935	0.0059	0.0378	**
Income below 185% poverty threshold	0.0887	0.0056	0.0465	*
Income missing (measure of respondent cooperation)	1.1028	0.0698	0.0488	***
Region:				
Midwest	-0.0424	-0.0027	0.0572	
South	0.0164	0.0010	0.0530	
West	0.0265	0.0017	0.0572	
Nonmetro	-0.0174	-0.0011	0.0400	
Household composition:				
One-adult household	-0.0078	-0.0005	0.0378	
No children in household	-0.0493	-0.0031	0.0422	
General health:				
Excellent health	-0.5621	-0.0356	0.0691	***
Very good health	-0.3638	-0.0230	0.0437	***
Fair health	-0.2725	-0.0173	0.0535	***
Poor health	-0.4436	-0.0281	0.0903	***
Measures of respondent cooperation:				
Number of diary activities	-0.0078	-0.0005	0.0020	***
Poor quality time diary	0.3116	0.0197	0.1274	**
Week call made (1-8)	0.0170	0.0011	0.0084	**
Likelihood ratio test, probability > ChiSq	<.0001			
Number of observations	37,485, 4.9% observations have missing BMI.			

Note: Population (weighted), age 15 and over, pregnant women excluded.
*** indicates significance at the 1-percent level, ** indicates significance at the 5-percent level, and * indicates significance at the 10-percent level. Excluded group is male, age 20-39, high school diploma, citizen, White, not employed, income above 185 percent of the poverty threshold, Northeast, Metro, two-adult household with children, and good health.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Missing BMIs—Time-Use Profiles

The ATUS and the EH Module facilitate analysis of Americans' time spent in various activities. Having an understanding of the characteristics of survey respondents with missing BMIs is useful to time-use research; however, it may be more important to understand whether missing BMIs cause bias in time-use estimates. Are the respondents who did not report height and/or weight different with respect to their time-use patterns than other respondents? On average, those who did not report height and/or weight reported fewer activities in their diaries, but what were the time-duration differences of these activities?

For time spent per day in major activities[19] (table 13), the most striking difference between the missing BMI group and the other BMI groups is the long amount of time spent by the missing BMI group in Personal Care (which includes Sleeping)—586 minutes (9.8 hours). The missing BMI group, of which the majority are women, also had a higher average time spent per day in household activities and caring for household members than the other BMI groups. Interestingly, the missing BMI group also had the highest average time spent in Other Activities. Other Activities include gaps in the time diary that the ATUS interviewer was not able to code due to insufficient detail, respondent refusal, or the inability of the respondent to recall activity. The higher average Other Activities time is consistent with the concept of uncooperative respondents.

[19]For definitions of the major activity groups, see ATUS User's Guide Appendix H: Bridge between published tables activity categories and ATUS coding lexicon activity categories, http://stats.bls.gov/tus/atususersguide.pdf

For major time-use activities by gender, the male missing BMI group spent about the same amount of time, on average, on Personal Care than underweight males (table 14a). The average time males with missing BMIs spent in Eating and Drinking was the shortest among all BMI groups. The female missing BMI group had a relatively high average time spent in Personal Care, the lowest average time spent in Eating and Drinking, and the most time spent in the Other category (table 14b).

The missing BMI group, both men and women, had a long-duration average time spent in Personal Care. The two main activities in Personal Care are Sleeping and Grooming; the missing BMI groups and the total population group differed more in time spent Sleeping than in time spent Grooming (table 15). The nonresponse bias as a result would be that minutes spent in Sleeping are underreported in analysis of BMI groups excluding the missing BMI respondents. However, it is unclear whether sleep duration is underreported for any specific BMI group, as the underreporting occurs across all BMI groups.

Based on the weighted absolute-deviation index (WADI),[20] a measure of dissimilarity of time use "activity profiles" across groups, the difference between the missing BMI group and the other BMI groups can be measured systematically over the 17 major time-use activities. Stewart (2006) defines WADI as:

[20]Note that weighting with respect to the WADI means applying the share of total time spent on an activity to each difference, whereas weighted elsewhere in this report indicates that sample weights were used to produce national estimates.

$$\text{WADI} = \sum_{i=1}^{k} \frac{|a_i - b_i|}{a_i + b_i}\left(\frac{a_i + b_i}{2880}\right) = \sum_{i=1}^{k} \frac{|a_i - b_i|}{2880}$$

where i = activity
k = number of activities
a_i = time in minutes spent in activity i by group a
b_i = time in minutes spent in activity i by group b

Table 13

Time spent (minutes) in major activities by Body Mass Index (BMI) group

Item	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Personal care	562.1 (0.86) [±1.41]	586.2 (4.86) [±7.99]	591.5 (7.33) [±12.06]	567.2 (1.66) [±2.73]	554.1 (1.48) [±2.44]	558.8 (1.99) [±3.27]
Household activities	111.6 (0.89) [±1.46]	120.9 (4.29) [±7.05]	100.1 (6.10) [±10.04]	112.8 (1.38) [±2.28]	111.8 (1.46) [±2.41]	108.8 (1.97) [±3.24]
Caring for household members	31.2 (0.42) [±0.69]	41.8 (2.68) [±4.41]	27.5 (4.14) [±6.81]	33.0 (0.69) [±1.14]	28.2 (0.72) [±1.19]	30.8 (1.01) [±1.67]
Caring for nonhousehold members	12.8 (0.35) [±0.57]	12.7 (1.55) [±2.56]	13.5 (3.27) [±5.38]	11.6 (0.54) [±0.88]	13.6 (0.70) [±1.15]	13.4 (0.70) [±1.15]
Paid work	226.1 (1.77) [±2.91]	198.8 (7.97) [±13.12]	153.7 (12.12) [±19.93]	209.3 (3.18) [±5.24]	245.7 (3.09) [±5.08]	233.8 (3.56) [±5.86]
Educational	27.8 (0.72) [±1.18]	26.0 (3.68) [±6.05]	83.6 (9.17) [±15.08]	44.2 (1.66) [±2.73]	17.0 (1.24) [±2.04]	15.7 (1.22) [±2.01]
Purchasing goods	38.0 (0.46) [±0.76]	40.9 (2.05) [±3.38]	43.5 (4.48) [±7.37]	38.1 (0.77) [±1.26]	37.5 (0.89) [±1.46]	37.5 (0.97) [±1.60]
Purchasing services	7.3 (0.23) [±0.38]	8.4 (0.95) [±1.57]	10.7 (2.58) [±4.24]	7.0 (0.38) [±0.62]	7.4 (0.40) [±0.66]	7.3 (0.40) [±0.66]
Purchasing household services	1.3 (0.08) [±0.14]	0.9 (0.25) [±0.41]	0.3 (0.22) [±0.37]	1.3 (0.15) [±0.25]	1.3 (0.15) [±0.25]	1.5 (0.20) [±0.33]
Government and civic	0.7 (0.07) [±0.12]	0.5 (0.29) [±0.47]	1.5 (0.68) [±1.12]	0.5 (0.11) [±0.18]	0.6 (0.11) [±0.18]	0.9 (0.20) [±0.33]
Eating and drinking	73.9 (0.40) [±0.66]	65.5 (1.63) [±2.67]	71.8 (3.03) [±4.98]	75.6 (0.75) [±1.23]	75.5 (0.74) [±1.21]	71.4 (0.72) [±1.19]
Leisure	285.7 (1.38) [±2.28]	284.1 (5.86) [±9.64]	284.2 (11.57) [±19.04]	270.3 (2.33) [±3.83]	286.2 (2.49) [±4.09]	307.3 (2.78) [±4.57]
Sports	22.6 (0.46) [±0.76]	13.2 (1.39) [±2.28]	19.9 (3.34) [±5.50]	27.4 (0.86) [±1.42]	23.6 (0.92) [±1.51]	16.6 (0.84) [±1.38]
Religious	9.5 (0.22) [±0.36]	10.5 (1.04) [±1.71]	7.8 (1.75) [±2.89]	9.2 (0.39) [±0.63]	9.4 (0.40) [±0.65]	10.2 (0.43) [±0.71]
Volunteer	10.0 (0.35) [±0.57]	7.2 (0.96) [±1.58]	6.7 (1.68) [±2.76]	10.7 (0.58) [±0.96]	10.4 (0.60) [±0.99]	9.2 (0.64) [±1.05]
Phone and mail	7.1 (0.19) [±0.32]	6.4 (0.84) [±1.38]	10.0 (1.33) [±2.20]	8.3 (0.35) [±0.58]	6.3 (0.28) [±0.45]	6.5 (0.37) [±0.61]

—continued

Table 13

Time spent (minutes) in major activities by Body Mass Index (BMI) group—Continued

Item	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Other	12.2 (0.34) [±0.57]	15.8 (1.51) [±2.48]	13.5 (3.26) [±5.36]	13.7 (0.66) [±1.08]	11.5 (0.63) [±1.04]	10.3 (0.45) [±0.74]
Total	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0

Note: Population (weighted), age 15 and over, pregnant women excluded. Activities listed are ATUS major activity groups. Travel time included with each activity. Standard errors in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health Module.

Table 14a

Time spent (minutes) in major activity groups, men only

Activity	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Personal care	551.5 (1.35) [±2.22]	592.4 (10.99) [±18.08]	592.8 (11.28) [±18.56]	563.9 (2.92) [±4.81]	545.3 (2.12) [±3.48]	541.8 (2.62) [±4.32]
Household activities	85.0 (1.17) [±1.93]	60.2 (5.85) [±9.63]	61.7 (10.44) [±17.17]	81.6 (2.21) [±3.63]	91.0 (1.91) [±3.14]	82.9 (2.32) [±3.82]
Caring for house-hold members	20.3 (0.50) [±0.82]	18.7 (3.41) [±5.60]	12.6 (4.09) [±6.72]	17.2 (0.78) [±1.29]	20.6 (0.63) [±1.04]	23.5 (1.31) [±2.16]
Caring for nonhousehold members	10.7 (0.47) [±0.77]	6.6 (1.76) [±2.90]	10.6 (4.42) [±7.28]	9.9 (0.71) [±1.17]	10.9 (0.80) [±1.31]	11.5 (0.98) [±1.62]
Paid work	271.1 (2.51) [±4.13]	254.0 (19.92) [±32.77]	159.1 (25.46) [±41.87]	244.0 (5.26) [±8.65]	285.4 (4.75) [±7.81]	284.8 (5.31) [±8.74]
Educational	25.5 (1.02) [±1.67]	37.3 (9.16) [±15.07]	105.3 (19.40) [±31.91]	45.8 (2.45) [±4.02]	14.6 (0.29) [±2.12]	16.1 (1.69) [±2.78]
Purchasing goods	30.3 (0.68) [±1.12]	26.1 (4.10) [±6.74]	29.7 (7.78) [±12.80]	27.00 (1.10) [±1.81]	31.9 (1.13) [±1.85]	32.0 (1.22) [±2.01]
Purchasing services	5.2 (0.27) [±0.45]	6.2 (1.81) [±2.98]	8.8 (3.79) [±6.23]	5.0 (0.56) [±0.93]	5.3 (0.44) [±0.72]	4.9 (0.46) [±0.76]
Purchasing house-hold services	1.6 (0.14) [±0.24]	0.4 (0.20) [±0.33]	0 (0) [0]	1.4 (0.31) [±0.51]	1.7 (0.24) [±0.39]	1.8 (0.34) [±0.56]
Government and civic	0.7 (0.12) [±0.20]	1.3 (1.06) [±1.75]	0.6 (0.44) [±0.72]	0.5 (0.14), [±0.24]	0.6 (0.16) [±0.26]	0.9 (0.32) [±0.53]

—continued

Table 14a

Time spent (minutes) in major activity groups, men only—Continued

Activity	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Eating and drinking	76.1 (0.58) [±0.96]	59.8 (2.39) [±3.94]	67.5 (5.41) [±8.90]	77.7 (1.20) [±1.98]	77.3 (0.98) [±1.61]	74.2 (1.06) [±1.74]
Leisure	299.8 (2.20) [±3.62]	331.4 (15.09) [±24.82]	343.7 (23.90) [±39.31]	295.5 (3.98) [±6.54]	291.3 (3.60) [±5.93]	312.9 (4.06) [±6.68]
Sports	29.8 (0.78) [±1.29]	15.1 (3.08) [±5.06]	19.1 (5.50) [±9.04]	35.8 (1.49) [±2.45]	30.4 (1.44) [±2.36]	24.2 (1.47) [±2.42]
Religious	7.9 (0.31) [±0.50]	11.5 (2.64) [±4.35]	6.2 (2.32) [±3.82]	7.7 (0.56) [±0.93]	7.8 (0.44) [±0.73]	7.8 (0.53) [±0.87]
Volunteer	9.2 (0.49) [±0.81]	3.5 (1.17) [±1.93]	5.7 (3.14) [±5.17]	8.7 (0.76) [±1.25]	10.3 (0.85) [±1.40]	9.0 (0.99) [±1.62]
Phone and mail	3.9 (0.20) [±0.32]	3.7 (1.18) [±1.94]	6.4 (2.42), [±3.98]	5.0 (0.43), [±0.70]	3.8 (0.32) [±0.52]	2.8 (0.27) [±0.45]
Other	11.4 (0.51) [±0.84]	12.0 (2.69) [±4.42]	10.2 (4.54) [±7.47]	13.2 (1.11) [±1.83]	11.8 (0.97) [±1.59]	8.8 (0.59) [±0.97]
Total	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00

Note: BMI = Body Mass Index. Population (weighted), age 15 and over. Activities listed are ATUS major activity groups. Travel time included with each activity. Standard errors in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health Module.

Table 14b

Time spent (minutes) in major activity groups, women only

Activity	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Personal care	572.2 (1.25) [±2.05]	584.1 (5.11) [±8.41]	591.0 (8.93) [±14.69]	569.4 (1.81) [±2.97]	566.8 (2.48) [±4.08]	578.0 (2.95) [±4.86]
Household activities	137.1 (1.36) [±2.24]	141.4 (5.31) [±8.74]	115.2 (7.71) [±12.69]	133.9 (1.93) [±3.17]	142.2 (2.63) [±4.33]	138.1 (2.72) [±4.48]
Caring for house-hold members	41.6 (0.63) [±1.04]	49.6 (3.39) [±5.57]	33.5 (5.26) [±8.65]	43.7 (1.01) [±1.66]	39.2 (1.38) [±2.27]	39.1 (1.54) [±2.53]
Caring for nonhousehold members	14.8 (0.54) [±0.88]	14.7 (2.02) [±3.32]	14.7 (4.10) [±6.74]	12.8 (0.80) [±1.32]	17.5 (1.17) [±1.93]	15.5 (1.00) [±1.64]

—continued

Table 14b

Time spent (minutes) in major activity groups, women only—Continued

Activity	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Paid work	182.9 (2.28) [±3.75]	180.3 (8.78) [±14.44]	151.6 (16.02) [±26.35]	185.8 (3.71) [±6.11]	187.6 (4.51) [±7.41]	176.3 (4.69) [±7.72]
Educational	30.0 (1.03) [±1.69]	22.2 (4.15) [±6.82]	75.0 (10.65) [±17.51]	43.0 (2.22) [±3.65]	20.6 (2.30) [±3.78]	15.2 (1.83) [±3.02]
Purchasing goods	45.3 (0.66) [±1.09]	45.8 (2.49) [±4.09]	48.9 (5.50) [±9.05]	45.6 (1.08) [±1.78]	45.7 (1.29) [±2.13]	43.8 (1.48) [±2.44]
Purchasing services	9.4 (0.37) [±0.61]	9.2 (1.10) [±1.81]	11.5 (3.30) [±5.43]	8.4 (0.51) [±0.84]	10.5 (0.77) [±1.27]	10.0 (0.73) [±1.20]
Purchasing house-hold services	1.1 (0.08) [±0.13]	1.1 (0.32) [±0.53]	0.4 (0.31) [±0.51]	1.3 (0.13) [±0.22]	0.7 (0.10) [±0.17]	1.2 (0.20) [±0.34]
Government and civic	0.6 (0.09) [±0.15]	0.3 (0.14) [±0.23]	1.8 (0.92) [±1.51]	0.5 (0.14) [±0.23]	0.5 (0.15) [±0.25]	1.0 (0.25) [±0.42]
Eating and drinking	71.9 (0.54) [±0.89]	67.4 (2.01) [±3.30]	73.5 (3.52) [±5.80]	74.1 (0.90) [±1.48]	72.8 (1.12) [±1.84]	68.1 (1.01) [±1.66]
Leisure	272.1 (1.81) [±2.98]	268.2 (6.24) [±10.27]	260.8 (13.11) [±21.57]	253.2 (2.84) [±4.67]	278.7 (3.40) [±5.60]	300.9 (3.97) [±6.52]
Sports	15.8 (0.50) [±0.82]	12.6 (1.57) [±2.58]	20.2 (4.06) [±6.68]	21.7 (0.92) [±1.52]	13.8 (0.95) [±1.56]	8.0 (0.57) [±0.93]
Religious	11.1 (0.33) [±0.55]	10.2 (1.08) [±1.78]	8.5 (2.11) [±3.46]	10.2 (0.51) [±0.84]	11.7 (0.68) [±1.13]	12.9 (0.68) [±1.11]
Volunteer	10.7 (0.47) [±0.77]	8.5 (1.18) [±1.94]	7.1 (1.87) [±3.08]	12.1 (0.82) [±1.34]	10.5 (0.84) [±1.38]	9.5 (0.85) [±1.40]
Phone and mail	10.2 (0.31) [±0.52]	7.3 (1.06) [±1.74]	11.5 (1.65) [±2.71]	10.5 (0.50) [±0.83]	10.1 (0.51) [±0.84]	10.7 (0.69) [±1.14]
Other	13.0 (0.43) [±0.70]	17.2 (1.84) [±3.03]	14.8 (3.58) [±5.89]	14.0 (0.83) [±1.36]	11.0 (0.66) [±1.08]	11.9 (0.73) [±1.21]
Total	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00

Note: BMI = Body Mass Index. Population (weighted), age 15 and over, pregnant women excluded. Activities listed are ATUS major activity groups. Travel time included with each activity. Standard errors in parentheses.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health Module.

Table 15

Time spent (minutes) in Personal Care activities by Body Mass Index (BMI) group

Activity	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Men						
Sleeping	509.7 (1.25) [±2.05]	553.9 (11.29) [±18.58]	557.3 (12.08) [±19.88]	522.9 (2.75) [±4.53]	502.1 (1.99) [±3.27]	500.7 (2.55) [±4.20]
Grooming	32.9 (0.31) [±0.50]	31.3 (2.13) [±3.51]	28.5 (3.70) [±6.09]	33.1 (0.50) [±0.83]	33.2 (0.49) [±0.81]	32.7 (0.54) [±0.88]
Women						
Sleeping	513.4 (1.22) [±2.00]	528.1 (4.58) [±7.53]	531.8 (9.64) [±15.86]	510.9 (1.67) [±2.76]	507.2 (2.39) [±3.93]	518.5 (2.83) [±4.66]
Grooming	47.0 (0.32) [±0.53]	43.3 (1.06) [±1.75]	51.3 (2.95) [±4.85]	48.7 (0.53) [±0.88]	47.1 (0.64) [±1.06]	44.5 (0.72) [±1.18]

Note: Population (weighted), age 15 and over. Sleeping is ATUS activity code 010101, and Grooming is 010201. Travel time included. Standard errors in parentheses, 90-percent confidence intervals in brackets.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey (ATUS) and Eating and Health Module.

The absolute difference in time spent is divided by the total time spent in activity *i* by the two groups, then that is weighted by the fraction of activity *i's* time by total available time to groups a and b (1,440 + 1,440 = 2,880, 1,440 is the total minutes in a day). These terms are then summed over all activities.

The smaller the WADI, the smaller the difference between the two groups, and a WADI=0 would indicate no difference in activity profiles. Stewart (2006) recommends using a WADI index over other dissimilarity indices as it is not sensitive to the level of aggregation of activities (e.g., ATUS major groups of two-digit activity codes versus ATUS four-digit activity code groups) and short-duration activities receive little weight. The index value is "equal to the average proportional difference in the time spent in all activities" (Stewart, 2006, p. 59). Looking specifically at Personal Care (ATUS codes 01xxxx), an index of the absolute deviation (ADI), not the WADI, can be used as it is only one activity so weighting is not needed.

Overall, the WADIs are small, indicating little difference between the activity profiles of the missing BMI group and those of other BMI groups[21] (table 16). Among the BMI groups, the missing BMI group had the lowest WADI with the normal-weight group for the total population and for men. This means the time use profile of those with missing BMIs most resembled that of normal-weight individuals. For women, the lowest WADI was with the overweight group, which indicates that the activity profile of women with missing BMIs is closest to that of overweight women. Looking only at the absolute deviation index for Personal Care activities, those with missing BMI had Personal Care durations most like the underweight group for the total population and for men and the obese group for women.

[21]The mean BMI for those who reported height and weight age 15 and older is 27.13; for men, it is 27.60, and for women, it is 26.66.

Table 16
Measures of dissimilarity by Body Mass Index (BMI) group

Item	Total population	Missing BMI	Under-weight	Normal weight	Over-weight	Obese
Total population						
WADI	0.0356	na	0.0600	0.0407	0.0513	0.0494
ADI, personal care only	0.0205	na	0.0045	0.0165	0.0282	0.0239
Men						
WADI	0.0626	na	0.0758	0.0566	0.0801	0.0692
ADI, personal care only	0.0358	na	0.0003	0.0246	0.0413	0.0446
Women						
WADI	0.0190	na	0.0586	0.0343	0.0250	0.0298
ADI, personal care only	0.0095	na	0.0059	0.0128	0.0150	0.0053

Note: na = not applicable WADI = weighted absolute deviation index. Population (weighted), age 15 and over. Shading indicates smallest index among the BMI groups.

Source: USDA, Economic Research Service using data from 2006-08 American Time Use Survey and Eating and Health Module.

Perhaps the long sleep times are due to unobserved characteristics more specific than general health. For example, the missing BMI respondents could be more likely to be suffering from depression or other illnesses at the time of the ATUS interview, which could result in longer sleep times, poorer health, and fewer activities in the time diary. It does appear that the missing BMI individuals may be in slightly worse health than others and, as a consequence, may sleep more.

However, the longer average times engaged in sleeping may also indicate that those in the missing BMI group are uncooperative respondents; that is, they cannot remember; they do not want to make the effort to remember; or they do not want to disclose their activities in detail. Reporting longer sleep times allows respondents to cover a large block of time with one activity. This is consistent with the earlier analysis on indicators of uncooperativeness. As a consequence, any nonresponse bias of underreported sleep time may be one of sleep time *as reported* and not *actual* sleep time, since the missing BMI group has a disproportionate share of uncooperative respondents.

Is a Remedy for Missing BMI Data Needed?

Several factors make it unnecessary to devise a remedy for missing BMI data in the EH Module: less than 5 percent of respondents are missing BMIs; respondents with missing BMIs have indicators of being uncooperative respondents with poor data quality; and the index of dissimilarity shows that the missing BMI group has time use patterns similar to normal-weight men and overweight women. The BMI data in the EH Module are suitable for research with the ATUS time diary data. Researchers can use case deletion in their analysis to exclude respondents with missing BMIs and calculate estimates using the responses with BMI values.

Researchers who want to increase the number of observations, or who want to fully account for any possible bias, may undertake one of two approaches. First, sample weights could be recalculated for BMI nonresponse (see Abraham et al. (2006) for analysis of unit nonresponse in the ATUS). The ATUS final sample weights control for a variety of factors, including unit nonresponse and interview day of week. A large number of technical adjustments are included as well.[22] A researcher considering this remedy may want to consider the extensive computational requirement of recalculating weights with the expected reduction of bias.

[22]See ATUS User's Guide section 7.2, and BLS and Census (2006), *Current Population Survey: Design and Methodology*, chapter 10.

The other approach would be to impute BMI, or impute height and weight, for the missing BMI values. One difficulty in imputing BMI from the ATUS and EH Module data is that there are no anthropomorphic or medical information available other than the self-reported general health. The studies cited above that imputed BMI used NHANES data and had medical history and waist circumference information for the respondents with missing BMIs. Having anthropomorphic and/or medical information would make for more informed imputations of BMI. Without this information, BMI imputations would essentially be cell averages of the demographic and labor force participation group of missing BMI respondents. Another possibility is to use the NHANES data and probabilistic matching to match the missing BMI respondents with NHANES respondents and then apply the NHANES BMI value to the ATUS/EH Module respondents.

Conclusions

The 4.9 percent of EH Module respondents who did not report height and/or weight had disproportionately higher indicators of being reluctant or uncooperative respondents. It took more call attempts over more weeks to interview these respondents, indicating that they were reluctant to participate in the survey. They were also more likely to have time diaries with little detail as measured by the number of activities in the diary, and they were more likely to have poor quality time diaries. They were less likely to answer other sensitive questions on the survey. These findings indicate that the respondents' lack of reporting height and/or weight had less to do with the height and weight questions and more to do with the respondents' views of participating in the survey.

The time-use profiles of the total population and of men with missing BMI closely resembled those of respondents with normal weight. For women, the missing BMI time profile closely resembled that of women who were overweight. This suggests that those who did not report height and weight are unlikely to be at either end of the BMI spectrum; that is, they are unlikely to be severely underweight or morbidly obese, mitigating any bias. Since the missing BMI respondents have time profiles close to those in the middle BMI groups (normal weight and overweight), excluding their time diaries in the analysis is unlikely to produce bias in time-use estimates. As a consequence of these findings, any item nonresponse bias in the EH Module height and weight data appears to be small, allowing for future analysis of time use by BMI.

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