

## Personalized Nutrition Intervention for Weight Control With Korean Foods via Internet Service System

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### ABSTRACT

People with obesity or over-weight need nutritional intervention to reduce their weight, because weight loss reduces the incidence rate of chronic diseases such as hypertension, type II diabetes, cardiovascular diseases and cancer in obese people. This study was to develop a system for individualized weight control program available both for wired and wireless internet users. This system is especially useful to users carrying wireless internet mobile device. If they input their physical information (height, weight and waist circumference) and mineral levels measured by hair tissue mineral analysis, the system provides evaluation of their health status and metabolic related functions such as endocrine and carbohydrate tolerance. Based on these evaluations, food menus are then offered to them to manage their health status and to improve their metabolic related physiological functions in a personalized way. The system also provides more information for recommended foods, such as nutritional information, food ingredients, recipes, and videos related to cooking. Bibimbap was selected as an example dish for customized contents for mobile web. Bibimbap is one of the most well-known Korean traditional dishes prepared with various kinds of ingredients including several different kinds of vegetables, meat, and egg so that it is a low calorie dish as well as a well-balanced diet. Therefore, this system developed in this study allows the mobile users to access web site through wired/wireless internet everywhere and provides a customized content to the users to manage their weight and finally to achieve a desirable weight.

**Keywords:** Wired/Wireless Internet, Weight loss, Adult disease, Bibimbap

### 1. INTRODUCTION

Obesity has been a great issue for society as it is a major risk factor for development of metabolic diseases such as cardiovascular diseases, hypertension, type II diabetes and cancer [1], [2]. The incidence rate of these metabolic diseases can be reduced by losing the weight in obese people [3]. However

there are several drawbacks in most of the current weight control means. One of the problems is to restrict only the amount of calorie intake not considering quality of meals [4]. When weight loss is accomplished only by reducing calorie intakes, a yo-yo phenomenon most likely arises after weight loss and overall health status becomes worse. Therefore a successful weight loss program should include the concept of food quality, biochemical individuality, and customized intervention [5],[6].

Korean traditional foods are excellent in weight management program as it possess the concept of food quality for having

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both low-caloric and well-balanced nutrition [7]. Korean foods count taste and visual artistic aspects as an important value. Korean food pursues natural, unique smell, flavor and texture of ingredients itself as well as temperature of food in terms of taste aspect. Also, Korean regards foods as an excellent medicinal tool allowing for healing or prevention of the most human health problems. So, the prefix *yak* meaning medicine in Korean, is used in the name of some Korean traditional foods such as *yakgwa* (honey cookies), *yaksik* (sweet rice with nuts and Korean dates), *yakju* (strained medicinal wine) and *yangnyeom* (various seasonings used for cooking). These names of foods implicate that Korean has made cuisine beneficial for health to the person who eats it. Korean traditional cuisine also pursuit aesthetic appeal by using a combination of five different colors and five different tastes. The five colors are blue, yellow, red, white, and black; the five tastes are sour, bitter, hot, sweet, and salty. Thus eating Korean foods imply healthy life style because of the proper combination with great taste, numerous health benefits and artistic appeal based on rich history. The excellence of Korean cuisine is now beginning to gain recognition through worldwide and has attracted attention from all around the world [8]. Recently by being introduced, it becomes one of foreigners' favorite among Korea dishes [9].

Bibimbap is one of the Korean traditional foods that have been historically popular. It was originated from agricultural and ancestral ritual cultures. It is served as a bowl of warm white rice topped with seasoned vegetables, meat, egg, hot red pepper paste and sesame oil. As included various ingredients, it is nutritionally well balanced with low caloric content [10].

Mobile phone is one of the strongest medium without being limited by place and time. Unlike PCs, their convenient accessibility and portability has led to a new era of providing information to the masses. There is immense potential for a single mobile application to provide information, in that mobile phone not only performs the simple communication functions but also has become the more powerful contents delivery medium than any others, as wireless internet becomes available [11]. Thus, wireless internet mobiles device can be an excellent medium which can provide content for Korean traditional foods to spread its historicity and excellence into all over the world.

If weight loss is accomplished with the excellent quality of meal using mobile application, it will bring a huge raffle effect. However, no contents offering weight control program through mobile system have been developed so far. Therefore, this research was conducted to develop a system consisting of evaluation of obesity index and obesity-related metabolic functions, recommendation for customized foods, and healthy management for weight loss whenever and wherever through wireless internet enabled mobile phones.

## 2. METHOD

### 2.1 Food Selection

Foods were selected with the following criteria: 1) should be representative for Korean traditional foods, 2) should be well-being-based and nutritious, 3) should be low calorie, and 4) should be enjoyable both by Koreans and foreigners.

### 2.2 Research on Bibimbap

**2.2.1 Characteristics of Bibimbap:** Bibimbap is a well-known Korean traditional meal. The word literally means 'mixed rice'. It was originated from Korea's agricultural and ancestral ritual cultures. Bibimbap is served as a bowl of warm rice topped with various seasoned vegetables and red pepper paste. A fried egg and sliced beef are common additions. The ingredients are mixed together just before eating. For visual appeal, the toppings are often placed so that adjacent colors complement each other.

**2.2.2 Types of Bibimbap:** Typical Bibimbap includes Jinju Bibimbap, Junju Bibimbap, Andong Hutjesatbab, Hajukyoban and Pyeongyang Bibimbap from North Korea, Motbab from Kangreung province, etc.

**2.2.3 Ingredients of Bibimbap:** Rice, meat, bean sprout, Japanese parsley, Chinese bellflower, fernbrake, shiitake mushroom, young pumpkin, cucumber, carrot, mung-bean jelly, pepper sauce, tangleweed, egg, chestnut, pine nut, ginkgo nut, walnut and other sauces.

**2.2.4 Characteristics of Bibimbap ingredients:** Nutritional contents of each ingredient have been verified using Food Nutrition Contents database. Nutritional data on Bibimbap ingredients is referred to database provided by Korean Nutrition Society, Food Ingredient Dictionary, Food Nutrition Dictionary, etc.

**2.2.5 Bibimbap as a weight control food:** Bibimbap was selected as one of customized weight control foods because it fulfills all the criteria described in the section 2.1.

### 2.3 Physical index

Users have to put their height, weight and waist circumference for evaluation of obesity index and blood pressure or blood sugar level for general health evaluation on the basis of their preexisting measurements. Body mass index (BMI) was calculated as weight divided by height squared ( $\text{kg}/\text{m}^2$ ) [12].

### 2.4 Hair Tissue Mineral Analysis (TMA)

Levels of Ca, Mg, Na and K in the hair were measured using ICP-MS as described previously [13].

Hair was cut as close to the scalp as possible and 3-4 centimeters from where it was cut on the head was taken. About 200mg of hair was measured and sent to the Korea Food Research Institute (Seongnam, Korea) for mineral analysis. Hair samples were wet digested overnight with 2.5 ml of  $\text{HNO}_3$  in a closed, graduated polypropylene tube (50 ml) at room temperature and then for 1 h at 60 to 70°C in a drying oven. After cooling to room temperature, the sample was diluted to a final volume of 25 ml with Milli Q water. This solution was used to analyze mineral contents in the hair with Perkin-Elmer Mass Spectrometer (Sciex Elan 6100, Perkin-Elmer corporation, Foster, CA, USA) [13]. Mineral levels in the hair are shown as ppm ( $\mu\text{g}/\text{g}$  of hair).

**2.5 Obesity-related physiological function assessment**

Obesity-related physiological functions such as adrenal activity, thyroid activity, immunity/vitality and carbohydrate tolerance, were also evaluated through the levels and ratios of the four macro-minerals in the hair.

**2.6 Obesity-related metabolic typing**

Based on the levels and ratios of the four macro-minerals in the hair, metabolic types of the subjects were specified into one of the 12 types; Fast, Tired-fast, Slow, Extreme-slow, Sub-oxidation, Stressed-slow, Carbohydrate-intolerance, Extreme carbohydrate-intolerance, Step-up, Step-down, Mixed I and Mixed II [14], [15].

**2.7 Mobile associated Research**

Since OS is iOS (Mac OSX), this research has materialized the development of weight control program APP (application) on the basis of mobile, using programming language provided by the Apple company. Programming tool is Xcode and language used is Object-C. Furthermore, Microsoft Internet Information Services (IIS) uses Net (ASP, C#) to enable web service on the mobile phone. This is the secondly well-known web server following Apache web server. Apache is developed using php. The environment for designing the mobile contents is shown in Table 1.

Table 1. Environment for designing the mobile contents

Item	Environment
Server	Linux Apache
Operating System	Linux
Database	MySQL
Language Utilized	PHP
DB Connection	ODBC
SmartPhone Development Tool	Xcode
SmartPhone Development Method	Native App Method

**2.8 Weight Control Program Design**

Weight control program are composed of text, video and photo of individual food. It progresses according to the following steps.

**2.8.1 Step 1:** One’s physical index and mineral data obtained through Hair Tissue Mineral Analysis (HTMA) are input on the main screen of mobile phone. Height (cm), weight (kg), and waist circumference (cm) were used for physical index. The levels of Ca, Mg, Na and K (ppm) were provided from Korea Food Research Institute.

**2.8.2 Step 2:** One’s obesity degree was presented as derived using height and weight input data. Metabolic types, possible reasons for metabolic dysfunction and problems were given based on mineral input data.

**2.8.3 Step 3:** Foods complementing one’s health status and physiological functions were recommended. Data on recommended foods such as benefit, ingredient, characteristics, recipes, etc can be received from the application. The classification of recommended foods is based on mainly active compounds, minerals and vitamins in it.

**2.8.4 Step 4:** Diet menu was set up by using recommended foods and then evaluated for its caloric nutrient composition. In addition, necessary minerals and vitamins were recommended. With this menu, users can manage their weight control on the daily-, weekly- or monthly-basis.

**3. RESULTS: MOBILE CONTENTS DESIGN AND an EXAMPLE of SERVICE**

**3.1 Evaluation of Obesity Index**

We assessed obesity degree by following steps presented in Fig 1. First, anthropometric measurements such as height (cm), weight (kg), and waist circumference (cm) were input as shown in Fig 1-A). After data input, calculated data and comparison to the published standard value for Korean population were shown in Fig 1-B). In Fig 1-C), BMI and obesity index were presented for obesity assessment. Users were also informed whether their blood pressure or blood sugar levels are within normal ranges based on their input data in Fig 1-C). In Fig 1-D), customized foods were presented on the screen and then favorite foods can be chosen from the presented list. Furthermore, information such as efficacies, recipes, and videos are provided for the foods chosen by the users. If the user is a pregnant, lactating women or health status with hypertension, diabetes, hyper-lipidemia, anemia or osteoporosis, proper foodswere presented without any estimation process for their obesity degree.



Fig. 1. How to assess obesity index

**3.2 Assessment of Obesity-related physiological Function.**

To determine accurately obesity-related physiological functions, mineral levels and the ratios between minerals in the hair such as Ca, Mg, Na, and K were used.

Mineral analysis in the hair has been used by clinicians for a diagnosis of mineral status, because analysis of the mineral

content in the hair provides a longer record of trace-element metabolism [16-18]. Hair grows, on the average, about 1-2 cm per month and mineral content of the hair reflect the body's health condition [19]. Thus, HTMA can evaluate nutritional excess, deficiency or imbalance in the body.

Ca, Mg, Na and K are the major macro minerals in human physiology. Na and K are strong electrolytes which is essential for the maintenance of membrane electric potential. Calcium and magnesium play their pivotal roles in nerve transmission, muscle contraction and relaxation. Levels of Ca, Mg, Na and K in the hair reflects various physiological functions including adrenal glands, thyroid glands, immunity, vitality and carbohydrate tolerance status etc. Therefore, measurement of these four macromineral levels in the hair can be used to monitor physiological functions related with obesity.

Procedure in search of obesity-related functions using HTMA is as follow (Fig 2). First, users were provided their hair mineral levels through iphone and then they input the values into the section designated on the iphone Fig 2-A). In Fig 2-B), obesity-related physiological functions were presented based on the levels and ratios of minerals; Na/Mg for adrenal activity, Ca/K for thyroid activity, Na/K for immunity/vitality, Ca/Mg for carbohydrate. Also, based on the levels and ratios of four minerals, users were assigned into one of the 12 different metabolic types Fig 2-C). Users were also offered potential causes and characteristics for their obesity, and then foods were recommended to prevent or correct their obesity according to their metabolic types.



Fig. 2. How to assess obesity-related function

**3.3 Customized Food Recommendation**

Based on assessment of the health status evaluated from one's obesity index and HTMA, customized foods were recommended using Korean traditional food in Fig 3-A), -B), -C). Also, as shown in Fig 3-D), the user was offered general data on foods recommended according to his/her health

condition, including its ingredients, benefits, characteristics, etc. In this study, Bibimbap was recommended for weight loss as a sample but various foods were included on the recommendation list that all foods were selected with the same criteria as Bibimbap. The user can chose his or her favorite foods from the recommendation list. Before choosing desired foods for his/her diet, the user can research related articles so that they can find out what is the best for them.



Fig.3. How to recommend customized foods based on obesity index(a) and obesity-related function(b)

**3.4 Menu Plan and weight control**

To continuously maintain weight loss without a yo-yo phenomenon, healthy diet was planned using recommended foods as presented in Fig 4. As shown in Fig 4-A), user can choose foods from the recommended food lists according to user's preference, so that they plan their diet (Fig 4-B). Then, planned diet was evaluated as follows; 1) total caloric contents for a day, 2) calorie composition ratio, 3) the amount of vitamin and mineral compared with the recommendation, 4) the intakes of major calorie nutrients compared with the published standard value for Korean population (Fig 4-C), 4-D)[20]. Through these steps, food quality can be evaluated. This is not just one time event, but can be carried out on the daily and weekly or monthly bases and manage one's menu (Data not shown). In addition, this system offers how to keep managing the weight (Data not shown). One user can put a desired weight on the screen then the system can provide ideal weight compared with one's current weight and ideal time span to achieve the desired weight. Finally, this integrated weight control system can be processed with good quality of meals.



Fig.4. How to customized menu plan

4. CONCLUSION

In this study, we developed a system for customized weight and health management system using wireless internet mobile device, a powerful delivery medium for contents. We adopt the management principle including restriction of calorie intakes and also improvement of meal quality to provide a successful healthy weight management program to users. Anyone with mobile phone can use this system anywhere and anytime with no limitation and can be served with the suitable contents focused on one’s input data. Weight control program APP can evaluate the obesity status based on the user’s physical measurement and metabolic functions with the levels of the four major minerals and the ratios between the minerals determined by the hair Tissue Mineral Analysis (TMA). In summary, this weight control APP provides evaluation of obesity status and physiological functions, qualitatively customized food menu and various data on the recommended foods and continuous weight control.

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