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AGE-RELATED CHANGES IN ENERGY INTAKE AND WEIGHT IN COMMUNITY-DWELLING MIDDLE-AGED AND ELDERLY JAPANESE

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Abstract: *Objective:* This study attempts to describe trends in energy intake and weight change over 12 years according to age at first participation in the study. *Design:* Prospective cohort study. *Setting:* The National Institute for Longevity Sciences - Longitudinal Study of Aging (NILS-LSA), a community-based study. *Participants:* Participants included 922 men and 879 women who participated in the first study-wave (age 40-79 years) and also participated in at least one study-wave from the second to seventh study-wave. Each study-wave was conducted biennially. For individuals, the entire follow-up period was 12 years. *Measurements:* Energy intake was calculated from 3-day dietary records with photographs. Weight and height were measured under a fasting state. To estimate linear changes in energy intake and weight over 12 years according to age at first study-wave, we used the mixed-effects model. *Results:* Mean (SD) follow-up time and number of study-wave visits were 9.5 (3.7) years and 5.4 (1.8) times, respectively. The fixed effect of the interaction of age and time in energy intake and weight was statistically or marginally statistically significant both in men ($p<0.01$) and in women ($p<0.06$). In men, when energy intake was estimated according to age, the rate of decrease in energy intake increased from -6.8 to -33.8 kcal/year for ages 40-79 years. In women, the rate of decrease in energy intake slightly increased in older age groups (-9.1 to -16.7 kcal/year for ages 40-79 years). Weight increased in males in their 40s (0.07 kg/year from age 40) and started to decline by age 53. In women, weight started to decline around age 47 (-0.04 kg/year). *Conclusion:* Twelve-year longitudinal data showed energy intake declined both in men and women in their 40s, and the rate of decrease increased in older males. Weight started to decline in men in their mid-50s and women in their late 40s. Further studies that focus on energy intake and weight reduction are needed to prevent weight loss or underweight in an increasingly aging society.

Key words: Energy intake, weight, longitudinal study, Japanese.

Introduction

In today's aging society, nutrition in the elderly has been attracting increasing attention. Total energy intake is reported to decrease with age (1), and cross-sectional and longitudinal studies in Western countries indicate a decline in food intake with aging (2, 3). Caloric restriction leads to lower body weight, and substantial weight loss or underweight in the elderly impairs health and reduces longevity (4, 5).

In Japan, people aged 65 years and older are the fastest-growing population, and by 2035, they will account for 1 of every 3 Japanese (6). Preventing weight loss or underweight among the elderly is an important part of public health programs. However, it is unknown how much energy intake or weight decreases with age in elderly Japanese, especially non-institutionalized community dwellers older than 70 years. The «Dietary Reference Intakes (DRIs) for Japanese, 2015» was published in April 2015, and as such, does not define a reference for nutrient intake, or energy intake, among those older than 70 years (7).

The National Institute for Longevity Sciences-Longitudinal Study of Aging (NILS-LSA) was started in 1997 (8). In this project, the normal aging process has been assessed using detailed questionnaires and nutritional examinations. Participants aged 40 to 79 years at baseline were randomly selected from resident registrations in an NILS neighborhood (in Aichi prefecture) and stratified by gender and age decade. We followed up with participants every 2 years from the first study-wave (1997-2000) to the seventh study-wave (2010-2012). All study waves include detailed nutritional assessments and physical examinations, and we have been reporting cross-sectional descriptive nutritional and the other health-related variables on our website (9).

In this study, to clarify the age-related changes in energy intake and weight of non-institutionalized community dwellers, we attempted to describe trends of changes in energy intake and weight over 12 years in community-dwelling, middle-aged and elderly Japanese participants according to age at first participation in the study.

Methods

Participants

Data for this survey were collected as part of the NILS-LSA. In this project, the normal aging process has been

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assessed using detailed questionnaires and medical checkups, anthropometrical measurements, physical fitness tests, and nutritional examinations. Details of the NILS-LSA are reported elsewhere (8). The initial survey of the NILS-LSA involved 2,267 men and women aged 40 to 79 years, including approximately 300 men and 300 women for each decade of life. Participants included were gender- and decade age-stratified random samples living in Obu-shi and Higashiura-cho, Aichi Prefecture, Japan. They have been followed up every 2 years from the first study-wave (November 1997 - April 2000), second study-wave (April 2000 - May 2002), third study-wave (May 2002 - May 2004), fourth study-wave (June 2004 - July 2006), fifth study-wave (July 2006 - July 2008), sixth study-wave (July 2008 - July 2010), and seventh study-wave (July 2010 - July 2012). Each study-wave was conducted biennially; the total length of the first through seventh waves was 15 years. However, in individuals, the entire follow-up period was 12 years.

When participants could not be followed up (e.g., they moved to another area, dropped out for personal reasons, or died), new age- and sex-matched participants were randomly recruited. All study-waves included nearly 1200 men and 1200 women. In this study, we selected participants who participated in the first study-wave (n=2,267; age range, 40-79 years) and also participated in at least one study-wave from the second to seventh study-wave (n=1,919), as variables could be followed up at least one time from the second study-wave. Those who did not complete nutritional, height, and weight assessments in any study-wave (n=118) were excluded. Thus, a total of 1,801 Japanese (922 men, 879 women) who were between 40 and 79 years in the first study-wave of the NILS-LSA were available for analysis. To simplify the analysis, age at first participation was used in all analyses.

Written informed consent was obtained from all participants. The Ethics Committee of the National Center for Geriatrics and Gerontology approved all procedures of the NILS-LSA.

Nutritional assessments

Nutritional intake was assessed using a 3-day dietary record in all study-wave surveys. The dietary record was completed over 3 continuous days (both 2 weekdays and 1 weekend day) (10), and most participants completed it at home and returned records within 1 month. Food was weighed separately on a scale (1-kg kitchen scales; Sekisui Jushi, Tokyo, Japan) before being cooked or portion sizes were estimated. Participants used a disposable camera (27 shots; Fuji Film, Tokyo, Japan) to take photos of meals before and after eating. Dietitians used these photos to complete missing data and telephoned participants to resolve any discrepancies or obtain further information when necessary. Averages for 3-day food and nutrient intake (including alcohol intake) were calculated according to the Standard Tables of Foods Composition in Japan 2010 and other sources (10, 11). Mean energy intake (kcal/day) calculated from the 3-day dietary record was used in this study.

Other measurements

Weight and height were measured under a fasting state (around 9-10 am) to the nearest 0.1 kg and 0.1 cm, respectively, with participants wearing light clothing and no shoes. BMI was calculated as weight (kg)/height (meters)^2 (kg/m^2). Physical activity was assessed by the METs score (a multiple of the resting metabolic rate), with participants interviewed by trained interviewers using a semi-quantitative assessment method to assess participants' levels of habitual physical activity during leisure time, on the job, and sleeping hours (12).

History of heart disease, stroke, hypertension, hyperlipidemia, and diabetes (past and current), education (years of school), and smoking status (yes/no) were collected using self-reported questionnaires. These measurements were assessed in the first study-wave. Follow-up time (year) was calculated by the length of time (days) that has elapsed since the day each participant entered the first study-wave.

Statistical analyses

All statistical analyses were conducted using Statistical Analysis System (SAS) software version 9.3 (SAS Institute, Cary, NC, USA) and were done separately by sex.

For analyses of repeated measures of energy intake and weight, the mixed-effects model (Proc Mixed) was used. This method is a generalized form of linear regression analysis that allows for repeated measures on each participant while accounting for the considerable variation across participants in overall average energy intake and weight. To estimate the fixed effects on energy intake and weight by follow-up time, age and the interaction of follow-up time × age were substituted into the model. We also included the individual deviation from the fixed effects as random effects. In addition, general linear mixed models can handle missing data; therefore we can use all variable data during follow up.

Linear changes in energy intake and weight for 12 years by age were estimated according to the slope of energy intake and weight, and the intercept based on the mixed-effects model.

In supplementary analyses, we estimated linear changes in BMI and physical activity for 12 years by age at first participation in the same manner as in the main analysis.

All reported P values were two-sided. A P value less than 0.05 was considered statistically significant, and a P value less than 0.1 was considered marginally statistically significant.

Results

Mean (SD, range) follow-up time and number of study-wave visits in participants were 9.5 (3.7, 1.9-13.6) years and 5.4 (1.8, 2-7) times, respectively.

Characteristics and nutrient intake at first participation are shown in Table 1. Mean age of study participants was 58.6 (10.5) years for men and 57.8 (10.5) years for women. Average energy intake was 2346.6 (408.1) kcal/day in men and 1913.2 (318.3) kcal/day in women, respectively.

Table 1
Characteristics and nutrient intakes at first participation

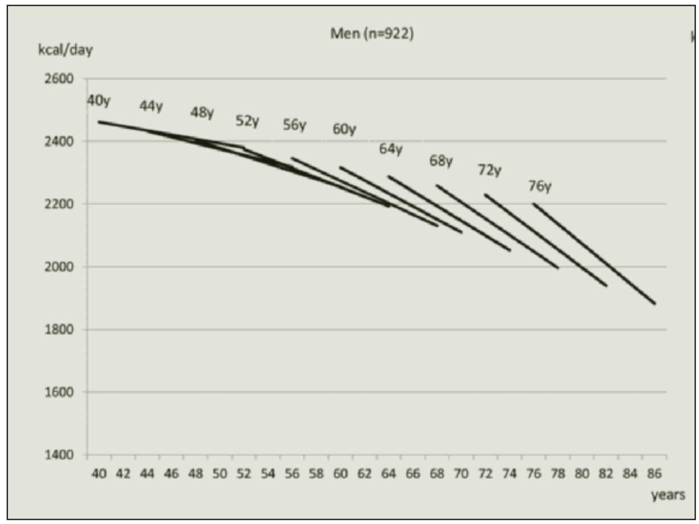
	Men (n=922) Mean ± SD	Women (n=879) Mean ± SD
Age (years)	58.6 ± 10.5	57.8 ± 10.5
Body mass index (kg/m^2)	23.1 ± 2.8	22.9 ± 3.2
Nutrient intakes		
Energy (kcal/day)	2346.6 ± 408.1	1913.2 ± 318.3
Protein (g/day)	88.2 ± 17.1	74.4 ± 14.8
Fat (g/day)	60.9 ± 17.3	54.1 ± 15.3
Carbohydrates (g/day)	325.8 ± 66.2	274.4 ± 51.3
Alcohol (g/day)	16.6 ± 19.2	2.9 ± 5.9
Physical activity (1000 METs*min/y)	1915.4 ± 246.8	2005.8 ± 190.4
Education (years)	12.2 ± 2.5	11.5 ± 2.1
Smoking status, n (%)		
Current	332 (36.0)	61 (7.0)
Former	381 (41.3)	26 (2.9)
Never	209 (22.7)	792 (91.1)
Clinical history, n (%)		
Heart disease	56 (6.1)	36 (4.1)
Stroke	16 (1.7)	5 (0.6)
Hypertension	162 (17.6)	147 (16.7)
Hyperlipidemia	51 (5.5)	68 (7.7)
Diabetes	61 (6.6)	28 (3.2)

SD, standard deviation.

The mixed-effects model of the fixed effects of energy intake and weight for 12 years are shown in Table 2. The fixed effect of age, time, and the interaction of age and time on energy intake and weight was statistically significant in men. In women, the fixed effect of age, time, and the interaction of age and time was statistically significant only for weight.

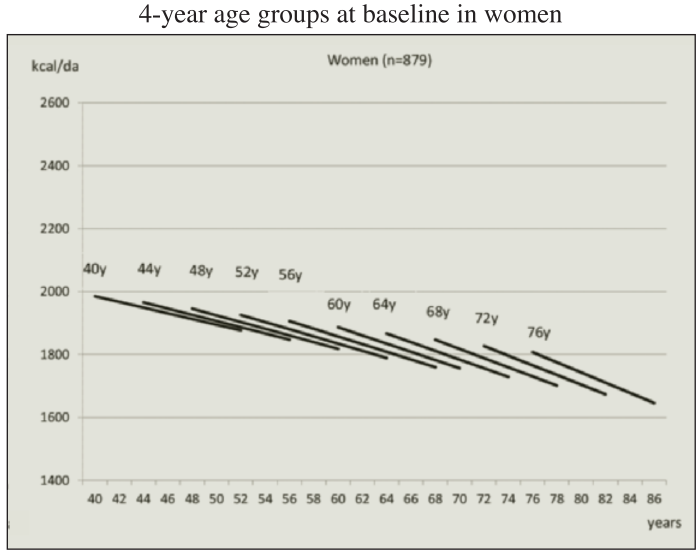
The fixed effect of the interaction of age and time in energy intake was statistically significant in men (p<0.001) and marginally statistically significant in women (p=0.057). Therefore, the slope of energy intake was different by age at baseline. When we estimated the slope of energy intake according to age at baseline, energy intake decreased over 12 years in both sexes and all ages (men: 40-year slope=-6.8 kcal/year, p<0.001, 79-year slope=-33.8 kcal/year, p<0.001; women: 40-year slope=-9.1 kcal/year, p<0.001, 79-year slope=-16.7 kcal/year, p<0.001). To simplify the illustration, we showed estimated linear changes in energy intake for 12 years using 4-year age groups at baseline (40, 44, 48, 52, 56, 60, 64, 68, 72, 76 years) in Figure 1-1 (men) and Figure 1-2 (women). In men, the slopes of energy intake gradually decreased with age, that is, -6.8, -9.5, -12.3, -15.1, -17.9, -20.5, -23.4, -26.2, -29.0, and –31.7 kcal/year at 40, 44, 48, 52, 56, 60, 64, 68, 72, and 76 years, respectively, when energy intake was estimated according to age. In women, the slopes of energy intake slightly decreased with age; values were -9.1, -9.8, -10.6, -11.4, -12.2, -13.0, -13.8, -14.6, -15.4, and -16.1 kcal/year among 40, 44, 48, 52, 56, 60, 64, 68, 72, and 76 years, respectively, in the same manner.

Figure 1-1
Estimated linear changes in energy intake for 12 years[a] by 4-year age groups at baseline in men



Solid line represents a significant slope (p<0.05); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves

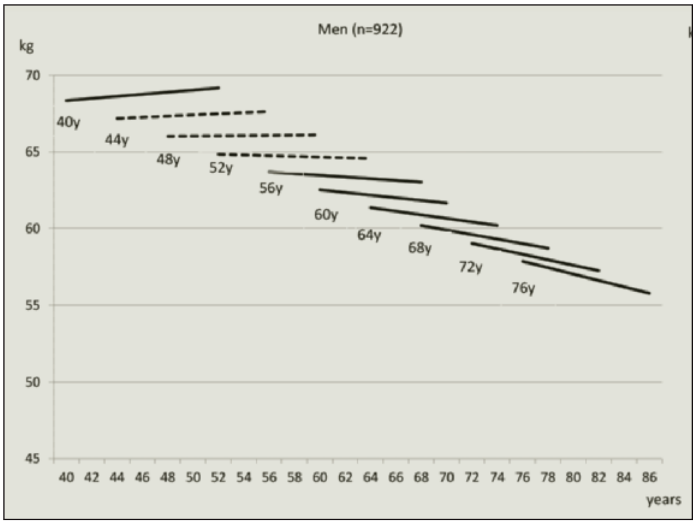
Figure 1-2
Estimated linear changes in energy intake for 12 years[a] by 4-year age groups at baseline in women



Solid line represents a significant slope (p<0.05); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves

Figure 2-1

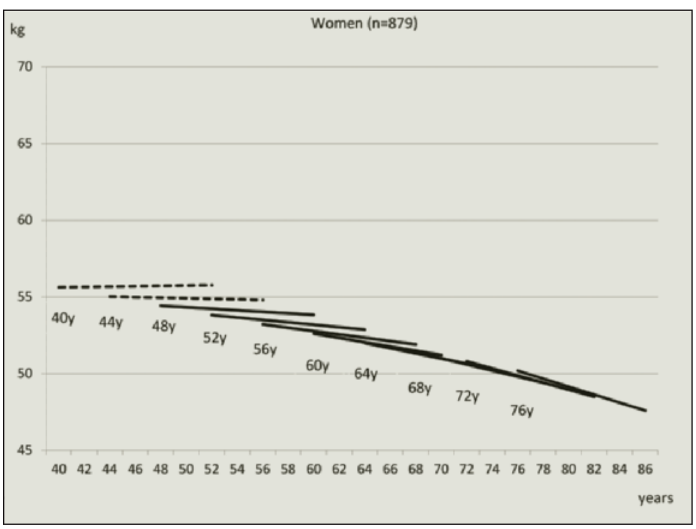
Estimated linear changes in weight for 12 years[a] by 4-year age groups at baseline in men



Solid line represents a significant slope (p<0.05); Dashed line represents a non-significant slope (p = NS); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves

Figure 2-2

Estimated linear changes in weight for 12 years[a] by 4-year age groups at baseline in women



Solid line represents a significant slope (p<0.05); Dashed line represents a non-significant slope (p = NS); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves

The fixed effect of the interaction of age and time on weight was statistically significant both in men and women (p<0.001). Therefore, the slope of weight differed by age at baseline. When we estimated the slope of weight according to age at baseline, weight among men aged 40 to 42 years increased (40-year slope=0.07 kg/year, p=0.02, 42-year slope=0.05 kg/year, p=0.04); on the other hand, the slope of weight among men aged 53 to 79 years and women aged 47 to 79 years decreased (men: 53-year slope=-0.03 kg/year, p=0.04, 79-year slope= -0.23 kg/year, p<0.001; women: 47-year slope=-0.04 kg/year, p=0.02, 79-year slope=-0.28 kg/year, p<0.001). To simplify the illustration, we showed estimated linear changes in weight for 12 years using 4-year age groups at baseline in Figure 2-1 (men) and Figure 2-2 (women).

The mixed-effects model of the fixed effects of BMI and physical activity for 12 years are shown in Supplementary Table 1. The fixed effect of the interaction of age and time on BMI was statistically significant both in men and women (p<0.01). When we estimated the slope of BMI according to age at baseline, the slope of BMI among men aged 40 to 46 years increased, whereas the slope of BMI among men aged 63 to 79 years decreased (40-year slope=0.03 kg/m^2/year, p=0.01; 46-year slope=0.02 kg/m^2/year, p=0.04; 63-year slope=-0.01 kg/m^2/year, p=0.04; 79-year slope= -0.04 kg/m^2/year, p=0.002) (Supplementary Figure 1-1). In women, baseline BMI was higher among older women, although the fixed effect of age on BMI was not statistically significant (p=0.143, Table 2). In women, the slope of BMI between 53 to 79 years decreased (53-year slope=-0.01 kg/m^2/year, p=0.03; 79-year slope=-0.05 kg/m^2/year, p<0.001) (Supplementary Figure 1-2).

The fixed effect of age, time, and the interaction of age and time on physical activity was statistically significant in men. When we estimated the slope of physical activity according to age at baseline, physical activity among men aged 46 to 79 years and women aged 40 to 79 years decreased (men: 46-year slope= -2.5 1000 METs*min/y, p=0.02, 79-year slope= -13.0 1000 METs*min/y, p<0.001; women: 40-year slope= -4.9 1000 METs*min/y, p<0.001, 79-year slope=-10.0 1000 METs*min/y, p<0.001) (Supplementary Figure 2-1 in men, and Supplementary Figure 2-2 in women).

Discussion

Twelve-year longitudinal data showed that 1) energy intake declined in both men and women from their 40s to 70s, and the decline got larger for men in older age groups, 2) weight increased in men aged 40 to 42 years and started to decline around 53 years, and weight in women started to decline around 47 years.

Energy intake declined from 6.8 to 33.8 kcal/year in men from their 40s to 70s and from 9.1 to 16.7 kcal/year in women from their 40s to 70s. In previous reports, total energy intake was reported to decrease with age (1-3): 16 kcal/year among New Zealand non-institutionalized men and women aged 70 and older (13); 20 kcal/year or 23 kcal/year among men living in the United States aged 57-67 years (2) or 70-74 years (14); and 10 kcal/year in healthy American men and 11 kcal/year in healthy American women (median age 72 years) (3). The degree of reduction has been shown to be higher in men than women (15). In our study, energy intake decreased around 30 kcal/year in men and 15 kcal/year in women Japanese participants in their 70s, and results were relatively consistent

Table 2
Mixed-effects model of fixed effects of energy intake and weight for 12 years[a]

Variables	Energy intake (kcal/day)		Weight (kg)	
	β ± SE	p	β ± SE	p
Men (n=922)				
Age[b]	-7.249 ± 1.143	<.0001	-0.291 ± -0.291	<.0001
Time[c]	20.957 ± 7.462	0.005	0.377 ± 0.377	<.0001
Age*Time	-0.693 ± 0.130	<.0001	-0.008 ± -0.008	<.0001
Women (n=879)				
Age[b]	-4.939 ± 0.913	<.0001	-0.151 ± 0.026	<.0001
Time[c]	-1.173 ± 5.821	0.840	0.314 ± 0.078	<.0001
Age*Time	-0.197 ± 0.104	0.057	-0.008 ± 0.001	<.0001

a. Twelve years was the entire follow-up period of individuals from the first to seventh study-waves; b. Age (year) at first participation; c. Time (year) from baseline.

with previous studies in Caucasians (2, 3, 15). Energy intake is mainly determined by physical activity, and we estimated linear changes in energy intake for 12 years by age while considering physical activity in the mixed effect model (data not shown). For both men and women, physical activity was positively associated with weight (men: β= 0.16 kg/1000 METs*min/y, p<.0001, women: β=0.097 kg/1000 METs*min/y, p=0.0006), but the trend of energy intake with aging was consistent in the main analyses. Therefore, energy intake declined both in men and women independent of physical activity.

In men, weight increased in their early or mid-40s and started to decline in their middle 50s. The proportion of overweight and obese men (BMI ≥25.0 kg/m^2) was 29.1% in the annual National Nutrition Survey in Japan (16). Recent surveys indicated the peak of overweight and obese prevalence was around in the 40s and 50s in men (17). These surveys were cross-sectional, but the peak trends among men were consistent with findings in this study. Obesity among middle-aged men is a focus of public health in Japan to reduce the incidence of metabolic syndrome (visceral fat syndrome) (18). However, when we focus on underweight in the elderly to extend the life-span, we identified a starting point for weight loss of around 53 years in men (-0.032 kg/year, slope p=0.04).

On the other hand, weight started to decline in women at around 47 years (-0.041 kg/year, slope p=0.02), which is earlier than in men. In free-living Australian women aged 70-85 years, 1.9 kg of weight was lost over 7 years (0.27 kg/years) (19). These results were comparable to women in our study who showed a loss of -0.21 and -0.28 kg/year at 70 years and 79 years, respectively. Despite the constant energy intake and physical activity decrease in their early 40s, weight decreases did not start until 47 years. Although the precise mechanism for this finding is unknown, considering that the mean age of menopause among Japanese women is 50.5 years (20) and the mean (SD) menopause age in the NILS-LSA at the 7th study-wave was 49.6 (4.5) years (9), food intake, calorie consumption, and physical activity might be unaffected by menopause, but body composition such as fat or muscle may change during perimenopause.

In weight loss intervention programs with moderate dietary energy restriction and aerobic and strength exercise training for older obese women, both lean soft tissue mass and body fat mass were lost, though strength and leg muscle quality were improved (21). Therefore, it might be important to interpret our results of weight loss considering energy intake, physical activity, body composition, and muscle quality. To eliminate the effects of energy intake, physical activity, and body composition on weight, we estimated linear changes in weight for 12 years by age considering energy intake, physical activity, and appendicular skeletal mass in the mixed effect model (data not shown). For both men and women, energy intake was positively associated with weight (men: β=0.0004 kg/kcal, p=0.006; women: β=0.0009 kg/kcal, p<.0001). On the other hand, physical activity was negatively associated with weight (men: β=-0.0012 kg/1000 METs*min/y, p<.0001; women: β=-0.0012 kg/1000 METs*min/y, p<.0001). Appendicular skeletal mass was not associated with weight in either men or women. Therefore, weight in our study would be determined by energy intake and physical activity rather than by body composition.

The baseline BMI trend in women was different from trends for energy intake and weight, with older women having a slightly higher BMI. In addition, BMI declined at around 53 years in women. Thinness among young Japanese women is a serious health concern in Japan (22), and our results also indicate that BMI was lower in the young cohort. The future prevalence of female thinness or underweight in Japan may increase if this trend continues.

BMI reduction started after weight reduction both in men and women. This discrepancy might be caused by height loss. To identify height changes, we estimated linear changes in height for 12 years by age at first participation in the same manner as in the main analysis. A loss of height began in men at age 41 and in women at age 42; the slope of height was -0.01

to -0.17 cm/year among men aged 41 to 79 years, and -0.02 to -0.25 cm/year among women aged 42 to 79 years. Therefore, BMI assessments might be less useful to compare individual changes in participants after their 40s.

Our study had several limitations. First, we assessed energy intake using 3-day dietary records with photographs. Although the 3-day dietary record is one of the best ways to assess individual food intake (10), it is difficult for men or the elderly to do this. However, more than half of the male or elderly participants in this study asked a spouse, child, or daughter-in-law who usually cooked to record their dietary intake. Therefore, the reliability of dietary records might be maintained even in the men or elderly.

Second, 3-day dietary records might be too short a period to assess energy intake. Considering the within- and between-individual variations in energy intake, 20 days for men aged 50-76 years and 14 days for women aged 50-69 years were required to ensure a specified correlation coefficient (r=0.95) between observed and usual (true) mean intake of energy intake among Japanese (23). That study also reported that the correlation coefficient for 3-day dietary records was r=0.75 in men and r=0.80 in women (23). Thus energy intake over 3 days may be adequate. The dietary study protocol has not changed from the baseline study, and most of the trained registered dietitians remain on board. In addition, these dietitians meet twice a month to adjust for differences of dietary coding based on a 3-day dietary record from the baseline survey. As a result, our records may be suitable to examine individual changes in food intake.

Third, energy intake decreased even in men and women aged 40 years at baseline. Further studies are needed to identify the starting point of energy intake decline in Japanese.

The main strengths of the present study are as follows: First, trends of energy intake and weight were assessed longitudinally. Second, trends of these variables were analyzed by age at first participation. Food consumption and BMI among Japanese have changed during the past few decades (24, 25). In addition, age or birth cohort differences in diet or BMI have been reported (24, 26). Therefore, it is essential to examine data separated by age (birth cohort) to understand trends in energy intake among Japanese participants. To the best of our knowledge, there are no longitudinal studies that assess energy intake according birth cohort group. Third, a recent Swedish study indicated there were large individual differences in energy intake among elderly (27), but we considered the individual differences as random effects in our mixed-effects model. Finally, the average dietary intake for participants younger than 70 years in the present study was similar to the National Nutrition Survey in Japan (28). Therefore the present results may be more applicable in non-institutionalized, community-dwelling, middle-aged and elderly participants.

Furthermore, the recent "DRIs 2015" in Japan indicated that it could not identify a reference for nutrient intake, including energy intake, among participants older than 70 years (7). The "DRIs 2015" recommend that nutritional professionals use weight variability to assess energy intake adequacy for elderly Japanese. Our results could contribute to the establishment of fundamental descriptive data not only for free-living Japanese elderly but also worldwide public nutrition in the elderly.

Conclusions

Twelve-year longitudinal data showed energy intake declined both in men and women in their 40s, and the rate of decrease was larger in older males. Weight in men increased in their early 40s and started to decline in the middle 50s. In women, a decline was noted in the late 40s. Further studies that focus on energy intake and weight reduction with aging are needed to prevent weight loss or underweight in an increasingly aging society.

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Conflicts of interest: All authors declare no conflict of interest.

Ethics Statement: The NILS-LSA followed the principles of the Declaration of Helsinki and the Ethical Guidelines for Epidemiological Research in Japan. The study was approved by the Ethics Committee of the National Center for Geriatrics and Gerontology (No. 369-2). Written informed consent was obtained from all participants.

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Supplementary Table 1

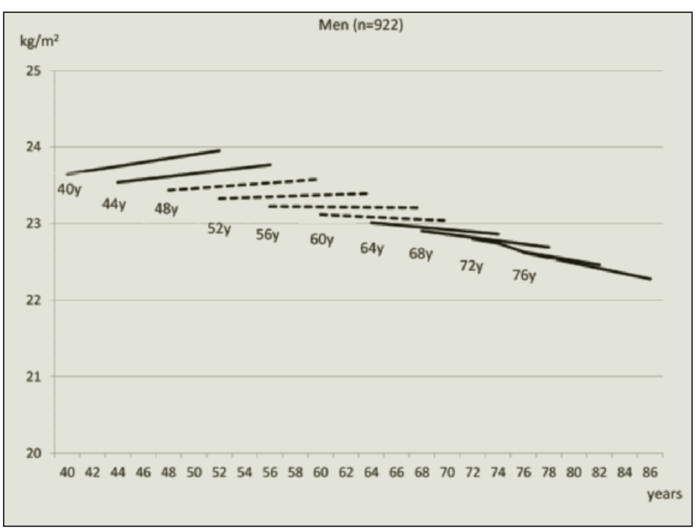
Mixed-effects model of fixed effects of body mass index (BMI) and physical activity for 12 years[a]

Variables	BMI (kg/m^2)		Physical activity (1000 METs*min/y)	
	β ± SE	p	β ± SE	p
Men (n=922)				
Age[b]	-0.026 ± 0.009	0.002	-4.372 ± 0.675	<.0001
Time[c]	0.093 ± 0.031	0.003	12.105 ± 4.414	0.006
Age*Time	-0.002 ± 0.001	0.002	-0.318 ± 0.077	<.0001
Women (n=879)				
Age[b]	0.015 ± 0.010	0.143	-5.221 ± 0.492	<.0001
Time[c]	0.070 ± 0.033	0.037	0.343 ± 3.109	0.912
Age*Time	-0.002 ± 0.001	0.008	-0.130 ± 0.055	0.018

a. Twelve years was the entire follow-up period of individuals from the first to seventh study-waves. b. Age (year) at first participation; c. Time (year) from baseline.

Supplementary Figure 1-1

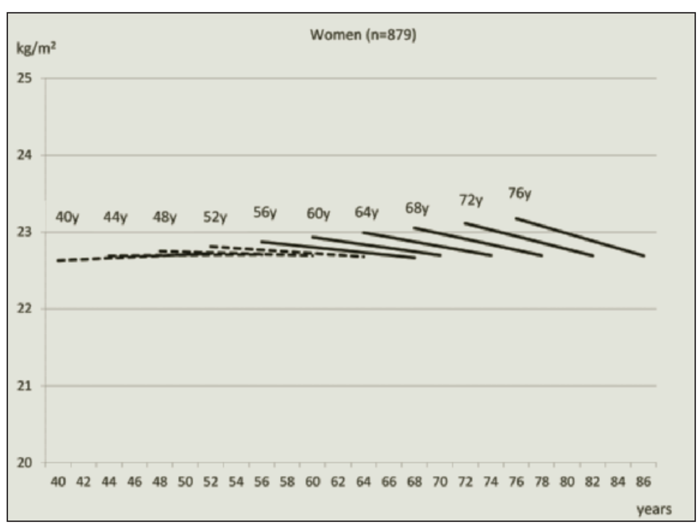
Estimated linear changes in body mass index (BMI) for 12 years[a] by 4-year age groups at baseline in men



Solid line represents a significant slope (p<0.05); Dashed line represents a non-ignificant slope (p = NS); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves

Supplementary Figure 1-2

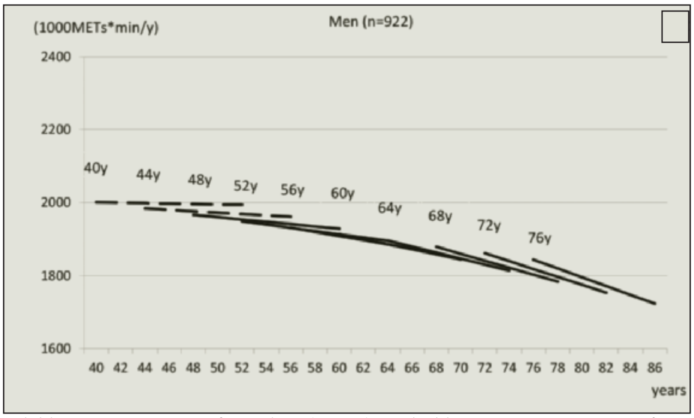
Estimated linear changes in body mass index (BMI) for 12 years[a] by 4-year age groups at baseline in women



Solid line represents a significant slope (p<0.05); Dashed line represents a non-ignificant slope (p = NS); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves

Supplementary Figure 2-1

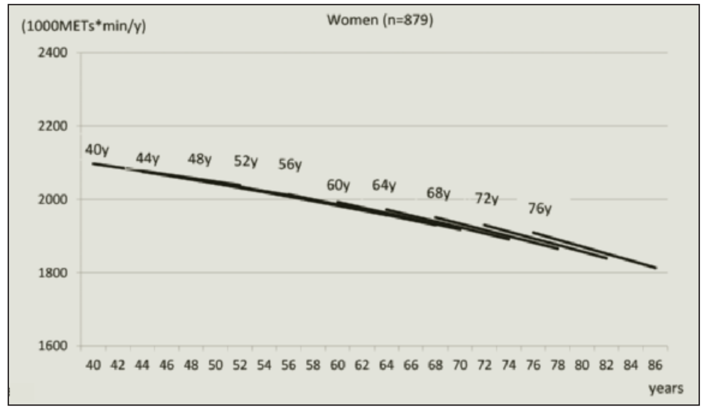
Estimated linear changes in physical activity for 12 years[a] by 4-year age groups at baseline in men



Solid line represents a significant slope (p<0.05); Dashed line represents a non-significant slope (p= NS); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves.

Supplementary Figure 2-2

Estimated linear changes in physical activity for 12 years[a] by 4-year age groups at baseline in woemn



Solid line represents a significant slope (p<0.05); Dashed line represents a non-significant slope (p= NS); a. Twelve years was the entire follow-up period in individuals from first to seventh study-waves.