

# Application Design for Child Obesity Management Based on Users' Preferences and Needs

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## Abstract

This study aimed to investigate the constructive preferences and needs of children and guardians in a child obesity management application, and to suggest and visualize the key features of its design. To reflect users' preferences and needs, the questionnaires used in this study were developed in four stages: draft, validity test, review, and final version. The survey was conducted with fifth and sixth grade children who are overweight or obese and their guardians. Differences were observed by gender and between children and guardians with respect to children's perceived body shape, technology experience and preferences, preferred obesity management method, application design, exercise and diet-related features, preferred partner for obesity management, and preferred reward after mission completion. Our study suggests and visualizes the key features of a child obesity management application for both children and guardians based on their preferences and needs, which can be utilized by both application developers and researchers.

## Keywords

pediatric obesity, family, mobile applications, health service needs and demands

Obesity is defined as excessive fat accumulation that may impair health (World Health Organization, 2018). It is a fast-increasing chronic disease caused by an imbalance between calorie intake and expenditure (Im, Park, & Gu, 2009). The obesity rate (overweight and obese) in young people between the ages of 2 years and 19 years is 32% in the US (Ogden, Carroll, Kit, & Flegal, 2014). In Korea, the obesity rate among elementary school children is 15%. The rate of children performing "vigorous physical activities three days or more per week" decreases as grade level increases; hence, the obesity rate among children in fourth through sixth grades is 22.3% (Ministry of Education, 2014). Obese children and adolescents are around five times more likely to be obese in adulthood than those who are not obese (Simmonds, Llewellyn, Owen, & Woolacott, 2016). Childhood obesity easily leads to adulthood obesity and can cause not only physical problems leading to metabolic risk factors that can cause chronic diseases but also psychological problems, such as internalizing disorders, attention-deficit hyperactivity disorder, low self-esteem, low self-efficacy, depression and anxiety, negative body image, and sociability degradation (Korean Society for the Study of Obesity, 2012; Pulgaron, 2013).

In addition, because children's diet habits are reflective of their parents, active parental participation is important in obesity management measures for obese children (Golan, Fainaru,

& Weizman, 1998; Wadden et al., 1990; Wang, Min, Khuri, & Li, 2017). In Korea, 51.3% of the women, who are primarily responsible for raising children, are working, and the yearly labor force participation rate among women is steadily increasing (Statistics Korea, 2015). Because both parents participate in the labor force, it is difficult for them to manage their children's weight at home through dietary and lifestyle changes, which are essential in obesity management.

As much of these childhood lives are spent in school, there are also a number of obesity management programs implemented in schools. However, obese children tend to avoid participating in obesity management programs at

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school because they are concerned that other children might make fun of them (Lee & Kim, 2007; Son, 2011). To encourage the participation and performance of obese children reluctant to participate in an obesity management program due to spatiotemporal restraints and psychological reasons, research has been conducted on a web-based obesity management program. However, the scope in which children can utilize web-based programs is limited, and the limit to the inability of real-time communication has been reached (Lee & Park, 2013; On, 2012).

Child obesity intervention through mobile technology has the advantages of flexibility, speed, and reduction in the burden of an obesity intervention. Mobile technology-based tools have been successfully utilized as data collection tools, assessment tools, platforms to provide intervention, behavioral self-monitoring tools, and real-time monitoring tools (Tate et al., 2013). In addition, smartphone use is steadily increasing. In the US, 68% of 13–14-year-old children and in Korea, 72.2% of elementary school students have smartphones (Lenhart et al., 2015). This suggests a possibility to utilize smartphones as tools for child obesity management. Owing to mobility and portability, a smartphone enables users to find out real-time obesity-related issues and health-status information. Thus, a smartphone application for weight management can be used more effectively (Cho, Kim, & Kim, 2011; Hyun, Song, Kim, & Kim, 2011). Additionally, the technology to increase accessibility and compliance to an application is required.

In randomized controlled trial (RCT) studies conducted between 2007 (the year when the smartphone was launched) and 2016 to intervene in child obesity in elementary school using mobile technology, parents participated in weight management or text messaging technology, and health trackers were utilized (Lee, Piao, Byun, & Kim, 2016). However, the mobile technology utilized in those studies mainly involved text messaging, and only four RCT studies were included in a systematic review. Hence, research has been insufficiently conducted to develop and test the effect of a smartphone application for child weight management.

The present study was conducted to investigate the constructive preferences and functional needs of children and guardians in a smartphone application for child obesity management and to suggest key factors for its design and development.

The detailed objectives for this are as follows:

- Children who are obese and parents should identify the basic elements necessary in using smartphone applications.
- Based on the factors derived, the questionnaire for the survey should be organized.
- The results of the survey should be analyzed to derive key factors.

## Methods

To reflect users' needs, the questionnaires used in the present study were developed in four steps: draft version, validity test, review, and final version.

### Step 1: Draft Version

**Personas' Needs.** "Persona" refers to a fictional character created to represent potential users of a product or service (Lidwell, Holden, & Butler, 2010). Personas method was used to identify the necessary basic elements. In the current study, four personas and scenarios about pediatric obesity were created. From the scenarios, we derived each persona's preferences and needs in a child obesity management application. The preferences and needs were constructed as survey items, which were included in the surveys (child version: 11 items, guardian version: 9 items).

#### Personas and Scenarios

**Persona A.** Persona A is a fifth-grader female who desires to be like her classmate, has many friends, and is relatively non-obese. She worries about becoming chubby like her mother when she grows up.

**Persona A's Mother's Persona.** Persona A's mother is a 42-year-old homemaker. She is not confident in helping her daughter lose weight because of having experienced failure to lose weight and weight cycling herself. She is unfamiliar with mobile applications and thus prefers a simple and user-friendly design with the ability to provide her daughter practical encouragement and rewards.

**Persona B.** Persona B is a fifth-grader male who likes to play smartphone games and uses food as a means to reduce stress. He feels bad about being compared with his non-obese brother. He prefers a weight loss application that is as fun as a game.

**Persona B's Mother's Persona.** Persona B's mother is a 47-year-old working mother who tends to take complete manage herself and is highly skilled at using a smartphone. She wants an application that allows her to communicate with her son and accurately monitor his weight management.

**Personas' Preferences and Needs.** Child personas' preferences and needs included weight reduction, change in habits, earning rewards, and fun. Guardian personas' preferences and needs included better communication with the child, healthy habits for the child, and increased monitoring reliability when the child performs diet and exercise missions (e.g., no soda for two weeks or 7,000 steps per day for a week).

**Other Study Tools.** To develop survey instruments, items pertaining to application characteristics, functions, and

preferences were reviewed in existing studies (child version: 26 items, guardian version: 10 items; Chung, 2009; Jeon, 2003; Lee, 2011; Ryu, 2002).

**Systematic Review Findings.** Items were developed based on the results of a systematic review of previous studies (child version: 2 items, guardian version: 4 items; Lee et al., 2016).

### **Step 2: Validity Test**

Experts in nursing informatics examined content validity for the survey items. One item in the survey for children scored lower than 0.5 points and was subsequently revised.

### **Step 3: Review**

Elementary school teachers and school nurses, as well as sixth-grade children and their guardians, reviewed the surveys, and as a result, some items were revised.

### **Step 4: Final Version**

The final version of the survey consisted of 35 items for the children version and 23 items for the guardian version.

### **Data Collection**

Researchers directly explained study objectives to principals and school nurses at 11 elementary schools and obtained permission to conduct research. Subjects include fifth- and sixth-grade children who are overweight or obese and their guardians. These grades were selected because we reasoned that children in those grades would be able to understand the study objectives, since the Internet and mobile technology are included in Korean fifth grade curriculum. The estimated sample size computed using G\*power analysis with the assumption of an effect size of 0.25, a significance level of 0.05, and a power of 0.95 was 305 pairs. In consideration of survey return and dropout rates, 420 pairs were recruited.

The fifth and sixth grade participants whose body mass index (BMI) was categorized as overweight/obese at the school health screening within the last two months and whose guardians understood the objectives of the surveys were chosen. Study descriptions aimed at guardians, consent forms for the guardian and child to fill out, and two surveys—for the guardian and the child—were sent in a sealed envelope to each child in the study sample. Completed surveys were collected by school nurses.

### **Data Analysis**

Data were coded in Microsoft Excel and were analyzed using SPSS Windows Program. Descriptive statistics were computed for each of the items. Differences according to

gender, grade, and BMI in each item were tested with a t-test, a  $\chi^2$  test, and a one-way ANOVA.

### **Ethical Considerations**

In addition to survey data, the height and weight of the child were collected at school. Before data were collected, the study was approved by the Seoul National University IRB and the elementary school principals (IRB No. 1508/002-011). The study descriptions written for subjects and the consent forms for children and guardians clearly stated that they had the right to refuse participation at any time.

## **Results**

### **General Characteristics**

From the 11 elementary schools, a total of 423 children were overweight or obese based on BMI, and the number of pairs (children who are overweight or obese and their guardians) who gave consent to participate in the study and whose surveys, consent forms, and height and weight data were returned was 324. Of those, one pair did not complete a survey; thus, the data from 323 pairs were analyzed. The rate of a child and the guardian responding simultaneously was 85.8%. The average age of children and guardians are 12.47 years and 42.1 years, respectively. Table 1 shows the general characteristics of the participants.

### **Differences in Children's Body Shape Perceived by Children and Guardians**

Data regarding children's body shape perceived by children and guardians, and the need for obesity management are shown in Table 2. The results of the analysis of children's perceived body shape by gender are as follows: 29.7% (n=96) of male children perceived themselves as plump and 11.1% (n=36) as portly, while 31.9% (n=103) of female children perceived themselves as plump and 17.3% (n=56) as portly. Guardians' perception of their child's body shape was also significantly different depending on the child's gender. The proportion of guardians perceiving their child as portly was higher for female children (n=65, 37.4%) than for male children (n=35, 23.5%) ( $\chi^2=7.231$ ,  $p=.027$ ).

### **Differences in Preferences for Obesity Management between Boys and Girls**

Table 3 shows data regarding preferred partner and method of managing obesity by the child's gender.

### **Diet and Exercise-Related Features**

Table 4 shows children's preferences and needs for diet-related features. Furthermore, regarding the dietary

**Table 1.** Participants' characteristics (N=646).

Children			N (%)	Guardians			N (%)
Gender	Male		149 (46.1)	Gender	Male		46 (14.2)
	Female		174 (53.9)		Female		277 (85.8)
BMI	Overweight		185 (57.3)	Occupation	Homemaker		117 (36.5)
	Obesity		138 (42.7)		Office worker		59 (18.5)
Grade	5th		171 (52.9)		Service worker		48 (15.0)
	6th		152 (47.1)		Professional		36 (11.3)
					Public employee		15 (4.7)
					Factory worker		14 (4.4)
				Other		30 (9.4)	
				Relationship to the child	Mother		281 (87.0)
					Father		37 (11.5)
					Others		5 (0.5)

**Table 2.** Differences in perceptions of child body shape and need for weight management between children and guardians (N=646).

	Children N (%)	Guardians N (%)	$\chi^2$
Perceived body shape			
Skinny	3 (.9)	0 (0)	70.332**
Normal	29 (9.0)	20 (6.2)	
Plump	199 (61.6)	203 (62.8)	
Portly	92 (28.5)	100 (31)	
Need for weight management			
To increase weight	6 (1.9)	4 (1.2)	40.230**
To lose weight	294 (91.0)	271 (83.9)	
To maintain weight	21 (6.5)	47 (14.6)	

\*\*p<.01.

monitoring feature, 33.2% (n=215) of the guardians stated that the child's daily diet should be monitored, 13.4% (n=87) had a neutral attitude, and 3.1% (n=20) stated that monitoring is unnecessary.

Children's responses for preferred exercise and mission-related features are shown in Table 4. The amount of exercise time needed per day was, on average, 48.26 minutes according to children and 48.30 minutes according to guardians, which were not statistically different from each other. However, the amount of exercise time needed on the weekend was statistically significantly different (t=2.037, p=0.042), that is, 56.08 minutes according to children and 50.11 minutes according to guardians. Guardians were categorized according to their job status: homemakers (n=117) or wage earners (n=199). The amount of exercise their child would need during the weekend was examined by group. Regarding the guardians characteristic, the homemaker group showed 63.50 minutes, and the wage-earners group showed 51.95, displaying a statistical difference (t=2.027, p=0.044). In addition, regarding the feature of monitoring the child's exercise activity (observation or record), 70.9% (n=229) of guardians considered it necessary, 4.9% (n=16) considered it unnecessary, and 23.8% (n=77) were neutral.

**Table 3.** Children's preferred partner and method of managing weight by gender (N=321).

	Male N (%)	Female N (%)	$\chi^2$
Preferred partner			
With family	68 (45.9)	100 (57.8)	7.961*
With friends	46 (31.1)	31 (17.9)	
Alone	34 (23.0)	42 (24.3)	
Preferred method			
Managing both dietary habits and exercise	88 (59.9)	71 (41.4)	17.044**
Dietary habits	38 (25.9)	46 (26.6)	
Exercise	21 (14.2)	57 (32.0)	

\*p<.05, \*\*p<.01.

### Experience Using Obesity Management Application and Preferred Design

Of the children, 88.7% (n=282) did not have experience using an obesity management application. Most of them preferred and used gaming applications (n=143, 44.3%), and they preferred Japanese animated characters (n=169, 52%). However, 63.2% (n=203) responded positively about the necessity for child obesity management applications, and 77.3% (n=249) said that they would like to use an application to manage their weight. This finding was similar for guardian as well (n=247, 77.2%). Understandably, the children of guardians who intended to use an application were also more likely to intend to use one (p=.029). The intention to use an obesity management application was greater in the overweight group (77.8%, n=144) than in the obese group (76.6%, n=105; p<.001). Moreover, the proportion of such guardians was higher among those of children who are obese (82.5%, n=113) compared to those of children who are overweight (73.4%, n=135; p<.001).

Of the child respondents, 74.6% (n=241) responded that measurement technology for daily total calorie consumption/number of steps would be needed to manage weight, and 64.4% (n=208) responded that sending text messages or

**Table 4.** Children's preferences and Needs for diet and exercise-related features (N=323).

		N (%)	t	
Diet-related	Time to eat the most	Breakfast	26 (8)	
		Lunch	124 (38.4)	
		Dinner	165 (51.1)	
	Preferred snack	Cookies, bread, pizza, rice cake, fruit and fruit juice	157 (31)	
		Milk and milk products	137 (27.1)	
		Soft drinks	123 (25.7)	
		Others	54 (10.7)	
			32 (6.3)	
	Preference for late-night meals	Yes	181 (56)	
		No	142 (44)	
Having confidence in diet-related mission completion	Yes: Male children	140 (94.6)	8.545*	
	Yes: Female children	156 (84.4)		
Exercise-related	Preferred exercise	Ball sports	116 (35.9)	
		Seasonal activities (e.g.: swimming, skiing)	83 (25.7)	
		Racket sports	69 (21.4)	
	Non-preferred exercise	Seasonal activities (e.g. swimming, skiing)	79 (25.2)	
		Ball sports	71 (22.7)	
	Having confidence in exercise-related mission completion	Yes: Male children	143 (96)	7.021*
		Yes: Female children	150 (87.7)	

\*p&lt;.05.

application notifications providing information on obesity management would be needed. By gender, 99 male children (66.4%) and 109 female children (62.6%) said this technology would be necessary; thus, the need for application notifications was greater for male children than for female children ( $\chi^2=9.761$ ,  $p=0.45$ ). Comparison between guardians and children showed that children more strongly demanded measurement technology for daily total calorie consumption/number of steps than guardians did (74.6%,  $n=241$  for children and 70.3%,  $n=227$  for guardians;  $t=4.426$ ,  $p<.001$ ). Regarding the necessity of obesity management reminders via text message or notification, 65.1% ( $n=210$ ) of guardians and 64.4% ( $n=208$ ) of children thought it necessary. Moreover, 171 children (53.3%) and 127 guardians (39.3%) showed an interest to participate in the design process of child obesity management application.

### Preferred Reward after Mission Completion

The type of reward children preferred the most from their guardian was a weekend picnic (31.5%), followed by increased spending money (25.6%). For online rewards, parties/gift certificates were wanted by 47% and game money by 30.4%. For feedback that children would like to receive from the guardian, 81.8% wanted praise to recognize them if they achieved a goal and 59.2% wanted encouragement if

they did not achieve a goal. For rewards guardians would like to provide, the most frequent response was what the child would want (22.6%), followed by picnics and travel (16%).

Regarding the intent to provide rewards, 86% ( $n=276$ ) of guardians responded that they would reward the child if they successfully managed their weight, and children of guardians with the intention to reward were more likely to have the intention to complete exercise-related missions ( $\chi^2=6.338$ ,  $p=.012$ ).

### Key Features of Child Obesity Management Application

The preferred key features for the children's version included an examination of the child's dietary and exercise habits as well as their preferences prior to setting diet- and exercise-related missions, gamification to induce interest, and dietary and exercise monitoring features, using familiar characters. The preferred key features for the guardian's version included accurate information regarding the child's BMI and activity duration, notification via texting or an application notification, and continuous updates.

Figure 1 shows the design of child obesity management application based on children's and guardians' responses to the questionnaires.



**Figure 1.** Screenshots of the child obesity management application.

## Discussion

Although this study was conducted for children with a BMI categorized as overweight or obese, three of the children who participated in the study thought of themselves as “skinny” and 29 as “normal.” This result is consistent with previous study findings reported by Paek (2002), Ter Bogt et al. (2006), and Fredrickson, Kremer, Swinburn, de Silva-Sanigorski, and McCabe (2013), that children do not accurately perceive their body shapes. With respect to gender, female children were more likely to perceive themselves as being portly than male children. Further, guardians of a female child were more likely to perceive their child as being portly than guardians of a male child; those who responded that their female child was portly were almost twice as many as those with a male child. This finding demonstrates the influence of mass media or societal perceptions regarding criteria for beauty in women and suggests that it is important to help children and guardians have an accurate perception of body shape.

Regarding the need for obesity management, in some cases, both the child and guardian responded that a weight increase was required. Therefore, not only children but also guardians should be provided pediatric obesity management education and accurate information on obesity (Spence et al., 2017; Yackobovitch-Gavan et al., 2018). Our findings are consistent with a previous study finding that only 50.6% of parents of children who are overweight and 61.9% of parents of children who are obese attempted to manage the child’s weight. Perception of the body shape affects the motivation to control weight and the choice of obesity management methods (Yoo, Oh, & Kim, 2014). Therefore, it is essential that information on accurate body shape perception and an additional feature for including their parents are incorporated in a child obesity management application.

Furthermore, with respect to the type of partner with whom children would like to manage weight, both male and female children most frequently selected family, suggesting that it would be significant to consider a format in which guardians can also play a part when designing a child obesity management application. Next to the family, boys preferred friends, whereas girls preferred managing weight alone, indicating that boys do not place great

significance on sharing information about weight or body shape or their participation in weight control, whereas girls do not prefer to share such information with friends. Additionally, there were significant differences in the preferred method of managing weight by gender. Globally, the gradual increase in gender disparity suggests that designing the application based on gender differences contributes to the weight management of children who are overweight or obese (Lee et al., 2015; Song et al., 2016).

The amount of food consumed by a child in the present study was the greatest at dinner, a finding compatible with what is suggested by a previous finding showing that more food consumed at dinner or late night corresponds with greater abdominal obesity (Na et al., 2016). Fruit juice, a frequently consumed snack type, contains high sugar, and cookies, bread, and meat in late night meals are obesity-causing foods (Rouhani, Salehi-Abargouei, Surkan, & Azadbakht, 2014; Santiago et al., 2015). Accordingly, features for determining the right type, amount, and timing of food consumed are necessary. One of the options to make it possible is using mission. The findings showed that most children responded that they have confidence in the diet-related missions. Accordingly, it would be effective to adjust the task difficulty or personalize the task according to the child’s response to the mission.

The exercise type most preferred by children was ball sports, but the proportions of children liking and disliking seasonal sports (such as swimming and skiing) were very close. Thus, sports preference is quite diverse. In recommending an exercise mission to application users, it would be useful to encourage them to do activities they prefer such as diet-related mission. Regarding the amount of exercise time needed, there was a significant difference between children and guardians, especially; wage earners responded with the need for a shorter exercise time than homemakers did. Guardians should be made aware that a sedentary lifestyle (Healy et al., 2008) and lack of physical activity are critical factors in child obesity (Gurnani, Birken, & Hamilton, 2015; Sahoo et al., 2015). Therefore, the exercise-related feature in an application for guardians, especially for wage earners, can be used to encourage children to make more time for physical activity.

In the present study, more than half of the children who are overweight or obese stated that they would like to use a child obesity management application even if they did not have any prior experience of using an obesity management application. Furthermore, children of guardians who intended to use a child obesity management application were more likely to intend to use one. Hence, a functional and effective child obesity management application should be developed. Additionally, the technology to increase accessibility and compliance to an application is required. The majority of children preferred game-related applications, suggesting that applications sufficiently reflecting the fun and motivation-inducing factors are important. However, most game-format applications for children who are obese have not been

sufficiently tested by experts (Schoffman, Turner-McGrievy, Jones, & Wilcox, 2013) and, therefore, an application should reflect experts' recommendations for setting diet or exercise missions and using related features. It cannot be said that a child who is overweight or obese performs less physical activity compared to a child who is normal weight (Im, Oh, & Suk, 2017), so it is necessary to lead children to perform physical activity in ways that are more fun and helpful in managing weight. Additionally, given the finding that the overweight group had a greater intention to use an application than the obese group, the latter group should be encouraged to better understand the need for weight management with the help of their guardians.

Technology measuring calorie consumption and number of steps through an internal sensor and recording consumed foods at any time the user wants are some of the advantages of a smartphone-based application (Lim, Kim, Yoo, & Zhang, 2012). Interestingly, children needed the measurement technology more than guardians did, and guardians needed the alarm technology more than children did. These findings indicate that children, that is, the agents of weight management, want to play an active role and be able to confirm the actual numbers, whereas guardians see themselves as a passive manager, receiving notifications about the measurements.

With respect to design elements, more than half of children preferred characters from Japanese animation. For an effective application, symbolic images familiar to them or providing a choice of diverse characters and characters with a story could increase attention and fun (Koh & Lee, 2011). More than half of the children showed an interest to participate in the designing of the application, a proportion higher in comparison to that of guardians. This suggests that it may be desirable to include children when developing the application or in the pilot stage. In addition, continuous content management is critical, as guardians perceived a need to improve features through continuous updating of existing obesity management applications.

Children most wanted time with family (e.g., picnic) as a reward, and guardians also selected time with family for the child as the second most preferred reward they wanted to provide after "what the child would want." Change in child weight or obesity risk occurs when there is a problem in family communication or conflict exists in the family (Halliday, Palma, Mellor, Green, & Renzaho, 2014). Accordingly, spending time with the family as a reward would further increase the effect of the obesity management application. When guardians intended to reward, the children were more likely to be willing to complete the missions; therefore, the effect of the application will increase with the appropriate use of reward.

The strengths of the present study are that the survey was conducted for 323 pairs of children who are overweight or obese and guardians, and that the preferences and needs derived through a unique research methodology, including the use of personas and scenarios. Furthermore,

the results of the systematic review (Lee et al., 2016) were confirmed in children who are obese and their guardians, based on the survey results. The questionnaire data were especially analyzed by connecting their weight and height data. Taken together, the present study suggested the key features in application design and visualized two versions of the application based on the user's preferences and needs (see Online Supplemental File 1: Key Features in Developing Child Obesity Management Applications). These findings can be utilized by both application developers and researchers. An intervention study may be conducted in the future to examine whether the application reflects the findings of the present study consistently. The limitations of this study were that it was conducted only for residents of a single city, so the results of the study are likely to be biased due to its local characteristics.

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### Author's Note

Jisan Lee is currently employed as Assistant Professor in the Department of Nursing Science, College of Life & Health Sciences, Hoseo University, Asan, Korea.

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### Supplemental Material

Supplemental material for this article is available online.

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