

Promoting Behavior Change in Food-Exercise Routine with Mobile Application Based on Social Support Strategy

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Abstract: Health is a universal concern for people of all ages. One of the major health factors is our food-exercise routine. However, our lifestyle, economic status, and willingness towards living a healthy life can have negative impacts on health that can lead to obesity, diabetes or physical problems. Therefore, we need an extra push or a trigger for changing our behavior. Social intervention and interpersonal relationships have provided positive results for behavior change. Similarly, the ubiquity of smartphones among people of all ages makes it an effective means for inducing behavior change. With that in consideration, we developed an iOS-based application, that can be used to track food intake and exercise routines of individuals and can be checked by their friends and family to provide suggestions regarding improvement in their routine. The application, UbiHealth, is aimed at providing a simple and easily understandable method to help each other in improving lifestyle. The results from our experiment are positive, as we received a total of 256 entries and 29 suggestions, and 50% of participants reported changing their behavior based on the suggestions received.

Keywords: behavior change, mobile application, social support

1. Introduction

Food is the basic requirement of our well-being. We consume food to get energy, get healthy and continue with our activities. In general, the calorie intake must be accompanied by appropriate exercise schedule, so that our body maintains a balance of food intake and burnt calories, also maintaining our metabolic and activity needs [1]. Too much or too less calorie burnt are leading causes of diseases and illness. However, maintaining a proper food-exercise routine is not something all can accomplish easily. Constraints such as time, money, and willingness to be healthy often are the causes of imbalance in food-exercise habits.

It was reported that about 39% of the world population in 2015 were overweight, out of which 13% were obese [2]. Increase in physical inactivity due to the sedentary nature of work, increased urbanization, and modes of transportation are considered to be major causes of overweight-ness in individuals. Along with that, changes in environment and society also affects our diet and physical activity [2].

Technology such as internet and mobile technology can help to induce health behaviour interventions for changing lifestyle patterns and weight management. 50% of smartphone owners in U.S have confessed to have downloaded applications related to weight loss and exercise [3]. Currently there are as much as 10,000 ap-

plications all targeting change in food-exercise routine enticing them towards a healthy lifestyle. But food-exercise routine is dependent on many factors such as availability of healthy foods, cost of healthy food or cost of joining a gym, time required for regular exercise, and so on [4].

Often so, we need incentives to complete some activities which we might not give much priority to. Individuals have difficulty in maintaining a healthy lifestyle improvement schedule without incentives. Those who lose 10% of their body weight, have confessed to have regained almost two-thirds of the lost weight within a year [4].

There has been many research and applications that have aimed at helping people have a proper food and exercise routine. These include helping people count calorie from all the food consumed throughout the day [5], [6] to maintaining a diary of food and exercise. We present a smartphone application, called UbiHealth, that can be used to keep track of the foods consumed and exercise carried out by the users. The application also supports social bonding by allowing friends and family to view the food-exercise routine, and provide suggestions to each other.

We conducted an in-situ study for a period of 2 weeks, with 8 participants (all male, average age: 25). The participants were asked to fill in their daily food and exercise intake. After a period of 1 week, their friends could check their intakes through graphical interface, and give suggestions as they deem necessary. We received a total of 256 entries and 29 suggestions. 50% said that they tried to change their food habits based on the suggestions provided by their friends.

In the following section 2, we describe previous research re-

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lated to this study. Section 3 includes description of our application, and section 4 explains our experimental setup and results in detail. We discuss the findings in section 5 followed by the conclusion of this research in section 6.

2. Related Studies

This section describes the existing research related to our study. The first subsection explains the growing interest towards research on food and exercise routines of people. In the second subsection, we explain the impact of social networking among individuals and how it helps to accomplish common goals.

2.1 Food and exercise

WHO have mentioned that only 1 in every 4 adolescents meets the recommended guidelines for physical activity: 60 minutes of moderate to vigorous physical activity daily [2]. Similarly, have found out that discomfort and lack of time are the main reasons that Japanese youths do not exercise enough. They also list a lack of social support and motivation as a reason youth tend not to exercise.

Young people normally do not have a fixed schedule, that impacts their meal intake and other activities [1]. Though health concern is a common topic of worry among people of all ages, we all need some extra push, motivation or influence towards achieving that goal. Eating healthy diet and appropriate physical activity in regular manner can help to decrease the risk of developing chronic diseases [7].

A healthy diet is also a topic of discussion. The constituents of a healthy diet vary between individuals, as food choices are a result of psychological, social, cultural, economic, and biological factors. Generally, an individual develops a personal taste and preference of foods based on the above mentioned factors, combined with life course events and experiences [7], [8]. A healthy diet can be defined as consumption of necessary nutrients by eating appropriate amount from all the food groups. Our diet can be regarded as a healthy diet if we consumes calories that are enough to maintain our metabolic and activity needs [1].

Many studies have aimed to maintain a proper healthy diet of individuals by the use of smartphone applications as well. HappyInu[9] encouraged healthy eating among its users, by changing the health of a virtual dog, as per the food consumption of its users. Similar concept was utilized in Time to eat [10], where based on food consumption of users, their virtual pet changed its physical appearance. Users were able to select the type of pet, and were sent regular notification through emails, encouraging them to eat, and upload pictures to the application.

Smartphone applications that help to encourage healthy eating and improve physical activity are getting popular recently [11]. In Fish'n'Steps computer game [4], corresponding to user's daily footstep count, the virtual fish they are taking care of, changes its appearance. The more the users walked, the healthier their fish was. This induced cooperation as well as competition among the users, since sometimes different fishes were kept in the same tanks for comparison. In UbitGarden, the growth of the garden and blossoming of flowers was affected by the amount of exercise conducted by the users [10].

Motivation is a key factor to achieve goals of healthy living, and specially if achieved through smartphone applications, it is very important to keep the user invested in using the application frequently. 45% of the users quit fitness related applications because they lose motivation to achieve their health goals and also many application lack features and feedbacks they require [11].

2.2 Social networking and health

Changing one's food-exercise routine is a matter of individual motivation and intention. However, it is argued that individual efforts can have full effect only when support is provided on a societal level [2]. Individuals tend to change their behaviour gradually, through a series of steps [4]. According to Fogg's behavioural model [3], the three factors required for behavior change are motivation, ability and triggers. Inclusion of societal impact for behaviour change can thus be the trigger for users. Many behaviour change application have placed reliance on interpersonal relationships and social influence [12].

Two participants were paired through a web application, and were asked to discuss and help each other change behaviours such as drinking more water, concentrating efficiently at work, etc. [13]. However, this study used strangers as motivators. Utilizing the pressure and influence of social relationship could provide much higher rate of motivation [11]. Behavior Change Support System Theory (BCSS) highlights the importance to give preference on user's needs and goals because changes induced by low sustainable methods can result only in temporary behaviour change [14].

Mobile phones play an important roles in the lives of people these days, especially young ones. The ever present connection to their social network and identity, entices them in using smartphones more so often. With that in mind, it is better to induce change in their food-exercise routines though the use of smartphone applications that also supports social interaction. A mobile game was developed, that can be used by all the members of the family, with the aim to reduce energy consumption of the house [15]. This game, played by all the members of the family, also included a competition feature with other family, and received positive results on energy consumption.

Similarly, in MyFitnessTeam application, daily challenges related to food consumption and exercise were assigned to users [11]. The application aimed to change behaviors of users by generating a sense of competition between them using weekly goals and accomplishments. However, we aim to change behaviors by using coordination among the users, and analyze their food-exercise routine without providing any recommendation from the application itself. We want to analyze if users will change their behaviors based on suggestions received from their friends. The following section explains our application and purpose of the experiment.

3. UbiHealth

We developed an iOS based smartphone application that can help friends and family track food-exercise routine of each other and give appropriate suggestions. Our hypothesis is that people will be willing to change their food-exercise routine when

(1) they receive suggestions from their close friends and family, and (2) they can observe that people close to them have a better diet and exercise routine than them. Most of the health related smartphone applications place higher effort towards user interface and keeping users engaged, rather than including strategies for behaviour change [3]. Since our main goal is to induce behaviour change, we have tried to keep the tasks in the application as simple as possible, and easy to understand.

The application was developed in Xcode Version 10.1 [16] in swift 4.2 [17], and could be installed in any iPhone or iPad with iOS version 11.2 or higher. Since young people generally do not care that much about their food-exercise routine, the affects of such negligence may be visible in their later years. It is thus necessary to address the issues regarding behaviours that lead to obesity, in-activeness, fatigue, and other health related problems [10]. Hence, we aim younger people as the target group for our application.

The application consists of 4 activities for the user :

- (1) Enter diary records
- (2) Check data of friends
- (3) Provide suggestions to friends
- (4) View personal report

We will now explain these sections in detail.

3.1 Diary

This is the section where users could input their daily food intake such as for breakfast, lunch, dinner and snacks. Along with that, the users also input their exercise routines of the day in the application. The users are provided with a list of items to choose from, for both food and exercise diary entries, where they can select multiple entries according to their activity.

A report from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) about food composition in Japan have classified the food consumed in Japan into 18 different groups, as shown in **Table 1**. The report depicting tables of food consumption in Japan has been developed to improve the health of Japanese people with each subsequent iterations of report [8]. We decided to use this food distribution for our application as well. But, we felt that some options such as seasonings and spices, algae, sugars and sweeteners, and confectioneries can be redundant at times which is why we reduced the food groups to 13, as shown in **Table 2**.

Table 1 Food groups according to MEXT, 2015

Beverages	Potatoes and starches	Cereals
Nuts and seeds	Vegetables	Fruits
Confectioneries	Prepared foods	Meat
Mushrooms	Fats and oils	Pulses
Milk and milk products	Fish, mollusks and crustaceans	Algae
Seasonings and spices	Sugars and sweeteners	Eggs

Table 2 Food groups for UbiHealth

Cereals	Fruits	Pulses
Fish	Milk and milk products	Alcoholic Beverages
Vegetables	Juice/drinks	Processed food
Meat	Eggs	Dry fruits
Salty/Sweet snacks		

The exercise we carry out can be divided into four basic types: Endurance, strength, balance, and flexibility [18]. Exercise preference also vary between individuals, so it is also difficult to determine what particular exercise could be considered as suitable for people of all age groups and preferences. For the purpose of this research, we chose the above mentioned four classification of exercise and asked the participants to input their exercise routines, by providing them a total of 12 physical activity to choose from, as shown in **Table 3**.

Table 3 Exercise groups for UbiHealth

Walking	Running	Dancing
Push up	Pull up	Yoga
Swimming	Neck, check or back	Cycling
Stretch	Lifting weights	Sports

The application interface for Table 2 and Table 3 are shown in **Fig. 1** and **Fig. 2** respectively. The interface for breakfast, lunch and dinner entry consists of the same interface and selection choices.

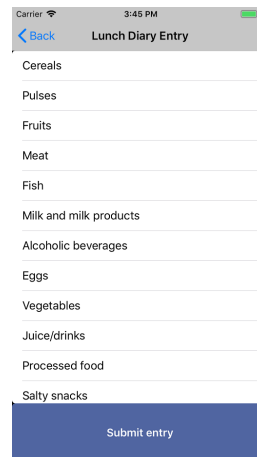


Fig. 1 Lunch entry interface

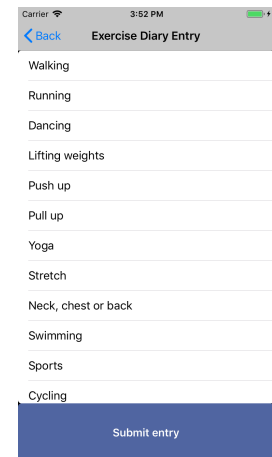


Fig. 2 Exercise entry interface

3.2 Check Friends

In this section of the application, the users are able to check weekly data of their friends. The data is divided into Diet and Exercise, as shown in **Fig. 3**. We use graphical interface to represent the food and exercise types, and show data for a 7-day period only. This is carried out because we feel it will be difficult to understand and analyze someone’s diet and exercise routine by analyzing data for a shorter time period. We believe a 7 day window can provide a satisfactory insight into an individual’s diet and exercise routine. Thus, using the 7 day food intake and exercise entries, we create a graphical weekly report for each users. After analyzing the graphical data of their friends, the user has the option to give multiple suggestions to them, as shown in **Fig. 4**. The suggestion to give to friends/family are also listed on **Table 4**.

3.3 Suggestion

This section is where the users can see the suggestions given to them by their friends or family. The application interface is shown in **Fig. 5**. We use similar graphical representation, of pie-chart, to depict the suggestions given to the user for Diet and

Table 4 Suggestions for friends/family

Less Cereals	More Cereals	Less Pulses	More Pulses	More Fruits
More Eggs	Less Meat	More Meat	More Vegetables	Less Alcohol
More Milk / Milk Products	Less Eggs	Less Processed Food	More Fish	Less Juice/Drinks
Less Salty Snacks	Less Endurance Exercise	Less Balance Exercise	More Strength Exercise	Less Strength Exercise
More Endurance Exercise	More Flexibility Exercise	Less Flexibility Exercise	More Balance Exercise	

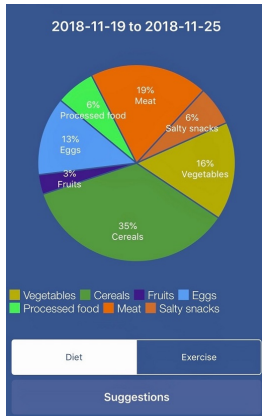


Fig. 3 Example of weekly Report

Less cereals

More cereals

Less pulses

More pulses

Less meat

More meat

More vegetables

More fruits

Less alcohol

More milk and milk products

Less eggs

More eggs

Submit suggestions

Fig. 4 Choices for Suggestions

Exercise by their friends or family. The graphical representation is simple and easy for the user to comprehend. We hope that through this the user can easily reflect upon the suggestions provided and decide whether to abide by them or not.

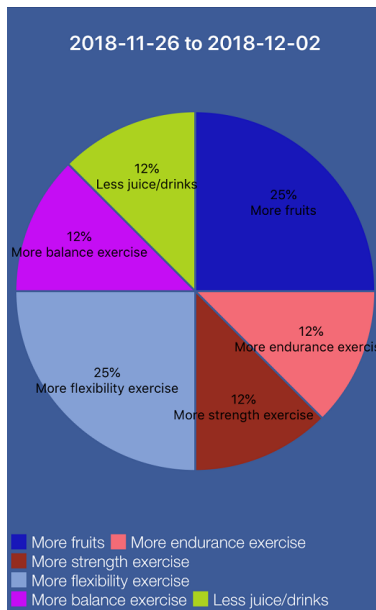


Fig. 5 Suggestions received

3.4 Personal Report

This section depicts the user’s data and is meant for self analysis. The weekly data of user’s food-exercise routine is shown, as in Fig. 3. This is helpful, if the users want to keep track of their Diet and Exercise routine themselves, or review their routine after going through the suggestions provided by their friends.

4. Experiment and Results

In this section, we will explain the experiment carried out to

test our application, and present the results based on the experiment. The main purpose of this experiment was to determine if:

- (1) the users will be willing to change their routine based on suggestions received from friends or family
- (2) the users will try to adopt a healthy lifestyle if their food-exercise routine is getting monitored

4.1 In-situ study

We conducted an in-situ study, by employing a total of 8 participants from Ubiquitous Computing Systems Laboratory, Nara Institute of Science and Technology, Japan. We used TestFlight, a platform to test iOS based applications, for distributing our application to the participants. The participants were all male, with an average age of 25 years. They were asked to use the application for a total of 2 weeks. The first week consisted of diary entry task only, while in the subsequent week, they were requested to check the data of their friends and give suggestions as they deemed necessary. At the end of 2-week period, we asked them to fill in a questionnaire, with some open ended questions, to get their feedback about the application, and its effect on their food - exercise routine.

For the purpose of our experiment, participants also received notifications (a total of 5 per day) for each entry: breakfast, lunch, dinner, snacks, and exercise. To ensure frequent use of the application, and keep motivation intact, each entry could be made only once per day, and entry could be made only for the current day. This feature, along with notifications, was added with the hope that participants would be encouraged to input their details as soon as they receive notifications. The notifications were sent at time periods that, in general, would succeed meal times (8:00, 13:00, and 20:00 for breakfast, lunch and dinner respectively). Since, people could exercise at different times, and have multiple snacks in a day, notifications regarding snacks and exercise were sent later in the day (21:00 and 21:30 for snacks and exercise respectively).

4.2 Results

We received a total of 256 entries from the participants in the study period of 2 weeks. Based on the entries, we found that, on an average, each participant contributed 14 entries in week 1 and 18 in week 2. Participants made a total of 114 entries in week 1 and 142 entries in week 2. Based on this, we can infer that the motivation to use the application and input entries did not decrease from the first week, showing that the participants were interested in using the application. Only 2 participants showed a decrease in their entry frequency, as shown in Fig. 6.

In week 2, when participants could view the food-exercise routine of other participants and give suggestions, we received a total

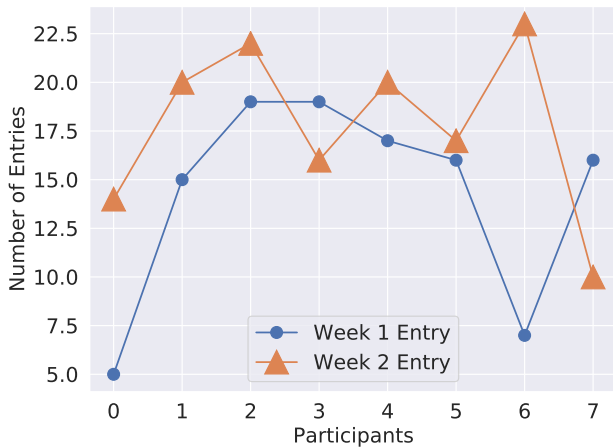


Fig. 6 Participant entries per week

of 29 suggestion entries. The suggestion response was also limited to one entry i.e. only one suggestion entry could be given to a particular participant per week. However, the suggestion entry could contain multiple suggestions such as less meat, more vegetables, more fruits, and so on.

We also asked the participants to fill in a questionnaire. 6 out of 8 participants said that they had previously used smartphone application related to tracking food and exercise. However, only 50% of them said that they were currently using the same application. Among the reasons for not using the application, participants responded as “I usually forget to fill in it, its a little bit troublesome for me.”, and “I always forgot adding.”. After the 2 week period, when we asked the participants whether they would prefer to use our application for a longer period of time, only 2 said they would not prefer to use it while 75% of the participants confessed they might be interested in using the application. We also asked the participants how often they were inclined to use the application. We found that the participants rated their inclination quite high, as shown in Fig. 7. 50% of them said that they were highly inclined (80-100 %) to use the application regularly. This shows that the usability of our application is fairly high compared to the ones used by our participants before.

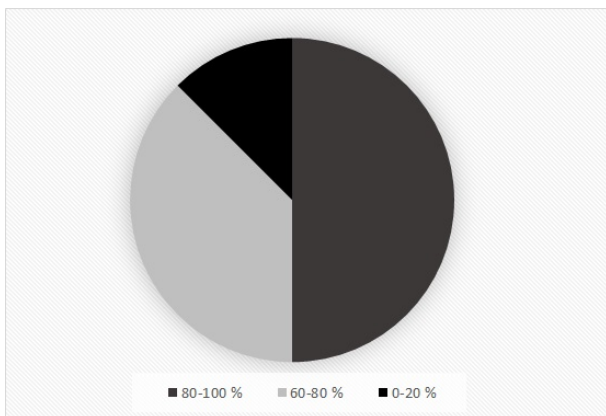


Fig. 7 Inclination of participants to enter data

Similarly, 50% of the participants said that they tried to change

their food-exercise routine after using the application. One participant responded as, “Yes. I try to eat vegetables.”. This shows that the application can inspire people to change their food-exercise habits, albeit the result is minuscule now, we feel that with continual use of the application, more changes in behaviour could be observed.

5. Discussion

In this section, we discuss about the findings of this study and how it affects our overall hypothesis in realizing the intended behaviour change. The main objective of this application was to introduce sharing of food-exercise habits of individuals among their friends and family so that they can give as well as receive suggestions about improving their habits. It has been proven that social sharing can provide better incentive towards achieving similar health goals among people [11]. Based on the results, we can confirm that our application induced some behaviour change among the participants. The fact that there was no decrease in the number of entries in the week 1 and week 2, and the average number of suggestions received by each participant was more than 50%, we can claim that our application was used regularly by the users.

Participants mentioned that the reason for not using food-exercise related applications was mostly being unable to remember to input the details. Since our application sent notifications to the users at different times through out the day reminding them to input their food-exercise routines, the rate of response was high. The application rating of 3 out of 5 provided by participants, proves that they were fairly satisfied with the application and its features. Similarly, since our application was simple and easy to use, the inclination of the participants to enter the data was also quite high.

50% of the participants confirmed that they tried to change their behaviour because of their use of our application. From buying more vegetables to exercising more often, we observed that the participants showed some tendency of behaviour change. This fulfills the first purpose of our experiment in knowing that people are willing to change their food-exercise routine if they receive suggestions from their friends or family. Although the short duration of this study might not provide concrete evidence of behaviour change, we feel that the intent and motivation of participants towards changing their food-exercise habit was reasonably high.

Only 2 participants showed a decrease in their data entry in the 2 weeks, and even so it did not affect the suggestions received by them. The participants actively checked the data of other participants and sent suggestions. This shows that when using among friends, the frequency of the use of application is high. We also found out that the participants are more inclined to change their behaviours when they know there are people observing them, as proven by one participant who confessed, “I felt like to remind myself to do exercise more than before installing this app.”. Thus, we can confirm that the second purpose of our experiment was also satisfied. We think this change occurred because the participants could view the data of each other and hence wanted to depict that they are living a healthy lifestyle.

However, we faced some limitations regarding the use of our application. The functionality to enter data for the current day was felt unsuitable by some of the participants (37.5 %). Similarly, we strictly followed the food group provided by MEXT, which meant that participant needed to make themselves familiar with the food group and could not enter or view more refined classification of food, as participants commented, “*I want to know more info of food. Example cereal separate into ramen and rice.*”, and “*I think its better to add drink water part.I think its also an important part of our health.*”. For further research, we aim to introduce food groups different than the one we used for this experiment, and also allow users to enter data of previous days.

6. Conclusion

We tried to induce food-exercise behaviour change among the participants by using the social support strategy, i.e. using friends as a trigger for changing food-exercise routines. We developed an iOS application that can be used among friends and family to check food intake and exercise routines of each other. The application also allowed users to provide suggestions to each other. We conducted an in-situ study for a period of 2 weeks and received a total of 256 responses and 29 suggestions from 8 participants. The participants regularly used the application, and 50% of them stated that they changed their food-exercise behavior based on the suggestions received in the application. Similarly, a participant stated to increase his exercise time and frequency in order to input more entries in the application, while another participant claimed to increase his vegetable intake. Furthermore, 75% of participants confessed that they might be interested to use the application for a longer period of time.

These results show that it is possible to change food-exercise behavior of individuals using their social circle, especially friends. Looking at the food-exercise habit of their friends, and receiving suggestions regarding change in their own habit can thus inspire individuals towards a healthy lifestyle. However behaviour change is something that cannot be confirmed by observing over a period of few weeks only. We would prefer to test the application over a longer period of time for more concrete results, however, current results, and mainly the desire of the participants to use the application frequently suggests that our application was successful in persuading users towards changing their behaviours.

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