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Self-Reported Energy Intake and Energy Expenditure in Elderly Women

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The elderly are a growing population; however, limited information concerning energy requirements of the elderly is available. Dietary intake data have been collected in research and clinical settings to determine the intakes of energy and nutrients, but the accuracy of dietary intake data has been difficult to verify. Studies using doubly labeled water have suggested that dietary energy intake is underreported by obese subjects (1), adolescents (2), and athletes (3). Diet records were collected for 6 to 14 days in these studies (1), (2), (3). Elderly subjects have also underreported energy intake compared with total energy expenditure (TEE), either measured (4), (5), (6) or predicted (7). However, these studies only collected dietary data for 3 or 4 days, while energy expenditure was measured for 10 to 14 days using doubly labeled water. It is generally accepted that a major source of random variation in dietary energy can be ascribed to a person's day-to-day variation in energy consumption, which averages 20% to 30% (8). This random variation decreases as the square root of the number of study days increases, such that it is approximately 10% for a 7-day record (9). Thus, some of the variability in self-reported energy intake may be attributable to the limited number of observations taken in previous studies of elderly women. To our knowledge, a comparison of TEE using doubly labeled water and concurrent diet records for a full week for elderly women has not been reported previously. The purpose of our study was to determine whether a complete recording of dietary intake would improve the accuracy of and reduce the individual variation in self-reported dietary energy intake compared with energy expenditure measurements using doubly labeled water.

Subjects and Methods

Eight apparently healthy, weight-stable, elderly women living in the surroundings of Champaign, Ill, were recruited (Table 1). All were nonsmokers and did not use any medication known to influence energy expenditure. The study was approved by the University of Illinois, Champaign, and all subjects signed an informed consent form.

Table 1. Physical characteristics of subjects

Subject no.	**Age (y)**	**Height (cm)**	**Weight (kg)**	**Fat-free mass[a](kg)**	**Fat mass[a](kg)**
1	63	155	68.4	39.1	29.3
2	67	152	55.4	37.9	17.5
3	65	158	53.6	35.1	18.4
4	70	168	77.0	50.9	26.1
5	66	144	61.7	39.6	22.1
6	80	150	57.6	37.4	20.2
7	71	163	76.1	44.0	32.0
8	61	165	69.3	38.1	31.2
Mean±SD[b]	68±5	157±7	64.9±8.6	40.3±5.0	24.6±5.8

[a]Values determined using total body water from isotope dilution.
[b]SD=standard deviation.

After an overnight fast, subjects provided a baseline urine sample and were given an oral loading dose of doubly labeled water (10% $H_2^{18}O$ [Isotec Inc, Miamisburg, Ohio] mixed with 99.8% deuterium oxide [Sigma Chemical, St Louis, Mo]). Doses were 0.3 g $H_2^{18}O$ and 0.12 g deuterium oxide per kg total body water as estimated from body weight. Urine samples were collected 3 and 6 hours after dosing, and a registered dietitian instructed subjects on how to record their dietary intake. During the next 7 days, an investigator arrived at each subject's home every morning to collect a urine sample and review the subject's diet record. Subjects recorded their food intake using standard household measures, such as cups, teaspoons, weights provided from packaged goods' labels, and the number of whole items, such as fruits. In addition, the diet record was carefully reviewed with the subject each day to avoid underreporting after 3 or 4 days (10).

Urine samples were analyzed in triplicate for deuterium oxide on a stable isotope ratio mass spectrometer (Finnigan MAT delta S, Bremen, Germany) by zinc reduction (11). Samples were analyzed for $H_2^{18}O$ by carbon dioxide equilibration (12). Dilution spaces for $H_2^{18}O$ and deuterium oxide were calculated using equation 2 devised by Goran and Poehlman (4). Fat mass and fat-free mass were estimated from total body water calculated from both dilution spaces. Carbon dioxide production rate was calculated as described by Schoeller et al (13). Oxygen consumption was derived by dividing the carbon dioxide production rate by the food quotient, derived from the composition of the diet on an individual basis using the equations of Black et al (14). TEE was calculated using equation 12 devised by de Weir (15). Energy and macronutrient content of the 7-day diet record were assessed using nutrition analysis software (Nutritionist III, version 4.0, 1987, N-Squared Computing, Salem, Ore).

Results and Discussion

Body weight measured at the beginning and end of the 7 days was unchanged, with values (mean±standard deviation) of 68.4±8.6 kg and 68.1±8.4 kg, respectively. Table 2 shows the results of self-reported energy intake and TEE measured during 7 days with doubly labeled water. There was a strong association between the 2 measures (r=.77, P<.05), although a negative bias was observed.

Table 2. Individual isotope turnover rates, energy expenditure, and energy intake for 7 days

Subject no.	**K_O[a]**	**K_H[a]**	**r_{co2}[b]**	**FQ[c]**	**Energy expenditure (kcal/d)**	**Energy intake[d] (kcal/d)**	**Difference, %**
1	0.104	0.078	18.57	0.880	1,888	1,698	10.06
2	0.126	0.103	15.10	0.834	1,625	1,496	7.94
3	0.134	0.106	16.97	0.876	1,735	1,571	9.45
4	0.133	0.115	14.56	0.887	1,474	1,324	10.18
5	0.098	0.076	15.91	0.883	1,616	1,740	−7.67
6	0.145	0.123	14.63	0.834	1,574	1,531	2.73
7	0.125	0.099	20.14	0.850	2,118	1,719	18.84
8	0.107	0.078	20.48	0.821	2,227	1,712	23.12
Mean±SD[e]	0.122±0.016	0.097±0.017	17.00±2.3	0.858±0.025	1,782±253	1,599±136[f]	9.33±9.39

[a]Isotope elimination rates were calculated using the 2-point method $[1n(E_{final})-1n(E_{initial})]/d$. K_O=oxygen-18 isotope elimination rate. K_H=deuterium isotope elimination rate.
[b]Carbon dioxide production rate was calculated as described by Schoeller et al (13). r_{co2}=carbon dioxide elimination rate.
[c]Food quotient (FQ) was calculated on an individual basis from the composition of the diet as described by Black et al (14).
[d]Values determined using a 7-day diet record.
[e]SD=standard deviation.
[f]Significantly lower than energy expenditure (P<.05).

Previous studies have suggested that free-living elderly women underreport energy intake compared with TEE. Goran and Poehlman (4), Reilly et al (6), and Visser et al (16), have reported energy intake values (mean±standard deviation) that were 68±18%, 74±17%, and 88±26% of TEE, respectively. These studies used 3-day diet records (4), (6) or a diet history (16) to obtain energy intake values. The results of our study are in agreement with these previous studies in showing that reported energy intake was significantly lower (P<.05) than TEE. However, unlike these previous studies, subjects in our study reported energy intake for 7 days, which resulted in a lower variation among individuals than reported in earlier studies.

Schoeller (9) suggests that in weight-stable persons, the doubly labeled water method can be used as a reference method for validation of dietary energy intake, assuming a coefficient of variation for energy expenditure of 9%. Assuming a coefficient of variation for energy intake of 10% for a 7-day period (9), the coefficient of variation for comparison of the 2 measures should be about 13%. This value is similar to the coefficient of variation found in our study (9%).

Application

The results of our study show that self-reporting dietary intake for 7 days reduces the coefficient of variation of reported intake among subjects, but does not eliminate the negative bias in comparison with doubly labeled water shown in previous studies that used 3- to 4-day diet records. Thus, dietary intakes of elderly women must be interpreted with caution, even when longer periods of data collection are used, and even when diet records are monitored on a daily basis. Further studies, which may make it possible to improve the design of dietary intake instruments, are warranted to identify the causes of low estimates of energy intake. ■

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