

## Original Article

# Improvement in the technological feasibility of a web-based dietary survey system in local settings

Hyun Ju Jung PhD<sup>1</sup>, Sang Eun Lee MS, PhD<sup>1</sup>, Dongwoo Kim PhD<sup>1</sup>, Hwayoung Noh PhD<sup>1</sup>, Sujin Song BS, PhD<sup>1</sup>, Minji Kang BS, PhD<sup>1</sup>, Yoon Ju Song PhD<sup>2</sup>, Hee-Young Paik ScD<sup>1</sup>

<sup>1</sup>Department of Food and Nutrition, Seoul National University, Gwanak-gu, Seoul, Republic of Korea

<sup>2</sup>Major of Food and Nutrition, School of Human Ecology, The Catholic University of Korea, Bucheon-si, Gyeonggi-do, Republic of Korea

The feasibility of a dietary survey tool is crucial for successful nutritional assessment via a community survey and for nutritional epidemiology. In 2012, we identified a newly developed computerized dietary survey system, the Diet Evaluation System (DES), which could be successfully applied to a community survey delivered during home visits using notebook computers when the internet environment was adequate, using either a WiBro modem or a smartphone as a tethered modem. In 2013, we retested DES feasibility using various mobile devices and in a larger number of subjects. We conducted a total of 430 interviews, representing two for each of 215 subjects of various ages, using tablet personal computers (PCs) and laptops. In addition, a group discussion with the interviewers was conducted. The interview success rate was improved to 84% (compared to 67% in 2012). Completing each interview took 14 min 1 s, and data processing was conducted automatically. The subjects' age, gender, and the type of mobile device used influenced the DES interview time. This study implies that the DES is an effective one-stop dietary survey system for use in a local setting. The interviewers' group discussion revealed that a one-stop system using the DES is convenient and that DES optimization for tablet PCs and continued database updating is needed.

**Key Words:** feasibility, dietary survey tool, computer program, automatic data processing, community survey

## INTRODUCTION

Accurate long-term documentation of dietary intake is useful for nutrition monitoring or evaluating nutritional inadequacy. The usual intake of an individual is the conceptually accurate exposure in nutritional epidemiological studies. How to measure the usual intake of an individual has become an important issue.<sup>1-5</sup>

Comparison of the validity of two major dietary assessment methods, multiple 24-h recalls and food frequency questionnaires (FFQs), using a biomarker showed that the attenuation factor for the relationship between energy and protein intake and disease was too large when energy and protein were assessed using an FFQ.<sup>6</sup> In addition, repeated recalls or multiple-day food records are more accurate than a single 24-h recall or a 1-day food record with regard to estimating usual intake.

Implementing repeated recalls in a large-scale study is difficult due to the long processing time, need for interviewers, and multiple-day interviews. The National Health and Nutrition Examination Survey (NHANES) in the United States utilizes an automated multiple-pass method (AMPM) to standardize the recall process. According to Blanton et al when the intake data from two 24-h recalls, which were collected using an AMPM, were compared with data from the Block Food Frequency Questionnaire and the National Cancer Institute's Diet History Questionnaire, the data collected using the AMPM was more accurate than that obtained using the

other two methods.<sup>7</sup> The AMPM includes the following steps: quick list, forgotten foods, time and occasion, detail cycle, and final probe. According to Kang et al in the final probing stage, 82.6% of the subjects reported<sup>1-8</sup> additional food items that accounted for 11.3% of the energy intake and 1.9%-20.2% of the micronutrient intake.<sup>8</sup> This finding implies that the use of the final probe step and a structured interview improves the accuracy of the survey.

The Dietary Intake Data System in the United States is entirely automated, from the beginning of the interview to computing the nutrient intake. It consists of two main parts: the AMPM and Post-Interview Processing System (PIPS). The PIPS includes data reformatting, food coding after the interview, and editing to allow the nutrient intake to be calculated. This system was fully implemented in the NHANES in 2002 (the pilot survey was started in 1999).<sup>9,10</sup> The European Prospective Investigation into Cancer and Nutrition (EPIC), a multi-national project of the European Union, developed a computer program, which applies a standardized 24-h recall method.<sup>11</sup> These

**Corresponding Author:** Dr Hee-Young Paik, Department of Food and Nutrition, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea.

Tel: +82-2-880-6834; Fax: +82-2-880-8775

Email: hypaik@snu.ac.kr

Manuscript received 03 June 2014. Initial review completed 05 August 2014. Revision accepted 02 September 2014.

doi: 10.6133/apjcn.2015.24.2.20

programs make the interview process effective and standardized, and they allow for automated data coding.

A self-administered web program that facilitates the probing step during interviews was also developed. According to Arab et al., subjects could self-administer eight 24-h recalls using his program.<sup>12</sup> The National Cancer Institute of the United States developed the Automated Self-Administered 24-Hour Dietary Recalls (ASA24), in which subjects can directly enter dietary data by connecting to the web.<sup>13</sup> A feasibility study of the ASA24 is ongoing.

In Korea, the Diet Evaluation System (DES) was developed to automate dietary data processing. The DES uses an AMPM in which the interviewer enters data while interviewing the subject. The interview is implemented via a three-step protocol that consists of a quick list, probe, and final probe.<sup>8</sup> In 2012, a feasibility test was performed to assess whether the DES could be applied to a household dietary survey using a mobile device.<sup>14</sup> The results showed that the average time per single 24-h recall was 15 min from interviewing to data coding and input in a local setting, indicating that this program is feasible for use in a large-scale study in Korea. To improve the feasibility of using this system in a local setting, the program has been updated and the list of mobile devices that can be used has been expanded to provide a more stable internet environment. Thus, this study investigated the effect of our updated system on the feasibility of using the DES for large-scale studies in Korea.

## MATERIAL AND METHODS

### *The DES, a web-based dietary assessment program*

The DES is a web-based computer program for conducting dietary surveys that allows an interviewer to directly input 24-h recall data (i.e., while interviewing the subject). The DES utilizes a three-step interview protocol. The first step is a quick list in which the subject states all dishes consumed and the portion sizes (e.g., Bi-bim-bab, one bowl) on the previous day without interruption from the interviewer. The dishes and portions stated by the subjects in this step are displayed in a separate window in the DES. In the second step (probe), the types and amounts of foods eaten (e.g., [cooked] rice, spinach, radish, egg, beef, and seasonings) are specifically queried and entered by dish (e.g., Bi-bim-bab). The interviewer searches for each dish by name, which results in a list of similar dishes in the DES database being displayed. When the interviewer chooses the correct one, the default food items are displayed, together with the amount of each. Next, the interviewer edits the food items and their amounts, and can add new foods. The DES also provides frequently used units (e.g., spoon, chopsticks, or teaspoon) for each food to make it easier to enter the amount, because determining portions can be difficult for the interviewer and the subject. The third step is the final probing stage, in which the interviewer reviews the data and checks for omissions. The dietary data are saved as a raw data file for further analysis and are assessed based on the latest standards for Korean nutrient intake and dietary plans<sup>15</sup> for later distribution to the subject and use in nutritional counseling. A hard copy of the results can be provided to the subject; the screen for the interviewee shows the type of dish con-

sumed or which dish contributes to the intake of each nutrient as well as the nutrients contained in each dish. In addition, the data may be used for counseling and downloaded as a spreadsheet file.

The DES contains several databases that can be used to process dietary data and calculate nutrient intake. The recipe database contains 3,916 recipes for common Korean dishes, including all of the ingredients and the amounts used. The nutrient database contains information on 17 nutrients for 4,222 food items, including dietary supplements, so that the intake of energy, protein, lipid, carbohydrate, calcium, phosphorous, iron, sodium, potassium, vitamin A, thiamine, riboflavin, niacin, vitamin C, vitamin E, total dietary fiber, or cholesterol can be calculated. The recipe database was established from data collected in a previous survey of rural and urban areas<sup>16,17</sup> and was reviewed by two nutritionists.

Regarding the evaluation process, the daily nutrient intakes were compared with the Dietary Reference Intakes for Koreans<sup>15</sup> and the food intakes recalculated based on six food groups (grains; meats, fish, eggs, and beans; vegetables; fruits; milk and dairy products; and oils and sugars) and the recommended serving sizes, and then compared with the Food Guide Wheels for Koreans.<sup>18</sup>

### *Study participants and data source*

From June to August 2013, 66 households (45 urban and 21 rural; n=215 participants) were recruited in a complex urban-rural city in Gyeonggi Province, Korea, to assess whether the DES could be used in a community setting. Specific target areas of the city, and sample size considering area and age group based on the housewife's age, were determined by a statistician using probability proportional to size sampling (PPS sampling) based on census data. Households with a housewife whose age was  $\geq 30$  years were recruited. A dietary survey was conducted for all available family members over 1 year of age who lived together in recruited households. For young children 1-6 years of age, surrogates such as parents or caregivers answered questions regarding their diet on the previous day. We excluded family members who: 1) were less than 12 months of age, 2) were terminal patients, 3) had an intellectual disability, 4) or were not eating together.

To compare the nutrient intake in this study, we used the data from Korean National Health Examination and Nutrition Survey (KNHANES) (2012).<sup>19</sup> KNHANES is a national survey composed of one day 24-h recall and other dietary questionnaires. We used the nutrient intake of 24-h recall data for 7,208 subjects over 1 year of age.

To evaluate the ease and effectiveness of the DES for dietary surveys, 12 interviewers who participated in the dietary survey were recruited for a group discussion.

### *Dietary survey*

Two 24-h diet recall interviews, given at 3-day intervals, were conducted in each subject's home using the DES. As the DES is a web-based program, access to the internet is essential. When an interviewer visited a participant's house, the internet connection was first checked and the device that would provide the best performance was chosen. The devices used in this survey were a tablet personal computer (PC) or laptop. The internet services used in

this study were wireless internet through a WiBro modem or a tethering service (hotspot) through a mobile device (smartphone). If neither method was available, the Wi-Fi owned by the subject was used with their permission. Finally, if the subject could not connect to the internet by any of the above methods, the interview was conducted using a paper and pencil. Subjects provided a written agreement to participate, which was reviewed by the Seoul National University Institutional Review Board (IRB; IRB no. 1307/001-001).

### Feasibility of the DES

The feasibility of the DES was assessed based on the interview success rate, time for a single 24-h recall interview per subject, the calculated daily nutrient intake, and feedback from the interviewers. The interview success rate was defined as the percentage of interviews among the number of total interviews conducted that were delivered entirely through the DES. We measured the interview time from the beginning to the end of the interview using the DES. The daily nutrient intake per subject was automatically calculated using the DES database after inputting all of the dietary data. We compared the nutrient intake in this study with that from the KNHANES (2012).

To obtain information on the ease and effectiveness of the DES for dietary surveys, 12 interviewers who participated in the dietary survey were asked to complete a questionnaire and participate in a group discussion. The questionnaire consisted of six questions (ease of preparing the interview, ease of administering the interview,

convenience, positive responses from the subjects, accurate data processing, and safe data processing); the interviewers were asked to respond using a 5-point scale. The group discussion involved a comparison of using the DES vs. a paper and pencil, based on the interviewers' experience during the dietary survey. Only 10 of the 12 interviewers were invited to participate because they had direct experience using both the DES and a paper and pencil to conduct the interviews. The group discussion was reviewed by the Seoul National University IRB (IRB no. 1310/001-022), and a written agreement to participate was obtained from the interviewers.

### Statistical analysis

Statistical analysis was performed using the Statistical Analysis System, version 9.3 (SAS Institute, Cary, NC, USA). The frequency difference for each variable was verified by 2-tests and the impact of the various categorized variables on the time for the dietary survey was verified using the general linear model (GLM).

### RESULTS

The general characteristics of the subjects are presented in Table 1. The mean age was 34.4 years (males 33.9, females 34.8) and the percentage of males was 45.6%. There were no differences in age, area, or study year according to gender.

The success rate was 84.4% in 2013 compared with 67.2% in 2012 (Table 2). The success rate increased for all regional, sex, and age groups, but particularly for rural

**Table 1.** General characteristics of the subjects

		Men (n=98)		Women (n=117)		<i>p</i> <sup>†</sup>
		n	%	n	%	
Age (years)	1-18	36	52.9	32	47.1	NS
	19-49	33	38.8	52	61.2	
	50-64	21	45.7	25	54.4	
	65+	8	50.0	8	50.0	
Area	Rural	30	45.5	36	54.6	NS
	Urban	68	45.6	81	54.4	
Study year	2012	32	47.8	35	52.2	NS
	2013	98	45.6	117	54.4	

<sup>†</sup>*p* from a  $\chi^2$  test by gender.

**Table 2.** Success rate<sup>†</sup> of a 24-h recall interview through the DES by study year

		2012			2013		
		Completed recalls (n)	Total recalls (n)	Success rate (%)	Completed recalls (n)	Total recalls (n)	Success rate (%)
Age (years)**	1-18	29	46	63.0	125	136	91.9
	19-49	45	66	68.2	133	170	78.2
	50-64	10	14	71.4	76	92	82.6
	65+	6	8	75.0	29	32	90.6
Sex*	Male	43	64	67.2	149	196	76.0
	Female	47	70	67.1	214	234	91.5
Area*	Rural	40	74	54.1	121	132	91.7
	Urban	50	60	83.3	242	298	81.2

<sup>†</sup>The interview success rate is defined as the percentage of interviews among the number of total interviews conducted that were delivered entirely through the DES.

\*\*The success rates were significantly different for each characteristic as determined by the  $\chi^2$  test in the 2012 and 2013 surveys.

\*The success rates were significantly different for each characteristic as determined by the  $\chi^2$  test in the 2013 survey only.

**Table 3.** The type of internet environment and device by study year

		2012		2013	
		Urban n (%)	Rural n (%)	Urban n (%)	Rural n (%)
Internet environment	WiBro	38 (76.0)	0 (0.0)	92 (38.0)	0 (0.0)
	Hotspot	4 (8.0)	27 (67.5)	134 (55.4)	114 (94.2)
	Wi-Fi	8 (16.0)	13 (32.5)	16 (6.6)	7 (5.8)
Device	Laptop	50 (100)	40 (100)	82 (33.9)	50 (41.3)
	Tablet PC A	-	-	88 (36.4)	39 (32.2)
	Tablet PC B	-	-	72 (29.8)	32 (26.5)

**Table 4.** The amount of time spent on each 24-h recall interview using a web-based dietary assessment program (per case)

		n	Time spent on each interview				<i>p</i> <sup>†</sup>
			Mean		SD		
			Minute	Second	Minute	Second	
Total		355 <sup>‡</sup>	14	1	6	41	
Area	Small city	234	12	58	6	11	<0.0001
	Rural	121	16	2	7	8	
Gender	Men	146	12	55	5	36	<0.01
	Women	209	14	46	7	15	
Wireless internet environment	WiBro modem (egg)	85	14	29	6	36	NS
	Tethering (hotspot)	247	13	54	6	43	
	Wi-Fi (home)	23	13	25	6	48	
Age group	<19	120	13	9	6	10	NS
	19-49	132	14	6	6	57	
	≥50	103	14	54	6	49	
Device	Laptop	132	14	52	6	55	<0.01
	Tablet PC A	119	14	31	6	40	
	Tablet PC B	104	12	21	6	7	

<sup>†</sup>*p* determined using a *t*-test, ANOVA, or GLM.

<sup>‡</sup>Among 363 cases using the DES, the time spent was recorded for 355.

areas.

The type of internet environment and device used by area type are presented in Table 3. Use of the WiBro modem decreased compared to 2012, while the use of a tethering service through a smartphone increased. A tethering service was predominantly used in rural areas because the WiBro modem did not function in these areas. In urban areas, the use of a tethering service increased from 8.0% in 2012 to 55.4% in 2013. To improve the booting speed of the laptop, two types of tablet PCs were used. The percentage of interviews conducted using a tablet PC was 66.0% in urban areas and 58.7% in rural areas.

The interview time per 24-h dietary recall is presented in Table 4. The average time using the DES was 14 min and 1 sec. The average time was longer in the rural area compared with the city, in female subjects compared with the males, and with laptop computers compared to tablet PCs. Wireless internet use and the age group of the subjects was not associated with the interview time.

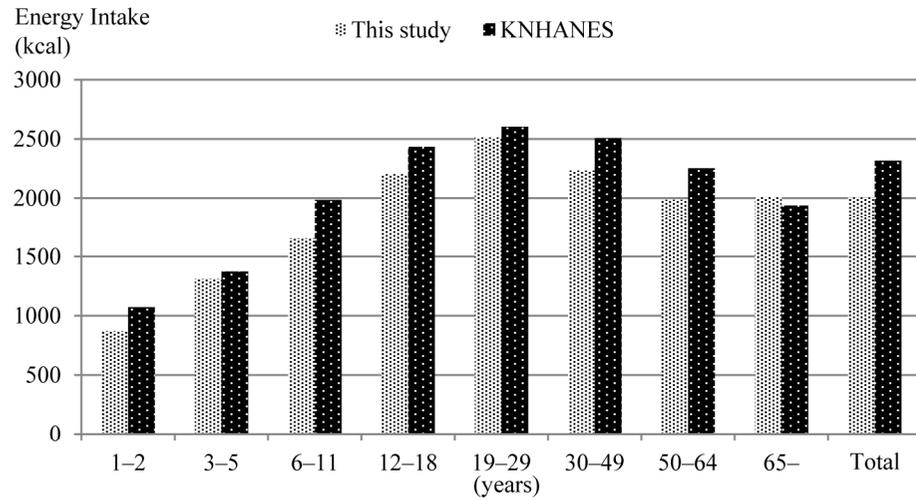
The nutrient intake in this study is presented in Figure 1 together with data from the KNHANES. The study compared the energy intake for each age group of the subjects in the DES to the average energy intake of Koreans in the same energy group. There was a similar trend in the average energy intake of Koreans. However, the small number of subjects in this study led to a very large

standard deviation. The particularly small number of subjects aged 1-2 years resulted in a large difference in average energy intake compared to the KNHANES results.

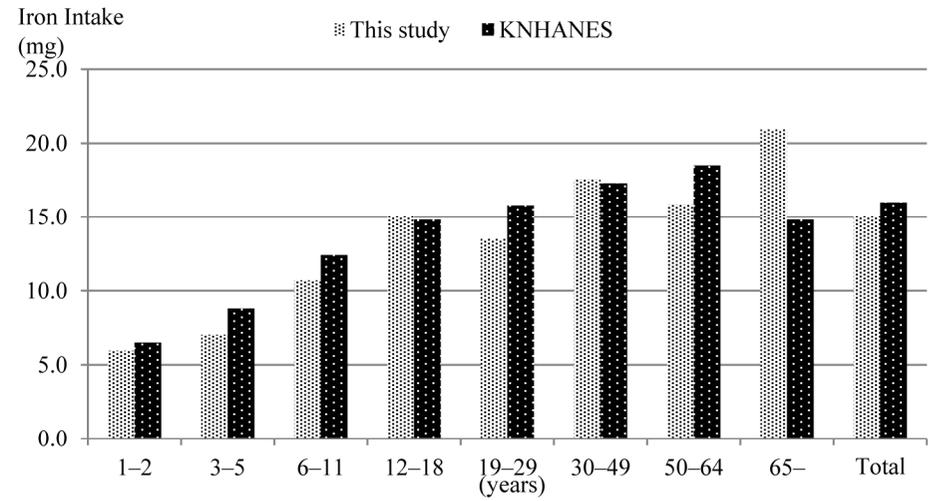
The feedback from the interviewers on using the DES to conduct a dietary survey is presented in Table 5. The interviewers awarded an average of 4 points (based on a 5-point scale) to ease of preparing the interview, ease of performing the interview, and post-data assessment. Only 40% of the interviewers who used a paper and pencil to deliver the survey responded that the DES was simpler than using a paper and pencil. In contrast, 80% of the interviewers stated that the DES was safer and more accurate than a paper and pencil in terms of post-interview activities such as coding, data handling, and data management.

## DISCUSSION

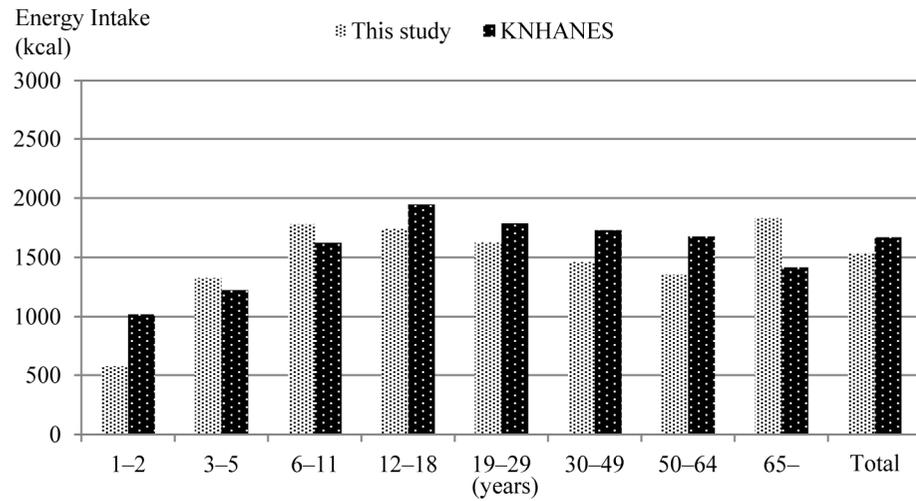
In this study, the DES, a web-based dietary survey program, was tested in a local setting. Two 24-h recalls were administered through the DES to 215 subjects by visiting each subject in his/her household. The success rate was 80.3% (67.2% in 2012; 84.4% in 2013) and the average time per 24-h dietary recall was 14 min and 1 s. The daily nutrient intake calculated through the DES was comparable to that calculated from the Korean national dietary survey.



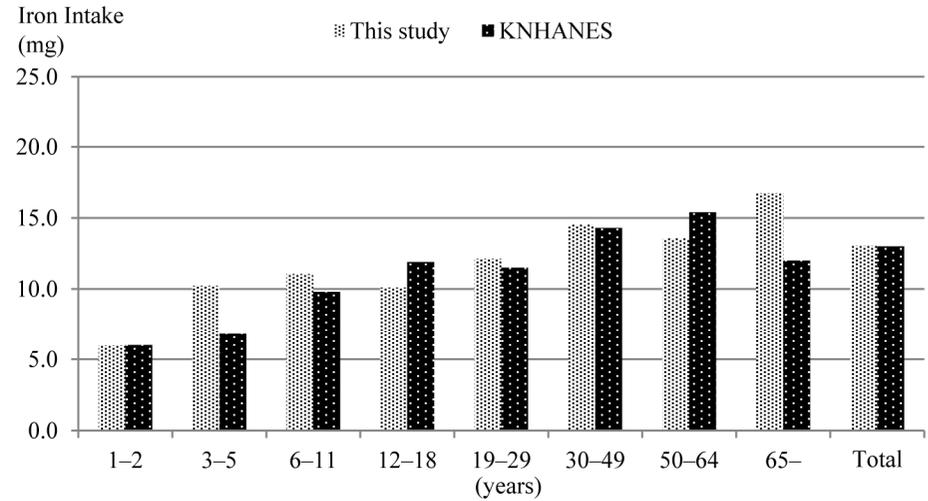
(a) Male



(a) Male



(b) Female



(b) Female

**Figure 1.** Mean daily energy and iron intake of the study population compared with that of the KNHANES.<sup>†\*</sup>

<sup>†</sup>A total of 7,208 24-h recalls from the Korean National Health and Nutrition Examination Survey 2012 was compared.

<sup>\*</sup>Source: Tables 2-43 and 2-44 in Korea Health Statistics 2012: Korean National Health and Nutrition Examination Survey (KNHANES V-3).

**Table 5.** Feedback from the interviewers<sup>†</sup>.

Question (comment)	Mean score (5-point scale)
Ease of preparing the interviews	3.8±0.4
Interviews ran smoothly	3.8±0.5
Interview convenience	3.8±0.8
Positive responses from subjects	3.8±0.8
Accurate data processing and quality control	4.0±0.9
Safe data processing and quality control	4.7±0.5
The DES vs paper and a pencil (%) <sup>‡</sup>	
The DES is simpler	40
The DES is more accurate	80
The DES is safer	80

<sup>†</sup>Twelve interviewers conducted dietary interviews.

<sup>‡</sup>Ten of the twelve interviewers used both the DES and paper and a pencil during the dietary interviews.

We found that the interview success rate, defined as the percentage of interviews among the number of total interviews conducted that were delivered entirely through the DES, improved from 67.2% in 2012 to 84.4% in 2013, which was attributable in part to improvement in the wireless internet environment. The DES is a web-based program; thus, an internet connection is essential. Compared with urban areas, the internet environment in rural areas is limited. In some rural households, wireless service using the WiBro modem was not available in 2012; thus, half of the interviews were performed through the DES using a tethering service (hotspot) by smartphone. In 2012, the speed of the tethering service was low, whereas it was improved in 2013. This greatly contributed to the increase in the success rate in the rural area in 2013. Overall, improvement in the wireless internet environment was the most important factor in ensuring smooth delivery of the dietary survey. In addition to the improved speed of the internet connection, the convenience of conducting a mobile survey was expanded by introducing a portable tablet PC, which is easy to carry. The interviewers preferred using a laptop computer with a fast booting speed, but the tablet PC was considered to be useful for checking dietary contents with the interviewee during the interview.

Two major dietary survey programs are used at present to interview people regarding their daily diet: EPIC-SOFT20 and the Dietary Intake Data System.<sup>9</sup> Both programs are used by an interviewer to determine a subject's diet, similar to the DES. The advantage of our system is that the DES is a web-based program; thus, the interviewer can go anywhere an internet connection is available. A web-based dietary survey program is also useful for data quality control when the survey is conducted at multiple centers. EPIC-SOFT is currently being developed as a web-based program by the International Agency for Research on Cancer while its existing methodological platform is maintained. This is being implemented because a web-based application is required to deliver the survey smoothly simultaneously with the standardized program in multiple countries.<sup>20</sup>

The majority of the computerized dietary survey systems have been developed in the western countries suita-

ble for dietary patterns of the population, using food composition tables developed in the country. Koreans, as in many Asian countries, have distinct dietary patterns and many specialized dishes. DES follows the pattern of Korean diet and is composed of recipes of various dishes, which enable survey participants to answer with ease leading to more successful completion of the dietary survey. Also, DES has adapted the three-step interview procedure which has been shown to be efficient and effective to capture diet of Korean population quite accurately.<sup>8</sup> Databases of various sources, including those developed by government agencies, professional societies such as the Korean Nutrition Society, as well as those developed from research projects of our research team, are integrated in the system. Included in the DES are database for recipe, nutrient composition, and food group servings, dietary supplements, thus making it possible to calculate intakes of nutrients and servings for each food group from almost all of the dishes and dietary supplements consumed by the Korean population. In fact, it is the only system which can calculate food group servings from dietary intake data in Korea. Therefore, DES is a unique tool for Korean nutritionists that can help conduct dietary surveys easily, and produce results quickly either for nutrients or for food groups. Although it is developed for the Korean diet, other Asian countries, which have similar dietary patterns with mixed dishes, can easily adapt the system by translating the language and modifying their recipe and nutrient composition database.

Compared with other programs, DES has improved performance on wireless platforms. DES also works not only on the personal computer, but also the tablet PC and the smartphone. During the dietary survey, several interviewers simultaneously used DES at different locations. The data were available for further analysis and hard copy reports for the subjects were available as soon as data cleaning was complete. Moreover the DES saved the quick list data and any information input by the interviewer during the final probing step, which was relevant for data check and cleaning.

We found that the average time spent on a single 24-h recall interview was 14 min and 1 s through the DES. This is similar to the time reported in another study conducted in Korea.<sup>17</sup> Our data suggest that the DES saved a considerable amount of time compared with the traditional method of paper and a pencil, which required 2 h for a single 24-h recall interview (including data coding and input).<sup>17</sup>

In this study, use of a tablet PC was introduced, which improved the portability of the survey. However, we obtained no clear evidence that the tablet PC was more convenient than a laptop in terms of data input. Currently, the DES is not optimized for delivery using a tablet PC; frequent taps are required to display the full screen at each stage in the current version.

In addition, the DES has several limitations. For example, considerable time is required to train the interviewers. Most of the interviewers in this study said that they required more knowledge to handle the DES, including understanding and using several databases and adding new foods or recipes. To some degree, errors are unavoidable despite automation of the survey due to the orig-

inal features of a 24-h recall, which relies heavily on the memory of the subject and carries the possibility of underestimation. Thus, additional studies are necessary to assess the feasibility of using the DES based on an updated version and a larger-scale or longitudinal study. DES also requires continuous maintenance efforts, quality improvement, data security and nutrient database updating.

We conclude that the success rate improved largely due to the addition of new devices and upgrading of the internet environment; in addition, the data were processed automatically so no time or money was spent on coding after the survey. Thus, the DES is an effective tool for administering 24-h recall interviews in a local setting or as part of a large-scale study of the Korean diet.

#### ACKNOWLEDGEMENT

This work was carried out with the support of the Research Program for Agricultural Science and Technology Development, National Academy of Agricultural Science, Rural Development Administration, Republic of Korea (Project no. PJ00899503).

#### AUTHOR DISCLOSURES

The authors declare that there are no conflicts of interest.

#### REFERENCES

1. Willett WC. Commentary: dietary diaries versus food frequency questionnaires—a case of undigestible data. *Int J Epidemiol.* 2001;30:317-9. doi: 10.1093/ije/30.2.317.
2. Bingham SA, Luben R, Welch A, Wareham N, Khaw K-T, Day N. Are imprecise methods obscuring a relation between fat and breast cancer? *Lancet.* 2003;362:212-4. doi: 10.1016/S0140-6736(03)13913-X.
3. Kristal AR, Peters U, Potter JD. Is it time to abandon the food frequency questionnaire? *Cancer Epidemiol Biomarkers Prev.* 2005;14:2826-8. doi: 10.1158/1055-9965.EPI-12-ED1.
4. Willett WC, Hu FB. Not the time to abandon the food frequency questionnaire: point. *Cancer Epidemiol Biomarkers Prev.* 2006;15:1757-8. doi: 10.1158/1055-9965.EPI-06-0388.
5. Kristal AR, Potter JD. Not the time to abandon the food frequency questionnaire: counterpoint. *Cancer Epidemiol Biomarkers Prev.* 2006;15:1759-60. doi: 10.1158/1055-9965.EPI-06-0727.
6. Schatzkin A, Kipnis V, Carroll RJ, Midthune D, Subar AF, Bingham S, Schoeller DA, Troiano RP, Freedman LS. A comparison of a food frequency questionnaire with a 24-hour recall for use in an epidemiological cohort study: results from the biomarker-based Observing Protein and Energy Nutrition (OPEN) study. *Int J Epidemiol.* 2003;32:1054-62. doi: 10.1093/ije/dyg264.
7. Blanton CA, Moshfegh AJ, Baer DJ, Kretsch MJ. The USDA Automated Multiple-Pass Method accurately estimates group total energy and nutrient intake. *J Nutr.* 2006;136:2594-9. doi: 10.3945/jn.108.103887.
8. Kang H, Jung HJ, Paik HY. Analysis of Foods and Nutrients Intake Obtained at the Final Probing Step in 24-hour Recall Method. *Korean J Nutr.* 2009;42:158-70. doi: 10.4163/kjn.2009.42.2.158. (In Korean)
9. Raper N, Perloff B, Ingwersen L, Steinfeldt L, Anand J. An overview of USDA's dietary intake data system. *J Food Compos Anal.* 2004;17:545-55. doi: 10.1016/j.jfca.2004.02.013.
10. Grandjean AC. Dietary intake data collection: challenges and limitations. *Nutr Rev.* 2012;70:S101-4. doi: 10.1111/j.1753-4887.2012.00545.x.
11. Slimani N, Deharveng G, Charrondiere RU, van Kappel AL, Ocke MC, Welch A et al. Structure of the standardized computerized 24-h diet recall interview used as reference method in the 22 centers participating in the EPIC project. *European Prospective Investigation into Cancer and Nutrition. Comput Methods Programs Biomed.* 1999;58:251-66. doi: 10.1016/S0169-2607(98)00088-1.
12. Arab L, Wesseling-Perry K, Jardack P, Henry J, Winter A. Eight self-administered 24-hour dietary recalls using the internet are feasible in African Americans and Whites: the energetics study. *J Am Diet Assoc.* 2010;110:857-64. doi: 10.1016/j.jada.2010.03.024.
13. Subar AF, Kirkpatrick SI, Mittl B, Zimmerman TP, Thompson FE, Bingley C et al. The Automated Self-administered 24-hour dietary recall (ASA24): a resource for researchers, clinicians, and educators from the National Cancer Institute. *J Acad Nutr Diet.* 2012;112:1134-7. doi: 10.1016/j.jand.2012.04.016.
14. Jung HJ, Lee SE, Kim D, Noh H, Song S, Kang M, Song Y, Paik HY. Development and feasibility of a web-based program 'Diet Evaluation System (DES)' in Urban and Community Nutrition Survey in Korea. *Korean Journal of Health Promotion.* 2013;13:107-15. (In Korean)
15. The Korean Nutrition Society. Dietary reference intakes for Koreans. 1st revision. Seoul: The Korean Nutrition Society; 2010. (In Korean)
16. Rural Development Administration. Studies on developing the software program for dietary evaluation in rural area. Suwon: Rural Development Administration (Republic of Korea); 2000. pp. 383-454. (In Korean)
17. Korea Centers for Disease Control and Prevention. Development of open-ended dietary assessment system for Korean Genetic Epidemiological Cohorts. Cheongwon: Korea Centers for Disease Control and Prevention (Republic of Korea); 2008. (In Korean)
18. Song S, Jung HJ, Shim JE, Paik HY. Assessment of food group intake in Korean population with a newly-developed food group database. *J Food Compos Anal.* 2014;36:72-8. doi: 10.1016/j.jfca.2014.04.010.
19. Korea Centers for Disease Control and Prevention, Ministry of Health and Welfare. Korea Health Statistics 2012: Korea National Health and Nutrition Examination Survey (KNHANES V-3). Cheongwon: Korea Centers for Disease Control and Prevention (Republic of Korea); 2013. Report No.: 11-1351159-000027-10. (In Korean)
20. Slimani N, Casagrande C, Nicolas G, Freisling H, Huybrechts I, Ocke MC et al. The standardized computerized 24-h dietary recall method EPIC-Soft adapted for pan-European dietary monitoring. *Eur J Clin Nutr.* 2011;65:S5-15. doi: 10.1038/ejcn.2011.83.

## Original Article

## Improvement in the technological feasibility of a web-based dietary survey system in local settings

Hyun Ju Jung PhD<sup>1</sup>, Sang Eun Lee MS, PhD<sup>1</sup>, Dongwoo Kim PhD<sup>1</sup>, Hwayoung Noh PhD<sup>1</sup>, Sujin Song BS, PhD<sup>1</sup>, Minji Kang BS, PhD<sup>1</sup>, Yoon Ju Song PhD<sup>2</sup>, Hee-Young Paik ScD<sup>1</sup>

<sup>1</sup>Department of Food and Nutrition, Seoul National University, Gwanak-gu, Seoul, Republic of Korea

<sup>2</sup>Major of Food and Nutrition, School of Human Ecology, The Catholic University of Korea, Bucheon-si, Gyeonggi-do, Republic of Korea

### 在当地进行网络饮食调查系统可操作性的技术改进

饮食调查工具的易操作性是成功进行社区营养评估和了解营养状况至关重要的因素。2012年，我们确认了新开发的计算机饮食调查系统（DES）的实用性，无论是使用无线宽带调制解调器还是使用智能手机连接调制解调器连接网络，只要网络畅通，此系统均可成功地用笔记本电脑进行社区内家庭式访问。2013年，我们在各种移动设备上对大批人群重新测试了DES的可行性。我们使用平板电脑和笔记本电脑，共调查了430位受访者，分两组，每组215人，分别涵盖各个年龄段。此外，还进行了访问者的小组讨论。访问的成功率提高了84%（与2012年的67%相比）。完成一次访问需14分1秒，访问同时系统自动对数据进行处理。影响DES访问时间有受访者的年龄、性别以及使用何种移动设备上网。此研究表明，DES是一项足不出户就可进行饮食调查的有效工具。受访的小组讨论表明，DES的一站式调查是非常方便有效的。此外，DES在平板电脑上的优化以及数据库的持续升级也是极为必要的。

**关键词：**可操作性、饮食调查工具、计算机程序、自动数据处理、社区调查