

Development and Evaluation of a Web-based Computer-Assisted Personal Interview System (CAPIS) for Open-ended Dietary Assessments among Koreans

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The accuracy of dietary assessments has emerged as a major concern in nutritional epidemiology and new dietary assessment tools using computer technology to increase accuracy have been developed in many countries. The purpose of this study was to develop a web-based computer-assisted personal interview system (CAPIS) for conducting dietary assessment and to evaluate its practical utilization among Koreans. The client software was developed using Microsoft's ClickOnce technology, which allows communication with a database system via an http server to add or retrieve data. The system consists of a tracking system for the subject and researcher, a data-input system during the interview, a calculation system for estimating food and nutrient intake, a data-output system for presenting the results, and an evaluation system for assessing the adequacy of nutrient and food intake. Databases of the nutrient composition of common food ($n = 3,642$), recipes for common dishes ($n = 1,886$), and photos of serving sizes for food and dishes ($n = 4,152$) were constructed, and logical processes for data collection, calculation, and output were developed. The functionality, on-site applicability, and efficiency of CAPIS were evaluated in a convenience sample of 181 participants (61 males, 120 females; aged 24 to 85) by comparing with manual 24 hour recall method with paper questionnaire. The CAPIS was functioned adequately in the field survey in terms of completeness of function, security, and compliance of researcher and subjects. Regarding on-site applicability, 23.2%, 32.6%, 35.4%, and 43.7% of subjects reported that CAPIS was easier to recall their diet, to estimate the amount consumed, to communicate with the interviewer, and to concentrate on the interview than the manual method with paper questionnaire, respectively. Although CAPIS required more interview time (9 min 42 sec) compared to the manual method (7 min 30 sec), it saved time and cost for data coding and entry (15 min 35 sec) and gave high satisfaction from the prompt feedback after interview to the subjects, which increase efficiency to apply on the field survey. Our results suggest that the newly developed CAPIS is suitable for conducting personal interviews for dietary assessment in Korean population.

Key Words: Nutrition assessment, Computer application software, Utilization

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Introduction

According to the 2012 Cause-of-Death Statistics in Korea, 47.1% of the total death toll was caused by cancers, cardiovascular disease, and cerebrovascular disease [1], which are closely related to dietary intake [2]. The social burden of chronic diseases will increase tremendously due to a rapid increase of aging population and lifestyle changes (e.g., physical inactivity and poor diet quality). Thus, there is a need for developing strategies to improve lifestyles in order to prevent chronic diseases.

Nutritional epidemiological studies have focused on understanding relationships between dietary factors and chronic diseases within populations [3]. An accurate dietary intake measurement is important to clarify relationships between dietary intakes and chronic diseases [4]. There are two dietary assessment approaches, structured questionnaire method and open ended questionnaire method. The structured food-frequency questionnaire (FFQ) method has been applied to obtain data on respondents' usual intake for a specific duration and widely used in research with large samples due to the low cost and its convenience. However, FFQ method may not accurately capture the actual dietary intakes because of the large measurement errors deriving from listing only a limited number of food items as well as recall bias [5]. Another approach is the open-ended dietary assessment, 24 hour recalls and food records, which collect data of dietary intakes for a specific day. Generally, open-ended dietary assessment can collect dietary intakes more accurately compared to the FFQ because all food and dish items eaten by subjects are provided with actually eating amounts, cooking method, and brand or product name etc. if necessary [6].

The accuracy of dietary assessments has recently emerged as a major concern in nutritional epidemiology because previous studies have reported that the association between dietary factors and health problems was highly dependent on the accuracy of the dietary assessment methods. For example, saturated fat intake was significantly associated with increased risk of breast cancer when a 7-day food diary method was used, but not associated when a FFQ was applied [7]. Thus, most researchers want to use more accurate dietary assessment methods, such as food records or 24-hour recall, but there are many difficulties of using these methods in large samples, owing to that require labor intensive and expensive process for interview and record of food amount consumed, data coding, data entry, and analysis [8]. Additionally, data on multiple days are needed to estimate usual intake due to large

daily variations in nutrient intakes, which places a major burden on both researchers and subjects [9]. Therefore, researchers in many countries have been attempting to develop convenient, feasible, and accurate dietary assessment tools using computer technology [10], such as computer software ("NINA-DISH" [11], "EPIC SOFT" [12], "DietDay" [13]) and applications for personal digital assistants (PDAs) or cellular phone [14].

Given Korea's access to world-class computer technology and Internet networks [15], the use of a computer-based dietary assessment soliciting 24-hour recall or records may be a feasible approach to field survey. Despite the presence of dietary assessment program such as CAN pro, which has been widely using in Korea for data coding and entry after interview, new computerized program for open-ended dietary assessment, which can cover all the processes for dietary assessment such as interview, coding, entry and evaluation, is needed to improve accuracy of dietary assessment in nutritional epidemiological studies. Thus, this study was conducted to develop a computer-assisted personal interview system (CAPIS) using a standardized dietary survey method [16] and to evaluate the functionality, onsite applicability, and efficacy of the system.

Materials and Methods

Development of the CAPIS

The CAPIS was developed by using computer technology to increase accuracy and utilization of open-ended dietary assessment among Koreans. We developed the environment, structure, and logical processes for CAPIS and constructed the databases supporting it in 2008.

Environment of the CAPIS

Microsoft Windows 2003 server was the basic platform for CAPIS, and the .NET Framework 2.0/3.0/3.5 of Windows 2003 Server was used. The web server, Internet Information Server (IIS), was used for program distribution, and the Click-Once method was adopted. Microsoft SQL 2005 was used as the database server, and the access method for the database server used WebService.

CAPIS structure

The CAPIS was developed to allow for the simultaneous data entry on individual dietary intake by many users and automatic calculations of the food and nutrient intakes for

output. To assess the food and nutrient intake, we designed a sophisticated data-processing structure that relied on databases containing food images, recipes, and food composition. The system was composed of input form, output form, and individual report form. The logic for input form and procedures were developed on the basis of the standardized dietary assessment protocols modified from the USDA's Automated Multiple-Pass Method (AMPM) [17,18]. To refine the capabilities of this instrument, the input procedures were examined and modified through pilot testing.

The output form was developed for user to view the contents of participant's food and meal intakes by meal time such as snack before breakfast, snack before noon, lunch, afternoon snack, dinner, and midnight snack through the "input" page of the CAPIS. Additionally, it was developed for the user to confirm the total food and nutrient intakes for a particular day, average intake over a particular period, and average intake for the total survey period through the "inquiry for results of intake" page of the software.

A report form was developed to provide evaluation results based on the adequacy of food and nutrient intakes. Each individual report was developed to present different color-coded results for weight status (risky, requires caution, and appropriate) and for the intake of major nutrients and foods (insufficient, increase required, adequate, and excessive). In cases of insufficient or excessive food and nutrient intake, the program presents potential clinical risks and recommendations for food consumption to improve the respondent's status.

Furthermore, we established the level of access right to the program and constructed an effective data management system.

Database construction

The food-composition database for the CAPIS was established from the 7th Food Composition database of the Rural Development Administration ($n = 2,505$) [19], the food composition database of the Korean Nutrition Society ($n = 933$) [20], and databases from foreign countries ($n = 24$) including the USDA National Nutrient Database for Standard Reference [21], the Standard Tables of Food Composition in Japan [22], and information about the composition of food in China [23].

Recipe database was constructed with 1,886 dishes frequently consumed by Korean adults over 20 years of age which were identified from the data of 2005 Korean National Health and Nutrition Examination Survey (KNHANES). The 1,247

recipes based on the database of the Korean Nutrition Society [24] were evaluated by professional chefs based on their extensive cooking experience. In addition, recipe for 467 dishes were identified based on cohort survey data and recipes for 172 dishes were tested by cooking. After assessing the recipes, we determined serving sizes based on the intake data from KNHANES.

The input system included images of servings of foods and dishes to assist respondents' recall of the amount they consumed. A food-and-dish image database was developed with $\frac{1}{2}$, 1, and $1\frac{1}{2}$ serving sizes for each item. Decisions on angles, lighting, brightness, saturation, table color, and plates were decided in consultation with professional photographers. The image database consists of the "taken-image database", which were really taken, and the "alternative-image database", which were coded with using taken-images of food or dishes to other food or dishes in similar amount without taken-image to aid estimating the amount eaten. The codes of the image databases were arranged hierarchically according to the food or dish amount for systematic management and utilization. The food-image code is the food code combined with the weight of the food, and the dish-image code is the dish code combined with the serving size.

Evaluation of the practical utilization of the CAPIS

The Guidelines for Evaluation Standards of Software suggests seven major evaluation indicators: functionality, site feasibility (practical utilization), efficiency, portability, maintainability, reliability, and the responsiveness of the service provider [25]. The technological aspects of portability, maintainability, reliability, and the responsiveness of the service provider were reviewed and examined as part of the process of developing the structure and programming to correct any flaws. Issues related to practical utilization (i.e., functionality, on-site feasibility, and efficiency) of CAPIS were examined by comparing with a manual non-computerized 24-hour recall method.

A functionality evaluation was performed to check the completeness of function, interoperability, security, and compliance. On-site applicability was examined ease of utilization including "ease of estimation", "ease of recall", "ease of communication with interviewer", and "ability to concentrate on the survey". The efficiency of the CAPIS was compared with a manual method using the existing program, the computer-aided nutritional analysis program (CAN pro), in terms of the time required to complete dietary assessment.

Study participants and design

A total of 200 participants older than 20 years of age recruited in a convenience sampling method completed one day dietary assessment by the CAPIS program and the manual 24-hour recall method with paper questionnaire. We excluded 19 individuals because of missing data on personal information, leaving a final analytic sample of 181 adults (61 males, 120 females; aged 24 to 85).

Participants were randomly divided into 2 groups. One group completed dietary assessment by using the manual 24-hour recall method with paper questionnaire and followed by using CAPIS; whereas the other group used CAPIS first and then a manual 24-hour recall method with paper questionnaire. When participants used the CAPIS, they estimated the quantity of their intake based on food images depicting three standardized serving sizes ($\frac{1}{2}$, 1, and $1\frac{1}{2}$) that were appeared on the CAPIS screen. On the contrary, when participants used the manual method, participants estimated the amount eaten based on standardized imitation food materials representing one serving size. Participants were also asked to respond to a questionnaire regarding on-site applicability after they completed both dietary interviews.

Statistical Analysis

Continuous data are expressed as means and standard deviation, and categorical data as percentage. Student's t test was used to evaluate the difference of time required between

CAPIS and manual 24-hour recall method with paper questionnaire. The chi-square test was applied to evaluate difference of the subjects' distribution between two methods. All analyses were performed using the Statistical Analysis System (SAS) software (version 9.1; SAS Institute Inc., Cary, NC, USA).

Results

The CAPIS for open-ended dietary assessment

Architecture of the CAPIS

After inputting information of participant's general characteristics (i.e., age, sex, height, weight, and physical activity level, pregnancy and lactation status, and chronic disease) and dietary intakes into the CAPIS, the client sends the information to the server through a Web service. The server that receives the information performs operations with databases, determines the results, and sends the results to the client through the Web service (Figure 1).

Structure of the CAPIS

The CAPIS consists of five systems: an input system to enter participants' intake, a calculation system to convert the input into food and nutrient units based on information from databases, an output system to provide information about food and nutrient intake suitable for participants, an evaluation system to make assessments on the basis of reference intake and provide the results of the evaluation in a format that participants can readily understand, and a tracking system for

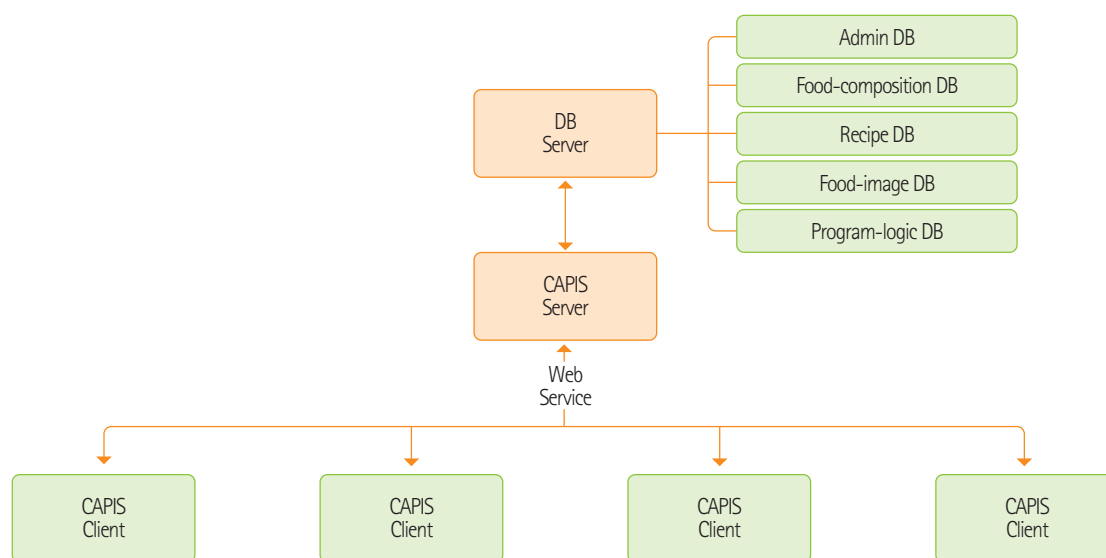


Figure 1. Architecture of the CAPIS.

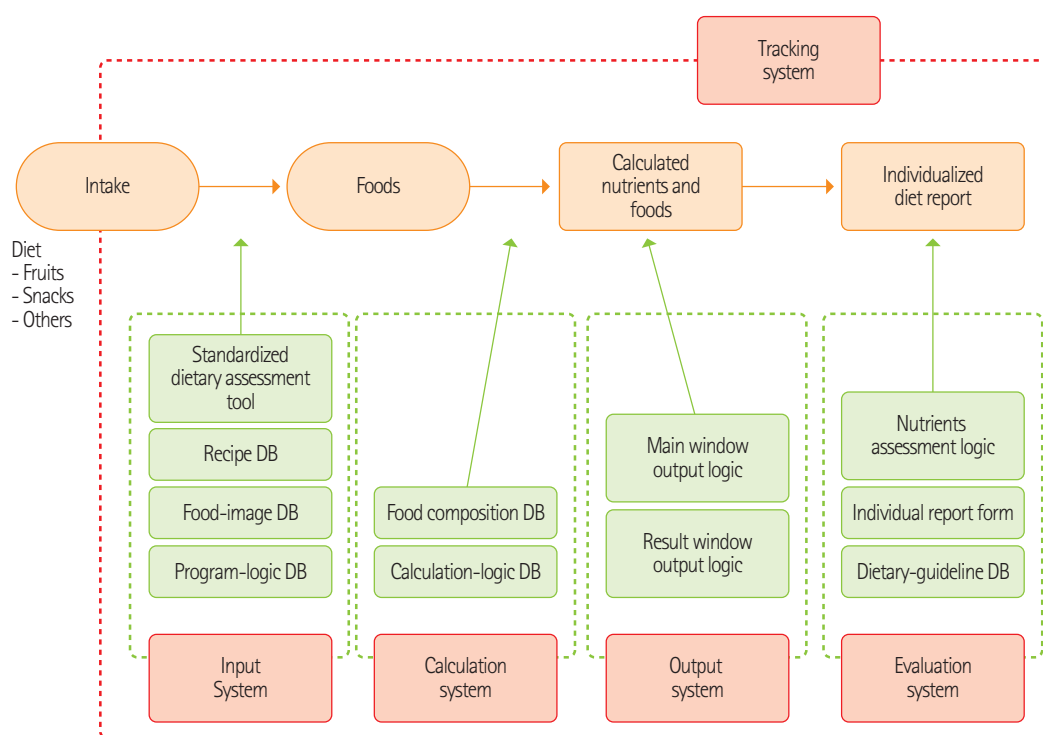


Figure 2. The structure of the CAPIS system.

the convenient data management for subjects and researchers (Figure 2). The five systems were implemented as a program on the basis of independently established databases, including a food-composition database, a food-image database, a recipe database, and a dietary-recommendation database (Table 1).

Databases

The food composition database of the CAPIS was constructed with 3,642 cases: 590 cereal and grain products; 80 potatoes and starches; 90 sugary items and sweets; 64 legumes and their products; 104 seeds and nuts; 496 vegetables; 56 fungi and mushrooms; 255 fruits; 414 meats, poultry, and their products; 29 egg items; 770 fish and shellfish; 69 seaweed items; 175 milk and dairy products; 39 oils and fats; 160 beverages; 122 seasonings; 81 processed foods, and 48 others.

The recipe database containing 1,886 dishes was constructed; the database included 69 recipes for rice, 217 for baked goods and confectionery items, 41 for noodles and dumplings, 32 for stews and casseroles, 106 for hot soups, 78 for gruels, 47 for steamed foods, 65 for grilled foods, 62 for pan-fried

foods, 93 for stir-fried foods, 62 for braised foods, 67 for fried foods, 145 for seasoned vegetables, 29 for kimchies, 54 for raw fish, 38 for salt-fermented foods, 32 for seasoned-fermented foods, 65 for seasonings, 53 for milk and dairy products, 119 for beverages, 89 for fruits, 165 for single foods, 24 for dduk (Korean-style rice cakes), and 134 for processed foods.

The dish-image database consisted of 575 taken images and 1,768 alternative images, and the food-image database included 580 taken images and 1,229 alternative images.

Input system

The input system consists of several sections including a "quick list of foods consumed", "a list of additional forgotten foods", "meal times", "corrections of amounts and recipes", and a "final review". The "input system" implemented in the "food registration" window includes the screen to input personal information, date, time, place, meal, dish, and amount of dish or food, a screen to modify the recipe and amount, an output screen for food and dishes, and a save function screen (Figure. 3). After entering the basic personal information the partici-

Table 1. Databases constructed for CAPIS

Database	Classification	Content
Food-composition list	Energy and macronutrients (6)	Energy, Proteins, Lipids, Carbohydrates, Fiber, Cholesterol
	Fat-soluble vitamins (6)	Vitamin A, Retinol, Carotene, Vitamin D, Vitamin E, Vitamin K
	Water-soluble vitamins (8)	Vitamin B1, Vitamin B2, Niacin, Vitamin C, Vitamin B6, Vitamin B5, Vitamin B12, Folate
	Macro-minerals (4)	Ca, P, Na, K
	Micro-minerals (2)	Fe, Zn
	Other information (3)	Water, Refuse, Ash
Food-composition DB	Total (3,642)	Cereals and grain products (590), potatoes and starches (80), sugar and sweets (90), legumes and their products (64), seeds and nuts (104), vegetables (496), fungi and mushrooms (56), fruits (255), meats, poultry, and their products (414), eggs (29), fish and shellfish (770), seaweed (69), milk and milk products (175), oils and fats (39), beverages (160), seasonings (122), processed foods (81), and others (48)
Food-image DB	Dish images (2,343)	Taken images (575), alternative images (1,768)
	Food images (1,809)	Taken images (580), alternative images (1,229)
Recipe DB	Total (1,886)	Rice (69), baked goods and confectionery items (217), noodles and dumplings (41), stews and casseroles (32), hot soups (106), gruels (78), steamed foods (47), grilled foods (65), pan-fried foods (62), stir-fried foods (93), braised foods (62), fried foods (67), seasoned vegetables (145), kimchies (29), raw fish (54), salt-fermented foods (38), seasoned-fermented foods (32), seasonings (65), milk and dairy products (53), beverages (119), fruits (89), single foods (165), dduk (24), and processed foods (134)
Dietary-guideline DB	Total (3)	Dietary Guidelines for Korean Adults, Dietary Guidelines for Korean Elderly, and Recommendations for Chronic Diseases

participant inputs a date, chooses the meal(s) eaten, searches for foods in the "food name" or "food group" tab, and registers the foods consumed.

The CAPIS was designed to cover the most commonly consuming foods and dishes with amounts of individual food ingredients by the dish database constructed in this study. The quantity of a dish can be selected in various ways, such as by clicking a dish image picture, using a scroll bar, or filling in the input column for intake amount. The food entered is displayed at the bottom of the search window, and "food deletion" and "food copy" functions are available. The amount of each food ingredient in a "standard recipe" can be changed. When new foods are added as new items, it is possible to search for them using the "food search" window, on which one can enter and change the weight of a relevant food. The "standard recipe" field was also designed to allow the deletion of food items that were not included and/or eaten. When all foods eaten for each meal have been entered, the participant presses the "save all food list" button to save the record of food intake.

Calculation system

Each food with weight entered into the CAPIS is converted into nutrient values by the "calculation system", which applies the food-composition database constructed for this study. The food-composition database includes 29 components, including energy, macronutrients, fat-soluble vitamins, water-soluble vitamins, macro-minerals, micro-minerals, and other information.

Output system

The CAPIS enables one to check the amount of food and nutrients consumed per meal as the survey is conducted. The information about the nutrients for a given meal and dish can be checked immediately in the "input" window. When a period is selected in the "output search" window, the information about food and nutrient intake during the selected period can be accessed on the screen. The output dataset includes participant ID, name, gender, age, height, weight, pregnancy/breast-feeding status, physical activity, date, meal, dish code,

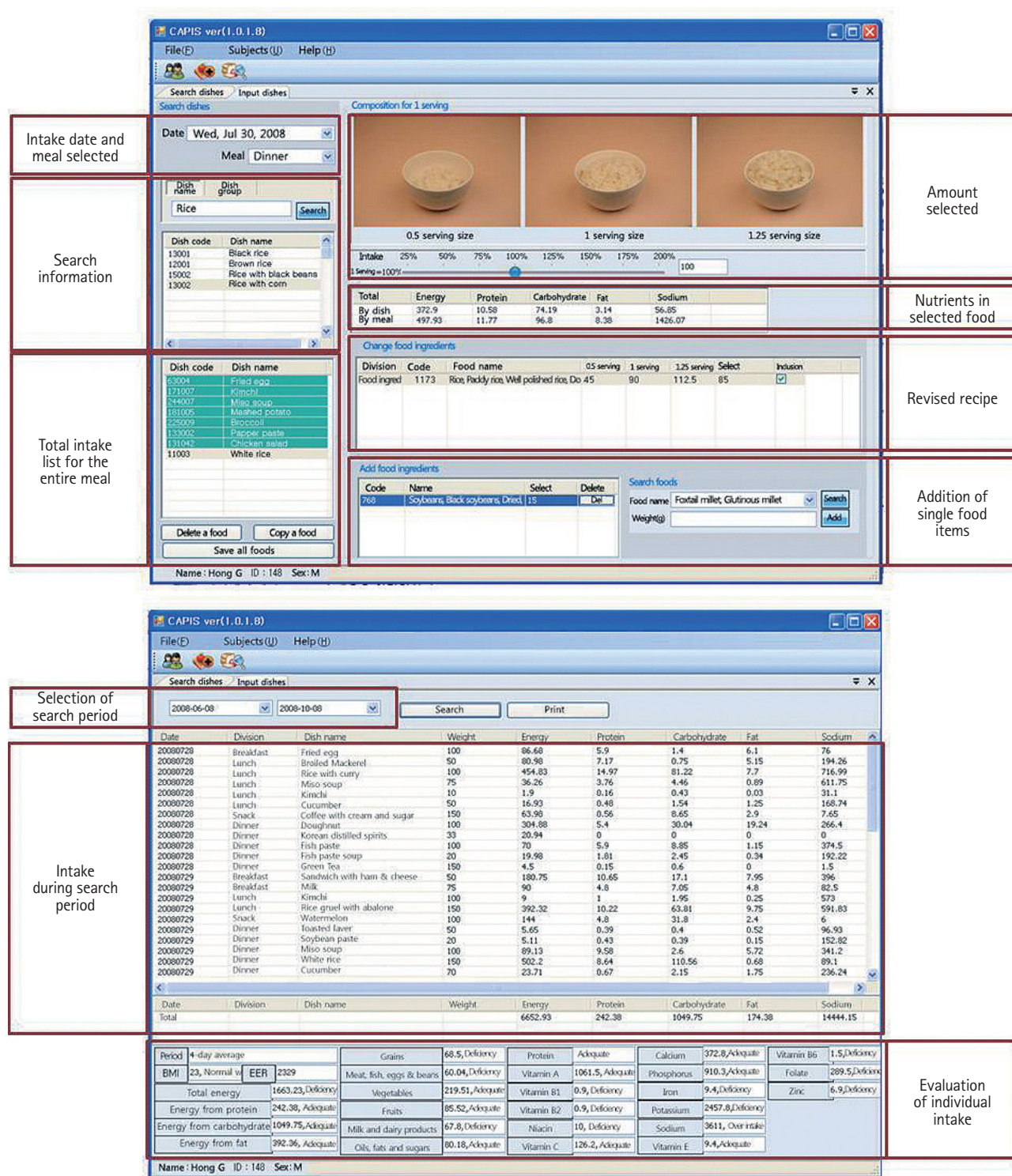


Figure 3. Data entry and output screens of the CAPIS.

dish name, food group, food code, food name, food amount, and nutrients.

Evaluation system

The information on general characteristics, such as age, weight, physical activity, and pregnancy/breast-feeding status,

as well as the dietary intake data, are used by the calculation system to determine adequacy of food and nutrient intake according to the basic logic developed in this study. The outputs are evaluated with the standard criteria of Dietary Reference Intakes for Koreans and Food Guidance System for Koreans to assess the adequacy of food and nutrient intake. The results of this process can be immediately printed on an evaluation form.

The evaluation form consists of a participant's personal information including ID, name, age, gender, adequacy of weight status, and adequacy of food and nutrient intake. An advisory note as well as dietary recommendations based on the evaluation results can be printed at the same time as the evaluation is completed. Additionally, the "Dietary Guidelines for Korean Adults", "Dietary Guidelines for Korean Elderly", and "Recommendations for the Prevention of Chronic Diseases" can be printed if requested by the participant or interviewer.

Tracking system

The tracking system facilitates the systematic management of data by researchers and participants. A participant first enters the system with basic information, such as name, gender, age, height, weight, pregnancy/breast-feeding status, and physical activity, and is then assigned an ID by the system. The CAPIS systematically saves all the information related to food and nutrient intake, such as date, meal, dish, dish code, dish name, food, food code, food name, and quantity of food according to ID, and these data can be retrieved by requests via this system. This system will be useful for managing recurring input as well as data from subjects participating in multiple projects. The tracking system also provides data to personnel at different levels (i.e., the general manager, research manager,

and interviewer) for convenience and security.

Practical utilization of the CAPIS

Functionality

The CAPIS functioned appropriately in inputting data with the dish and image database, which assists in the selection and estimation of foods and dishes eaten, in viewing the outputs with calculated foods and nutrients, and in providing evaluation results immediately in a hard copy of the results form in a pilot survey. In terms of the application of the results, the database can be exported as an Excel or text file for statistical analysis. For purposes of secure data management, respondents are granted participant-level authority that allows them to access only their own data, interviewers are granted surveyor-level authority that allows them to access the data from the participants they manage, and research managers can access all the data in the project.

On-site applicability

The data from 181 participants (61 males, 120 females; aged 24 to 85) (Table 2) showed that 32.6% of participants preferred the CAPIS over the manual method in terms of the ease of estimating their intake, 23.2% preferred it in terms of the ease of recalling their intake, 35.4% preferred it in terms of the ease of communicating with the interviewer, and 43.7% preferred it in terms of the ease of concentrating on the interview (Table 3).

Efficiency

Both methods required explanations of how to answer the questions addressing food and nutrient intake about 5 min in face-to-face interviews with subjects. The mean interview time

Table 2. General characteristics of participants in the practical utilization study

Variables	Male (n = 61)	Female (n = 120)	Total (n = 181)	p value*
Age		Mean (SD)		
	51.1 (13.0)	43.9 (12.4)	46.3 (13.1)	
		N (%)		
≥ 50 yr	27 (44.3)	81 (67.5)	108 (59.7)	0.003
< 50 yr	34 (55.7)	39 (32.5)	73 (40.3)	
Education				
≤ High school (12 yr)	25 (41.0)	38 (31.7)	63 (34.8)	0.214
≥ College (13 yr)	36 (59.0)	82 (68.3)	118 (65.2)	

* χ^2 test.

Table 3. Comparison of practical utilization between using CAPIS and the manual method

Comparison		24-Hour recall with software (CAPIS)	24-Hour recall with manual (CAN-pro)	p value
N (%)				
Feasibility [†]	Which made it easier to estimate the amount of food consumed?	59 (32.6)	46 (25.4)	0.024
	Which made it easier to recall dietary intake?	42 (23.2)	22 (12.2)	< 0.0001
	Which made it easier to communicate with the interviewer?	64 (35.4)	24 (13.3)	< 0.0001
	Which made it easier to concentrate during the interview?	79 (43.7)	29 (16.0)	< 0.0001
Mean (SD)				
Time required for assessment process [‡]	Introduction	5 min	5 min	-
	Interview	9 min 42 sec (4 min 30 sec)	7 min 30 sec (3 min 12 sec)	< 0.0001
	Calculation & Coding/Input	These procedures are not required CAPIS.	15 min 35 sec*	-
	Total time required	14 min 42 sec	28 min 5 sec	-

*Results from the DES study conducted by Jung [26]; [†]p-value from χ^2 test; [‡]p-value from Student's t-test.

for collecting dietary intakes with manual method (7 min 30 sec) was significantly shorter than with CAPIS (9 min 42 sec) ($p < 0.001$). However, the manual method required an additional 15 min 35 sec for food-unit-based weight conversion and coding [26], while CAPIS did not require this process (Table 3). Therefore, overall time required to collect and evaluate dietary intakes was shorter with CAPIS than the manual method.

Discussion

We developed a web-based computerized open-ended dietary assessment program (CAPIS) that can be used to assess the dietary intakes of Koreans. It can automatically provide output in accordance with a standardized dietary assessment. Although various computer-assisted dietary assessment programs have been developed in many countries, CAPIS is the only program that can assist in estimating amount of foods and dishes eaten with food and dish images on the screen and provide immediately a hard copy of the results in Korean populations. The newly developed CAPIS has the following strengths. First, it makes easy to collect dietary intake data via the web. Participants and researchers can access their records at any time as often as desired. Second, the images of foods and dishes included in the program displaying various sizes

of servings on the screen can help subjects provide more accurate estimates of food and dishes eaten as their recall. Third, the time for interview and coding and input process is considerably shortened because the coding and input processes are performed simultaneously with entering food-intake data. Fourth, evaluation results can be provided to the participant immediately after completing the interview, which can increase satisfaction with open-ended dietary assessments. Fifth, the tracking system of CAPIS enables to researcher collecting individual's repeated dietary intakes data in multi-center prospective studies due to the convenient data management system in multistage. Sixth, the website can be used to perform a 24-hour recall interview as well as to maintain a food record, which results in increased feasibility in survey with a large sample. When it is used to maintain food records, participants should be provided a standard guidelines for this process that were developed for this study. Finally, the system was developed to assess the diets of Koreans in particular. The system used databases including food-composition tables for common Korean foods and recipes of common Korean dishes.

Various kinds of computer assisted dietary assessment programs were developed in the world. Daniel et al. [11] developed a computer program, "NINA-DISH", which has been

effectively used to collect and assess data on food intake in large samples, and another standardized computer program, "EPIC SOFT", was also developed for the same purpose [12]. Arab et al. developed a web-based computer dietary survey program called "DietDay", in which participants enter their dietary intake with reference to displayed food photographs and see the results soon after entering data [13]. Recently, a cellular phone-based dietary survey program named "Wellnavi" was also developed [14]. Several studies regarding the development of dietary assessment programs for PDAs have been conducted in USA and Japan [27,28]. Additionally, a previous study attempted to use a portable camera to obtain accurate data on food intake [29,30].

In Korea, a computer program named "CAN pro", developed for open-ended dietary survey by the Korean Nutrition Society is broadly used to conduct epidemiological survey. However, it can be applied only on the coding and entry after interview. The Korean Society of Community Nutrition developed a website, "Dietnet (<http://dietnet.or.kr>)" providing a web-based dietary diagnosis, but it is based on food frequency questionnaire [31]. "Health Diary (<http://diary.hp.go.kr>)", a web-based program developed to make participants be able to manage their diets by entering their dietary intake in open-ended food diary tool, has limitation on obtaining accurate data on food intake because of restricted food list and recipes. Whereas with "CAPIS", participants can select their dietary intake with photographs of food and beverage and can modify overall amount and food recipes, which allows to obtain accurate data on food intake. Thus, the CAPIS is a unique web-based computer program for open-ended dietary assessment for Koreans based on the Koreans' dietary behaviors.

To enhance its accuracy and utilization, the food-composition database and recipe databases of CAPIS should be updated on an ongoing basis. Because the system includes images of limited common foods and dishes, the inventory of the photos must be continuously increased to include more portion sizes and dishes [6]. The CAPIS is web-based program, which guarantees convenient accessibility regardless of time and location, however, the security of the data should be monitored by researchers and participants. In addition, further researches that apply CAPIS to large populations and prove validity to estimate food and nutrient intakes are necessary.

Conclusion

The newly developed CAPIS worked well in terms of func-

tionality, on-site applicability, and efficiency. It was preferred by subjects in terms of their ability to recall or estimate the amount of food and dishes eaten, and to concentrate on the interview. It also allowed the researchers and participants to reduce time and effort for the interview and data processing. The results imply that CAPIS may enable the inclusion of open-ended dietary assessments in large-scale surveys with immediate feedback as well as efficiency.

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