



Maternal body weight and diet management system

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ARTICLE INFO

Keywords:

Gestational weight gain
Maternal information systems
Multi-platform
Internet
Maternal weight
Mobile devices

ABSTRACT

Background: Body weight control is a significant issue to pregnant women. Overweight or underweight not only affects the normal growth of the fetus but also results in health impacts for pregnant women. Currently, some mobile applications which have released to stress how to achieve the purpose of weight control are not suitable for pregnant women. To design an appropriate mobile application of body weight control for pregnant women, a multidiscipline team collaborated.

Objective: This study proposed a mobile application approach to assist women to maintain an ideal weight control during their pregnancy. In addition, the usefulness of the application was evaluated among pregnancy women.

Methods: Firstly, the guidance of weight and diet management for pregnant women were obtained from textbooks and professional healthcare providers including nurses and nutritionists. Secondly, the researcher considered aspects of Human-Computer Interaction and theories of information technology behavior to design the mobile application. Finally, 52 pregnant women were recruited to test the prototype, which is a mobile application available on different devices with browsers.

Conclusions: Compared with other similar types of body weight and diet management mobile applications, the proposed application offers several characteristics to increase pregnant women's willingness to use it.

1. Introduction

Maternal underweight or obese would influence the health of mothers and fetuses, resulting in childbirth and pregnant complications such as gestational diabetes, hypertension among others [1,8,11,12,14].

From a health perspective, it is important to help pregnant women how to manage their body weight and have a nutritional intake. Accordingly, healthcare providers should advise pregnant women to maintain their weight within an ideal region, instead of overweight or underweight. The Institute of Medicine in America has published a new edition for pregnancy weight gain guidelines in 2009, as shown in Table 1.

Recently, smart mobile devices have closely linked to people's daily life, and their applications have rapidly increased [15,16]. E-health refers to the delivery of health care through the Internet or Web-based system and information technology [15]. Many body weight and diet management applications have been designed for weight control and body sculpting; however, these applications may not be suitable for pregnant women.

In the current study, a body weight and diet management system, MomweightCare, which is designed exclusively for women during pregnancy and after childbirth. The following features are included in MomweightCare: (1) being available through varied internet-accessible devices; (2) providing individual nutritional recommendations based on their pregnant trimester; (3) illustrating a line chart which shows body weight changes, allowing users to easily understand whether their current body weight is within the recommended weight range or not; (4) a user-friendly interface to record daily diet and help users estimate the intake of food calories with visual aids; and, (5) providing related maternal information and knowledge.

2. Related works

Although body weight loss or body weight control has been applied to the field of e-Health, most applications are not user-friendly and difficult to clearly find their features and functions [13]. The research identified the key factors for developing the MomweightCare by analyzing Human-Computer Interaction and theories of information technology [2]. In addition, the evolutionary prototype strategy was

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Table 1
Institute of medicine weight gain recommendations for pregnancy [9].

Pre-pregnancy Weight Category	Body Mass Index ^a	Recommended Range of Total Weight (kg)	Recommended Rates of Weight Gain in the Second and Third Trimesters (kg) (Mean Range [kg/wk])
Underweight	< 18.5	12.5–18	0.5–0.6
Normal Weight	18.5–24.9	11.5–16	0.4–0.5
Overweight	25–29.9	7–11.5	0.2–0.3
Obese	> = 30.0	5–9	0.2–0.3

^a Body mass index is calculated as weight (in kilograms) divided by height (in meters squared).

introduced to understand users' needs, and correlated with suggestions of professional nurses. Currently, several mobile applications have been developed to achieve the purpose of weight loss [13]. However, rare applications have been used to maintain ideal body region for pregnant women [14]. Furthermore, balanced diet and exercise are important for pregnant women [21]. So expert suggestions from a professor specializing in “Maternity and Neonatal Nursing” were considered and implemented in the proposed system. To design an appropriate mobile application of body weight control for pregnant women, a multi-discipline team collaborated.

A user interface is the connection between people and computer systems [10], and plays the roles of communication and controller. User experience design was developed from psychology, and it was not only considered the system itself but also the user's psychological reactions and behaviors [5,18,20]. Designing an information system should consider the aspects of basic task function and the feel of the interface presented to users as well as possible scenarios.

The most referenced models for evaluating the usefulness of an information system are Information System Success Model (ISSM) [22,23] and Technology Acceptance Model (TAM) [24]. The ISSM, proposed by DeLone and McLean, contains a sequence of six key factors of for a successful system [22], as shown in Fig. 1. In comparison, TAM shows that the perceived usefulness and the perceived ease of use are the main decisive factors in using information technology [24, 25].

3. System design

The architecture of the proposed system is presented in Fig. 2. MomweightCare is composed of internet-connected smartphones and computers, as well as a MomweightCare server, which includes a web application server and a database. A pregnant woman can start using MomweightCare after she has been confirmed by an obstetrician.

For simplicity and rapid module development, the model-view-control (MVC) [29] software design pattern was adopted. This model can be divided into three layers. The first layer is the model layer, which retrieves data according to the commands from the controller and displays them in the view. The second layer is the viewing layer, which generates an output presentation to the user based on changes in the model. The third layer is the controller layer, which sends commands to the model to update and control the model's state.

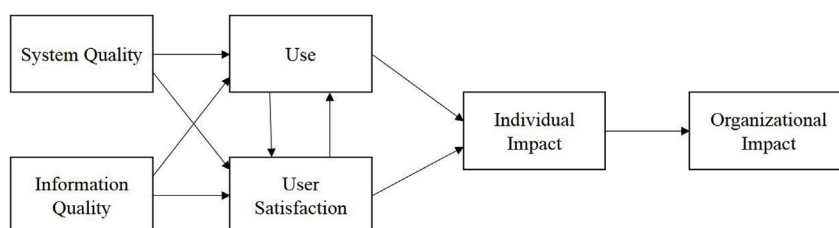


Fig. 1. DeLone and McLean information system success model [22].

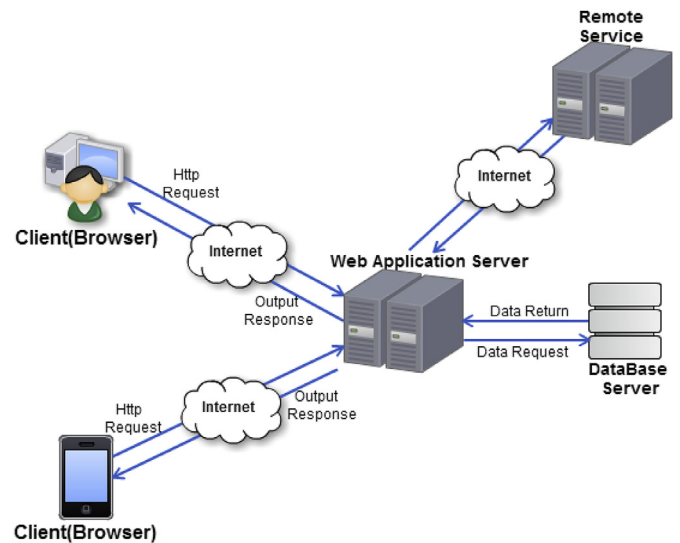


Fig. 2. MomweightCare system architecture.

4. Implementation

The MomweightCare system is written in PHP5 [3] and HTML5 and runs on a remote server with an Apache HTTP Server 2.5. Users can access the system using web browsers on their smartphones or computers. MySQL is the database used in the system.

Data security is very important to internet systems. HTTPS is used to establish an encrypted link between the server and the client. We use OpenSSL [27] for secure transfers, which is an open-source implementation of the Secure Sockets Layer (SSL v2/v3) and Transport Layer Security (TLS) protocols.

The final implementation is a web-based application, accessible from mobile devices, personal computers and notebooks, for maternal body weight and diet management. There are three primary points in the software: (1) a line chart that simultaneously presents user changes in body weight and their recommended body weight range during pregnancy (Fig. 3); and, (2) seeking mode or my favorite mode with a food database for users to record their daily diet and calorie intake, as shown in Fig. 4; and, (3) easy to use estimation of food calories per unit by utilizing objects like a coin or debit card to estimate food calories .

As shown in Fig. 3, the user can input their weight daily, and it is displayed as a line with dots. Most important of all, a ‘safe’ (recommended) range is shaded for guidance. In this way, the user can easily learn and see if her weight is well controlled between the recommended ranges. Fig. 4 shows the user-friendly interface for entering (choosing) what the user had just consumed. It can search the target food quickly and accurately by using the keywords and the categories. In addition, it also filters the list of candidate food to the user. The user can enter some parts of the food name or food manufacturer's brand in the keyword field; the user also can check the classification of food in the categories field, which contain breakfast, lunch, dinner, afternoon tea, late-night supper, snacks, beverages and fruit in it.

Fig. 5 presents the function of food calories estimation. When the food is a part of sample, it is difficult to accurately know the exact

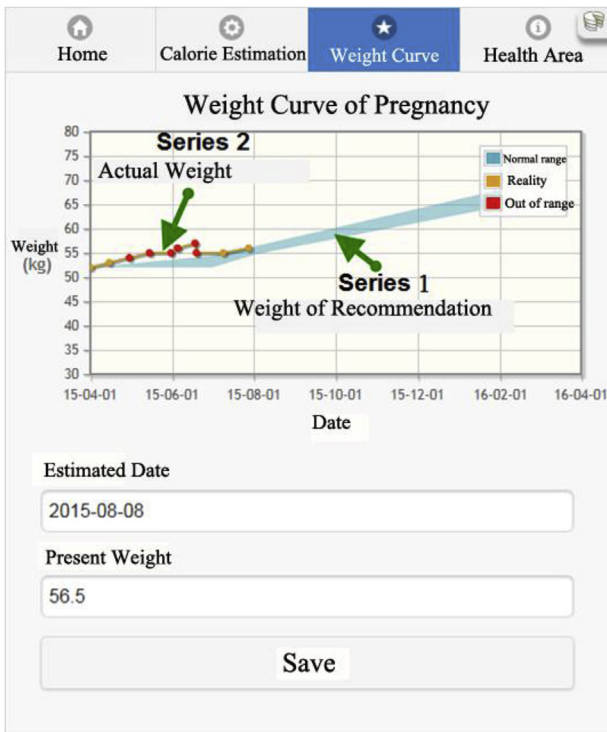


Fig. 3. Weight curve of pregnancy.

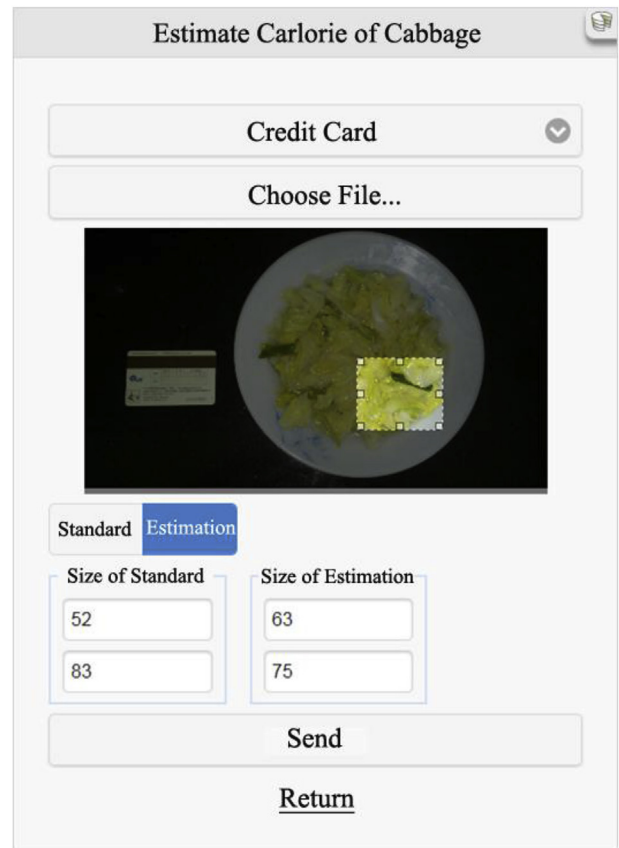


Fig. 5. Food calories estimation by area.



Fig. 4. Diet management.

calories of food. This proposed system adopts a food calories estimation model with food area as follows: (1) the user can choose the estimation food into the food list, and click “Edit” button as shown as the bottom of Fig. 4; and, (2) the user should login the page of estimation model with food area, and choose the standard object to compare with the target

food; and, (3) the user should upload a picture for the standard object and the target food. Finally, the user who draw the area for the standard object and the target food separately, and she will achieve the exact calories of food after sending it out.

Fig. 6 presents the real-time communication of this MomweightCare system. If this is the user’s first time to enable this function, she can click “join” button to join this official account. When the user encounters any problems, she can use this function to ask our professional nursing team.

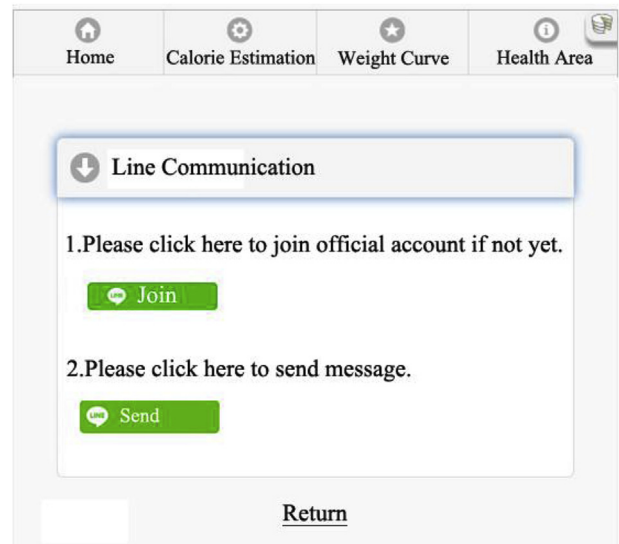


Fig. 6. Real-time communication.

Table 2
User satisfaction with proposed system (all participants n = 52).

Topic	Mean (SD)	Strongly satisfied (%)	Satisfied (%)	Fair (%)	Dissatisfied (%)	Strongly dissatisfied (%)
How do you feel about the overall system?	4.08 (0.48)	8 (15.4%)	40 (76.9%)	4 (7.7%)	0	0
Do you think all information of this system was easy to understand?	4.1 (0.53)	10 (19.2%)	37 (71.2%)	5 (9.6%)	0	0
Can you use this system easily?	3.94 (0.61)	8 (15.4%)	33 (63.5%)	11 (21.2%)	0	0
How do you feel about the recommended weight curve during pregnancy?	4.44 (0.61)	26 (50%)	23 (44.2%)	3 (5.8%)	0	0
How do you feel about the diet management?	4.04 (0.59)	10 (19.2%)	34 (65.4%)	8 (15.4%)	0	0
How do you feel about the “my favorite food” function?	4.08 (0.48)	8 (15.4%)	40 (76.9%)	4 (7.7%)	0	0
How do you feel about the food calorie estimation with pictures function?	3.58 (0.8)	6 (11.5%)	22 (42.3%)	20 (38.5%)	4 (7.7%)	0

Table 3
User satisfaction with proposed system (1st trimester participants n = 8).

Topic	Mean (SD)	Strongly satisfied (%)	Satisfied (%)	Fair (%)	Dissatisfied (%)	Strongly dissatisfied (%)
How do you feel about the overall system?	4 (0.76)	2 (25%)	4 (50%)	2 (25%)	0	0
Do you think all information of this system was easy to understand?	4.13 (0.35)	1 (12.5%)	7 (87.5%)	0	0	0
Can you use this system easily?	4.13 (0.35)	1 (12.5%)	7 (87.5%)	0	0	0
How do you feel about the recommended weight curve during pregnancy?	4.50 (0.76)	5 (62.5%)	2 (25%)	1 (12.5%)	0	0
How do you feel about the diet management?	4.38 (0.52)	3 (37.5%)	5 (62.5%)	0	0	0
How do you feel about the “my favorite food” function?	4.13 (0.35)	1 (12.5%)	7 (87.5%)	0	0	0
How do you feel about the food calorie estimation with pictures function?	3.88 (0.99)	3 (37.5%)	1 (12.5%)	4 (50%)	0	0

Table 4
User satisfaction with proposed system (2nd trimester participants n = 24).

Topic	Mean (SD)	Strongly Satisfied (%)	Satisfied (%)	Fair (%)	Dissatisfied (%)	Strongly dissatisfied (%)
How do you feel about the overall system?	4 (0.42)	2 (8.3%)	20 (83.3%)	2 (8.3%)	0	0
Do you think all information of this system was easy to understand?	4. (0.51)	3 (12.5%)	18 (75%)	3 (12.5%)	0	0
Can you use this system easily?	3.63 (0.65)	2 (8.3%)	11 (45.8%)	11 (45.8%)	0	0
How do you feel about the recommended weight curve during pregnancy?	4.21 (0.59)	7 (29.2%)	15 (62.5%)	2 (8.3%)	0	0
How do you feel about the diet management?	3.79 (0.51)	1 (4.2%)	17 (70.8%)	6 (25%)	0	0
How do you feel about the “my favorite food” function?	3.96 (0.36)	1 (4.2%)	21 (87.5%)	2 (8.3%)	0	0
How do you feel about the food calorie estimation with pictures function?	3.29 (0.62)	0	9 (37.5%)	13 (54.2%)	2 (8.3%)	0

Table 5
User satisfaction with proposed system (3rd trimester participants n = 14).

Topic	Mean (SD)	Strongly satisfied (%)	Satisfied (%)	Fair (%)	Dissatisfied (%)	Strongly dissatisfied (%)
How do you feel about the overall system?	4.21 (0.43)	3 (21.4%)	11 (78.6%)	0	0	0
Do you think all information of this system was easy to understand?	4.14 (0.66)	4 (28.6%)	8 (80%)	2 (20%)	0	0
Can you use this system easily?	4.21 (0.43)	3 (21.4%)	11 (78.6%)	0	0	0
How do you feel about the recommended weight curve during pregnancy?	4.71 (0.47)	10 (71.4%)	4 (28.6%)	0	0	0
How do you feel about the diet management?	4.29 (0.47)	4 (28.6%)	10 (71.4%)	0	0	0
How do you feel about the “my favorite food” function?	4.29 (0.47)	4 (28.6%)	10 (71.4%)	0	0	0
How do you feel about the food calorie estimation with pictures function?	3.86 (0.54)	1 (7.1%)	10 (71.4%)	3 (21.4%)	0	0

5. Evaluation

Fifty-two women who are pregnant or at postpartum were recruited for the evaluation of users' satisfaction. The survey of evaluation was conducted to access their satisfaction with the proposed system using an 18-item questionnaire. Likert scales [28] were used for this questionnaire. Each topic had five items, namely strongly dissatisfied, dissatisfied, fair, satisfied, and strongly satisfied, represented by 1–5,

respectively. The mean score for most topic was close to 4, indicating that the respondents were satisfied with MomweightCare.

Of the 52 women, 8 (15%) were at the 1st trimester, 24 (46%) were at the 2nd trimester 3–6 months; 14 (27%) were at the 3rd trimester, and 6 (12%) were at postpartum (< 1 year). The most pregnant women used continuously about 1–2 months based on their login records. Table 2 represents all participants' satisfaction with the proposed system. 92.3% of the respondents have satisfaction (satisfied and

Table 6
User satisfaction with proposed system (postpartum < 1year n = 6)

Topic	Mean (SD)	Strongly satisfied (%)	Satisfied (%)	Fair (%)	Dissatisfied (%)	Strongly dissatisfied (%)
How do you feel about the overall system?	4.17 (0.41)	1 (16.7%)	5 (83.3%)	0	0	0
Do you think all information of this system was easy to understand?	4.33 (0.52)	2 (33.3%)	4 (66.7%)	0	0	0
Can you use this system easily?	4.33 (0.52)	2 (33.3%)	4 (66.7%)	0	0	0
How do you feel about the recommended weight curve during pregnancy?	4.67 (0.52)	4 (66.7%)	2 (33.3%)	0	0	0
How do you feel about the diet management?	4 (0.89)	2 (33.3%)	2 (33.3%)	2 (33.3%)	0	0
How do you feel about the “my favorite food” function?	4 (0.89)	2 (33.3%)	2 (33.3%)	2 (33.3%)	0	0
How do you feel about the food calorie estimation with pictures function?	3.67 (1.37)	2 (33.3%)	2 (33.3%)	0	2 (33.3%)	0

strongly satisfied) with the overall system. 84.6% of the respondents stated that the system was helpful for their diet management. Tables 3–6 represent 1st trimester, 2nd trimester, 3rd trimester and postpartum < 1year phases, respectively. Table 3 shows 75% of the respondents have satisfaction (satisfied and strongly satisfied) with the overall system. Table 4 shows 91.6% of the respondents have satisfaction (satisfied and strongly satisfied) with the overall system. Table 5 shows 100% of the respondents have satisfaction (satisfied and strongly satisfied) with the overall system. Table 6 shows 100% of the respondents have satisfaction (satisfied and strongly satisfied) with the overall system. Moreover, the lowest means in the all tables of topics was the function of food calories estimation that it was lower than 4 points. It is due to an inconvenience of calories estimation. It is needed to create other methods to obtain calories information rapidly, such as photographing or barcode scanning.

6. Conclusion and future work

This study proposed and implemented the MomweightCare system, and added valuable instructions about weight and diet management for pregnant women. They record each dietary pattern, and it can be realized how many calories they will take before eating. In addition, it also improved willingness and satisfaction for users with Information System Success Model.

In the future, the proposed system could be upgraded with food nutrient content to achieve a balanced diet among pregnant women. In addition, the study period can be extended from prenatal to postnatal period. Finally, the proposed web-based weight system could be combined with a healthcare support system to help women make better choices about nutrition during their pregnancies.

Acknowledgement

We would like to thank Cheng-Hsien Wang for discussing various issues related to this research. This research was supported in part by the National Science Council of Taiwan under grant NSC 104-2221-E-006-248.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to this work.

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Further reading

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