

## Characteristics and Nutritional Status of Elders Who Under-report Intakes on 24 Hour Recalls in USA

Seung-Hee Kye<sup>†</sup>

Nutrition Research Team, Department of Food Industry, Korea Health Industry Development Institute, Seoul, Korea

### ABSTRACT

The objectives of this study were to determine whether older Americans would provide valid energy intake information using a 24-hr recall method and to determine which characteristics were predictive of under-report of energy intake. We conducted 24-hour recalls on 83 male and 105 female community-dwelling older adults (66–87y) in the USA to assess energy (EI) and nutrient intakes. Basal metabolic rate (BMR) was calculated from age- and gender-specific equations of Schofield. Under-reporting was defined *a priori* as  $EI : BMR < 0.9$ . Subjects volunteered demographic information, underwent depression and cognition exams, and completed a Level II Nutrition Risk Screen. Differences between under- and adequate-reporters were assessed using t-tests for characteristics and macro-nutrient profile. Stepwise regression analyses were used to predict under-reporting status. Under-reporting of EI occurred in 34% of the sample. Neither geriatric depression scale (GDS) score, nor self-reported weight loss were related to under-reporting. On average, under-reporters had higher body mass indices. The most significant variables for the main effect to predict the ratio of energy intake to estimated basal metabolic rate ( $EI : BMR_{rest}$ ) were BMI and age. Using a standard cut-off of 76% of the recommended dietary allowances for Americans, under-reporters were consistently more likely to be classified as having inadequate nutrient, as well as energy, intakes. (*J Community Nutrition* 2(2) : 135~140, 2000)

**KEY WORDS** : under-reporting of energy · older adults in USA · EI : BMR · GDS · BMI.

---

### Introduction

---

The results of dietary surveys, whether limited in size or national in scope, constitute a database that strongly influences the accuracy of many important conclusions relating to nutritional status or to risk for certain diseases in populations or their subgroups (Mertz et al. 1991). One of the major obstacles in nutritional epidemiology research has been uncertainty about the validity of existing dietary assessment methodologies (Block 1982).

The doubly-labeled water method for measuring total daily energy expenditure can serve as a reference for assessing the accuracy of conventional dietary intake methodologies (Schoeller 1990). In general, recall and

record methods result in much lower energy intakes than do doubly-labeled water estimates of energy expenditure or supervised feeding to maintain body weight (Black et al. 1993 ; Mertz et al. 1991).

A number of studies have compared self-reported dietary energy intake with energy expenditure measured by the doubly-labeled water method in free-living subjects (Schoeller 1990 ; Bandini et al. 1990 ; Goran & Poehlman 1992 ; Singh & Prentice 1990 ; Lichtman et al. 1992). These studies confirmed that self-reported food intakes underestimated habitual energy intakes.

However, it is also possible that certain physiological characteristics may be predictors of the discrepancy between reported energy intake and total energy expenditure (Johnson et al. 1994). Elucidating these characteristics could be a meaningful step toward the application of correction factors to national dietary survey data to arrive at more accurate determinations of habitual energy intake in elderly people.

The doubly-labeled water method is too expensive and technically demanding to be used as a validator

---

<sup>†</sup>Corresponding author : Seung-Hee Kye, Nutrition Research Team, Department of Food Industry, Korea Health Improvement Development Institute, 57-1 Nolyangjin-Dong, Dongjac-Gu, Seoul 156-050, Korea  
Tel : 02) 2194-7430, Fax : 02) 823-9542  
E-mail : shkye@khidi.or.kr

of energy intake measurements in large samples. Thus, we predicted total daily energy expenditure from an equation by Schofield (Schofield 1985). The objectives of this study were to determine whether older Americans would provide valid energy intake information using 24-hr recall method and to determine which characteristics were predictive of under-reporting of energy intake.

---

## Subjects and Methods

---

### 1. Subjects

105 females and 83 males' age 60 years or older' residing within 100 miles of Geisinger Medical Center in Danville, Pennsylvania State were recruited using a computer-based random selection process. All subjects were Medicare risk enrollees.

### 2. Study variables

Subject characteristics such as age, marital status, and education, dietary data, anthropometric data, and cognitive evaluation using the geriatric depression scale (GDS) and mini mental exam (MME) were obtained by all subjects.

### 3. Anthropometric measures, depression and cognitive evaluation

Height (cm) was measured using a portable metric rule and weight (kg) with a portable self-zeroing scale during home visits. Body mass index ( $\text{kg}/\text{m}^2$ ) was then calculated.

The geriatric depression scale (GDS) and mini mental status exam (MMSE) were conducted on all subjects during home visits to help determine the existence of depression and cognitive status respectively. The number of "wrong" answers from the 15 questions in the GDS were added up. After all questions of the MMSE had been answered, the scores from "correct" answers were added. The maximum score was 30 points. Participants were excluded if the MMSE results indicated cognitive impairment ( $\text{MMSE} \leq 23$ ) or the GDS score suggested clinical depression ( $\text{GDS} \geq 6$ ).

### 4. Twenty four-hour recall by telephone and level II nutrition risk screen

Within 1 month of the home visit, telephone interviews to administer random 24-hour recalls and the

Level II Nutrition Risk Screen were conducted by the Diet Assessment Center at Pennsylvania State University in Pennsylvania. The interviews were conducted by a registered dietitian or a senior undergraduate dietetics student, all of whom had experience. Both interviewers and subjects used a poster depicting a two-dimensional visual (Nutrition Consulting Enterprises, Framingham, MA). The Level II Risk Nutrition Screen includes detailed questions regarding weight change, dietary habit, living environment, and functional status.

### 5. Estimation of energy requirements

To evaluate under-reporting of dietary intake, we used body weight measured to estimate the ratio of the reported energy intake (EI) to the estimated basal metabolic rate (BMR<sub>est</sub>), using age- and gender-specific formulas derived by Schofield (1985).

$$\begin{aligned} \text{M} & [0.038 * \text{Weight}(\text{kg})] + [4.068 * \text{Height}(\text{m})] - 3.491 \\ \text{F} & [0.033 * \text{Weight}(\text{kg})] + [1.917 * \text{Height}(\text{m})] - 0.074 \end{aligned}$$

The cutoff value of 0.9 was used to classify individuals on the basis of 1-day of intake (Goldberg et al. 1991). Participants with an  $\text{EI} : \text{BMR}_{\text{est}} < 0.9$  were considered to be under-reporters whereas those with an  $\text{EI} : \text{BMR}_{\text{est}} \geq 0.9$  were considered to be adequate reporters.

### 6. Data analyses

Dietary data were analyzed using Minnesota Nutrient Data System (NDS) software (Food Database 8A, Nutrient Database 20) developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN. Macronutrient intakes were analyzed as the percent of calories from protein, fat, carbohydrates, and alcohol. Micronutrient intakes were analyzed as the percent of individuals with inadequate intake ( $< 76\%$  of recommended intakes).

Statistical analyses were performed using SAS version 6.0 software (Cary, NC). T-tests were used to compare the differences between adequate- and under-reporters for characteristics and macronutrients. Spearman correlation coefficients were calculated to identify relationships among subject characteristics. Cross-tabulation tables were examined with a  $\chi^2$  statistic to compare the difference of percent  $< 76\%$  of RDA between adequate- and under-reporters for micronutrients.

Stepwise regression analyses were performed to predict the energy intake to estimated basal metabolic rate (EI : BMR<sub>est</sub>). Variables included in the models were age, marital status, education, GDS, weight gain or loss in the past 6 months, BMI, smoking, drinking alcohols, and MMSE results.

## Results

### 1. Characteristic of study

Characteristics of adequate- and under-reporters in energy intakes are shown in Table 1. Under-reporters were older than adequate-reporters. The percent who were married was higher in adequate-reporters than in under-reporters. Under-reporters were less well educated with fewer having graduated high school. Under-reporters had higher BMIs than adequate-reporters. However, there were no significant differences between under-reporters and adequate-reporters for each characteristics except BMI ( $p < 0.01$ ). The percent who had weight loss or gain of 10 or more pounds in the past 6 months were higher in under-reporters compared with adequate-reporters, respectively, but not significantly different.

Among under-reporters compared with adequate reporters, higher mean, which can be interpreted as the percent of the sample that responded positively, were following a special diet, having a poor appetite, and spending  $< \$25$ /week on food. However, there were no significant differences of the mean.

Under-reporters scored higher on the GDS, which is indicative of a higher level of depression. The MMSE score, which indicated impairment, was not different between under-reporters and adequate-reporters.

There were more under-reporters who currently use tobacco than adequate-reporters. The percentage of the group who drink  $> 2$  alcoholic beverages per day for men and  $> 1$  alcoholic beverages per day for women were higher in under-reporters compared with adequate-reporters. The number of respondents between under- and adequate-reporters did not differ significantly for current smoker and excessive alcohol use.

Age and GDS scores were inter-correlated (Table 2). Higher GDS scores were associated with older age.

**Table 1.** Characteristics of adequate- and under-reporters

	Adequate-reporters (n=123)		Under-reporters (n=65)	
	Mean	SD	Mean	SD
Gender(% male) <sup>1)</sup>	0.45	0.50	0.42	0.50
Age(years)	73.1	5.1	74.2	5.2
Marital status <sup>2)</sup>	1.75	0.44	1.62	0.49
Education <sup>3)</sup>	3.10	0.88	2.88	0.82
BMI <sup>4)</sup>	27.6	3.9	30.0	6.1
Recent weight loss <sup>1)</sup>	0.13	0.34	0.17	0.38
Recent weight gain <sup>1)</sup>	0.12	0.33	0.14	0.35
Polypharmacy <sup>1)</sup>	0.63	0.49	0.59	0.50
Has a poor appetite <sup>1)</sup>	0.02	0.16	0.06	0.24
Follows a special diet <sup>1)</sup>	0.15	0.36	0.20	0.40
Spends $< \$25$ /week on food <sup>1)</sup>	0.19	0.39	0.22	0.41
GDS score <sup>1)</sup>	1.05	1.19	1.17	1.18
MMSE score <sup>5)</sup>	28.5	1.50	28.1	1.70
Previous smoker <sup>1)</sup>	0.53	0.50	0.52	0.50
Current smoker <sup>1)</sup>	0.09	0.29	0.18	0.39
Excessive alcohol use <sup>1)</sup>	0.07	0.25	0.03	0.17

1) The mean can be interpreted as the percent of the sample that responded positively to this item

2) The mean of marital status reflects the percent who are married

3) Education is coded as 1=elementary school, 2=some H.S., 3=graduated H.S., 4=some college

4) Geriatric Depression Scale, scale 0-15,  $\geq 6$ =depression

5) Mini-Mental State Exam, scale 0-30,  $\leq 23$ =cognitive impairment

\*\* : Significantly different between adequate- and under-reporters at  $p < 0.01$

**Table 2.** Correlations among subject characteristics : Age, Education, BMI, MMSE score, and GDS : Pearson correlation coefficients

	Age	Education
BMI	-	-0.2126**
MMSE score	-	0.2291**
GDS score	0.2009**	-

\*\* :  $p < 0.01$

Education was intercorrelated with BMI and the MMSE score, respectively. Higher BMI and a lower MMSE score were associated with lower education.

### 2. Nutritional status

Comparisons of macronutrient- and micronutrient intakes between adequate- and under-reporters are shown in Table 3, 4, respectively. Calories were significantly higher in adequate-reporters than in under-reporters. Only protein intake expressed as a % of calories was significantly higher for under-reporters. Significantly more under-reporters were classified as  $< 76\%$  of Korean RDA for all micronutrients.

**Table 3.** Comparison of macronutrient profiles

	Adequate-reporters (n=123)		Under-reporters (n=65)	
	Mean	SD	Mean	SD
Calories***	1896	599	1000	251
Percent of calories from				
Protein (%)**	14.6	3.5	16.8	5.0
Fat (%)	30.5	8.5	28.3	9.3
Carbohydrate (%)	56.1	9.9	57.0	10.6
Alcohol (%)	1.0	3.3	0.3	1.7

These items are significantly different between adequate- and under-reporters at  $p < 0.001$ \*\*\* and  $p < 0.01$ \*\*.

**Table 4.** Comparison of micronutrient profiles

	Adequate-reporters (n=123)		Under-reporters (n=65)	
	Percent <76% of RDA			
Calcium	41.5		76.9	
Iron	3.3		43.1	
Magnesium	35.0		76.9	
Phosphorus	1.6		36.9	
Zinc	62.6		89.2	
Selenium	3.3		30.8	
Vitamin A	36.6		60.0	
Vitamin D	44.7		76.9	
Vitamin C	12.2		26.2	
Thiamin	0.8		35.4	
Riboflavin	2.4		36.9	
Niacin	1.6		33.9	
Folate	9.8		44.6	
Vitamin B <sub>12</sub>	18.7		32.3	
Vitamin B <sub>6</sub>	23.6		56.1	

All items are significantly different between adequate- and under-reporters at  $p < 0.001$  except for vitamin A ( $p < 0.01$ ) and vitamin C and vitamin B<sub>12</sub> ( $p < 0.05$ ).

### 3. Determinants of main effect

Stepwise regression analysis showed that the most significant variables for main effects to predict the ratio of energy intake to estimated basal metabolic rate (EI : BMRest) were BMI and age (Table 5).

## Discussion

Under-reporting of energy intake has been widely cited. In the present study we used prediction equations to estimate the total energy expenditure of elderly Americans and thereafter examined factors that were predictive of the discrepancy between energy intake by the 24-hr recall method and predicted total energy expenditure.

**Table 5.** Results of multiple-regression analyses to predict the ratio of energy intake to estimated basal metabolic rate (EI : BMRest)

Variables	Partial R2	Total R2
BMI	0.0691	0.0691
Age	0.0221	0.0912

The major findings are that the elderly had higher BMI under-reported energy intake to a greater degree than did those who had a lower BMI. Previous studies documented that food consumption (energy) is under-reported by as much as 25% and that such under-reporting occurs most often in women, overweight persons, and weight-conscious respondents (Bingham 1987 ; Bingham 1994 ; Black et al. 1991 ; Black et al. 1993 ; de Vries et al. 1994 ; Johnson 1994 ; Mertz et al. 1991 ; Scholler 1990 ; Tarasuk & Beaton 1991).

In our sample a, higher BMI was more likely to be associated with under-reporters. BMI was the strongest independent predictor of under-reporting, even though they accounted for only 6% of the variability in under-reporting.

These results mirror recent national survey data. In the third National Health and Nutrition Examination Survey (NHANES III), under-reporting of energy intake was highest in women and persons who were older, overweight, or trying to lose weight. Also, weight status was the largest independent predictor of under-reporting (Briefel et al. 1997). There is some evidence that the older men were less likely to under-report their energy intake than older women (Johnson et al. 1994 ; Kye et al. 1999). However, these sex differences were not noted in our samples.

Depression among the elderly is an important and frequent problem in general practice (van Marwijk 1997). Kretsch observed that emotional factors related to depression appear to be more determinant of under-reporting for obese women in middle age (Kretsch 1999). In this study, however, it was not found that depression may impact under-reporting of energy. Participants in this study were not clinically depressed. While depressed persons might be more likely to refuse to participate, the impact of depression on reporting adequacy requires further attention.

Nutrient intakes paralleled energy intake and any differences in mean nutrient intakes between under-reporters and adequate-reporters appeared to be energy-

driven. The finding of a higher proportion of energy from protein and a lower proportion of energy from fat in the under-reporter are consistent with an other study (Rothenbreg et al. 1997). Hirvonen et al. (1997) found that under-reporters consumed significantly less fat than others and that the absolute intake of most micronutrients increased when under-reporters were excluded. In this study, micronutrient intake is higher in adequate-reporters than in under-reporters. This result seems to agree with the general assumption that micronutrient intakes were distorted by under-reporting.

The implications for measurement of specific nutrient intake depend on the still-unknown cause of the under-reporting. Scholler (1990) reported that if the under-reporting of habitual energy intake by obese subjects was due to an inability to measure portion size, then it is likely that all nutrients would be under-reported by similar amounts. And if the under-reporting was due to the omission of nutrient-dilute snack foods, then many micro-nutrient intakes would be close to the reported values, while intakes of saturated fats, salt, and refined sugar would be even less accurate than energy intakes (Scholler 1990). Unfortunately however, it was not possible to distinguish between these two possibilities from our data. Therefore, more survey analyses are necessary to determine whether certain foods and beverages are more likely to be under-reported.

Additional research is needed to evaluate the validity and applicability of existing formulas in various population subgroups, such as smokers, older persons, and persons with various levels of physical activity. Additional research is also needed to determine the extent of under-reporting of foods consumed, food-preparation methods and ingredients, and food quantities and the effect of under-reporting on estimates of food and nutrient intakes; to improve interview methods with use of additional memory or recall cues, probes, and measurement aids.

---

### Summary and Conclusion

---

The aims of this study were to determine whether older Americans would provide valid energy intake information using the 24-hr recall method and to determine which characteristics were predictive of under-

reporting of energy intake.

The results of this study were summarized as follows:

1) On average, under-reporters had higher BMIs than adequate-reporters.

2) Neither the GDS score, nor self-reported weight loss was related to under-reporting.

3) The most significant variables to predict the ratio of energy intake to estimated basal metabolic rate (EI : BMR<sub>est</sub>) were BMI and age.

4) Using a standard cut-off of 76% of the RDA, under-reporters were consistently more likely to be classified as having inadequate nutrients, as well as energy, intakes.

A higher BMI was more likely to be associated with under-reporters. These results mirror recent national survey data. In this study, it was not found that depression may impact under-reporting through an effect on memory as well as motivation. Participants in this study were not clinically depressed. While depressed persons might be more likely to refuse to participate, the impact of depression on reporting adequacy requires further attention.

### ■ Acknowledgement

---

This work was supported by grants from the U.S. Department of Agriculture. I would like to thank all the staff and Dr. Helen Smiciklas-Wright at the Nutrition Center, Pennsylvania State University, USA where I conducted this study as a post-doctoral fellow.

---

### References

---

- Bandini LG, Schoeller DA, Cyr HN, Dietz WH (1990) : Validity of reported energy intake in obese and nonobese adolescents. *Am J Clin Nutr* 52 : 421-425
- Bingham SA (1987) : The dietary assessment of individuals : methods, accuracy, new techniques and recommendations. *Nutr Abstr Rev* 57 : 705-742
- Bingham SA (1994) : The use of 24-h urine samples and energy expenditure to validate dietary assessments. *Am J Clin Nutr* 59(suppl) : 227s-231s
- Black AE, Goldberg GR, Jebb SA, Livingstone MBE, Cole TJ, Prentice AM (1991) : Critical evaluation of energy intake data using fundamental principles of energy physiology : 2. Evaluating the results of published surveys. *European J of Clin Nutr* 45 : 583-599
- Black AE, Prentice AM, Goldberg GR, Jebb SA (1993) : Measure-

- ments of total energy expenditure provide insights into the validity of dietary measurements of energy intake. *J Am Diet Assoc* 93 : 572-579
- Block G. A review of validations of dietary assessment methods(1982) : *Am J Epidemiol* 115 : 492-505
- Briefel RR, Sempos CT, McDowell MA, Chien S, Alaimo K (1997) : Dietary methods research in the Third National Health and Nutrition Examination Survey : under-reporting of energy intake. *Am J Clin Nutr* 65(suppl) : 1203s-1209s
- de Vries JHM, Zock PL, Mensink RP, Katan MB(1994) : Underestimation of energy intake by 3-d records compared with energy intake to maintain body weight in 269 non-obese adults. *Am J Clin Nutr* 60 : 855-860
- Goldberg GR, Black AE, Jebb SA, Cole TJ, Murgatroyd PR, Coward WA, Prentice AM(1991) : Critical evaluation of energy intake data using fundamental principles of energy physiology : 1. Derivation of cut-off limits to identify under-recording. *European J of Clin Nutr* 45 : 569-581
- Goran MI, Poehlman ET(1992) : Total energy expenditure and energy requirements in healthy elderly persons. *Metabolism* 41 : 744-753
- Hirvonen T, Mannisto S, Roos E, Pietinen P(1997) : Increasing prevalence of under-reporting does not necessarily distort dietary surveys. *European J of Clin Nutr* 51(5) : 297-301
- Johnson RK, Goran MI, Poehlman ET(1994) : Correlates of over- and under-reporting of energy intake in healthy older men and women. *Am J Clin Nutr* 59 : 1286-1290
- Kretsch MJ, Fong AK, Green MW(1999) : Behavioral and body size correlates of energy intake under-reporting by obese and normal-weight women. *J Am Diet Assoc* 99(3) : 300-306
- Lichtman SW, Pisarska K, Berman ER, Pestone M, Dowling H, Offenbacher E, Weisel H, Heshka S, Matthews DE, Heymsfield SB(1992) : Discrepancy between self-reported and actual calorie intake and exercise in obese subjects. *N Engl J Med* 327 : 1893-1898
- Mertz W, Tsui JC, Judd JT, Reiser S, Hallfrisch J, Morris ER, Steele PD, Lashley E(1991) : What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. *Am J Clin Nutr* 54 : 291-295
- Rothenbreg E, Bosaens I, Steen B(1997) : Evaluation of energy intake estimated by a diet history in three free-living 70 year old populations in Gothenburg, Sweden. *European J of Clin Nutr* 51 : 60-66
- Schoeller DA(1990) : How accurate is self-reported dietary energy intake? *Nutr Rev* 48 : 373-379
- Schofield WN(1985) : Predicting basal metabolic rate, new standards and review of previous work. *Hum Nutr Clin Nutr* 39 (suppl 1) : 5-41
- Kye SH, Kim CI, Smiciklas-Wright H(1999) : Accuracy of estimating energy intake in the Korean urban elderly : 24-Hour Dietary Recall. *Nutritional Sciences* 2(2) : 113-118
- Singh J, Prentice AM, Diaz E(1990) : Energy expenditure of Gambian women during peak agricultural activity measured by the doubly-labeled water method. *Br J Nutr* 300 : 708-712
- Tarasuk V, Beaton GH(1991) : The nature and individuality of within-subject variation in energy intake. *Am J Clin Nutr* 54 : 464-470
- van Marwijk HW(1997) : Depression in the elderly in family practice. *Tijdschr Gerontol Geriatr* 28(2) : 69-75