Towards an Engaging Mobile Food Record for Teenagers

Maurizio Caon[1(✉)], Stefano Carrino[1], Federica Prinelli[2], Valentina Ciociola[2], Fulvio Adorni[2], Claudio Lafortuna[2], Sarah Tabozzi[2], José Serrano[3], Laura Condon[4], Omar Abou Khaled[1], and Elena Mugellini[1]

[1] University of Applied Sciences and Arts Western Switzerland, Fribourg, Switzerland
{maurizio.caon,stefano.carrino,omar.aboukhaled,
elena.mugellini}@hes-so.ch
[2] Consiglio Nazionale delle Ricerche, Milan, Italy
{federica.prinelli,valentina.ciociola,fulvio.adorni,claudio.lafo
rtuna,sarah.tabozzi}@cnr.it
[3] Universitat de Lleida, Lleida, Spain
jceserrano@mex.udl.cat
[4] University of Nottingham, Nottingham, UK
laura.condon@nottingham.ac.uk

Abstract. In the frame of the PEGASO European project, we aim at promoting healthier lifestyles among teenagers focusing on the alimentary education and physical activity. This paper presents a novel concept of mobile food record developed following a multidisciplinary approach to innovate both the monitoring and the user experience. This mobile food record does not count calories but is focused on tracking dietary patterns and support the adoption of target behaviours. Moreover, the introduction of game mechanics developed through participatory design techniques aims at sustaining engagement in the long term.

1 Introduction

The evaluation of dietary intake provides useful information for intervention programs aimed to prevent chronic diseases such as obesity [1]. For the assessment of food intake, three conventional tools are widely used for both adults and adolescents: the food frequency questionnaire (FFQ), food record (or diary), and 24-hour dietary recall. Each one with strengths and weaknesses [2].

Several issues have to be taken into account for monitoring dietary intake and especially designing a tool, which is able to evaluate the dietary habits of adolescents, and considering that youths have particular food choices and meal habits compared with children and adults. They differ in irregular eating patterns, frequent snacking and frequent skipping of meals, particularly breakfast [3]. Furthermore, the measurement of energy and nutrient intakes in adolescents is particularly challenging because they are more limited in their abilities to estimate portion sizes accurately in comparison with adults [4].

With the advent of new technologies, such as mobile phones, tablets, and other devices, the possibilities for rapid dietary data logging and real-time dietary analysis are

V. Murino et al. (Eds.): ICIAP 2015 Workshops, LNCS 9281, pp. 417–424, 2015.
DOI: 10.1007/978-3-319-23222-5_51

growing. Recent results reported that individuals, especially adolescents, prefer the use of a technology-based approach, rather than the traditional paper food record [5] suggesting that for this particular target population, dietary methods incorporating new mobile technology might increase the user adherence.

Due to the complexity of diet and the interaction among dietary components, instead of traditional methods of examining single foods or nutrients, holistic approaches able to capture the variation in overall food intake have been suggested. Dietary pattern is a set of habits regarding consumption of food and beverages and is characterised on the basis of usual consumption of foods and food groups and more closely describe real world conditions [6]. Furthermore, it has been reported that the relationship between diet and obesity, should focus not only on energy and macronutrient intake, but also on dietary patterns [7].

A number of specific food items and dietary behaviours have been associated with weight gain and chronic diseases in youth, including inadequate fruit and vegetable intake [8], breakfast skipping [9], frequent consumption of fast-food (energy-dense take-away meals) [10], increased sugar-sweetened beverages intake [11]. Snacking between meals (with high-calorie foods) has been associated with increased incidence of overweight and obesity increased [12]. Taken together, these data suggest specific areas of focus around which a nutrition education and a healthy diet promotion program may be structured.

Another important factor for the success of a food record is the user experience design. Indeed, teenagers have specific interests and understanding how it is possible to convey their attention in order to sustain their engagement over time is crucial. Moreover, other factors such as fashion and peer pressure play a critical role not only in the positive acceptance of the tool but also in the dietary habits [13].

In this paper, we present the multidisciplinary approach thought to design a food record application for smartphones that could be desirable for teenagers. In next section, we will present the context of the PEGASO project and the overview of its technological system. Successively, we will explain how we changed perspective on the food tracking in order to simplify the interaction and, at the same time, to go beyond the mere calorie counting function in order to focus on the change of target behavioural patterns that are associated with unhealthy lifestyles. Then, we will present the user experience design that aims at sustaining teenagers' engagement over time, and enhancing usability and acceptance. Finally, we will conclude this paper describing the work that we will conduct in the next months for the validation of the prototype developed using this approach.

2 The PEGASO System

Obesity is becoming epidemic and the World Health Organization estimated it to be the first leading risk related to nutrition for global deaths outranking famine [14]. Considering that besides genetic factors, the scarce health literacy level plays a crucial role in the spreading of this disease and that, as reported by the World Health Organization, over 60% of children who are overweight before puberty will be overweight in early adulthood, it becomes obvious that the best moment to intervene in order to

promote healthy lifestyles is during adolescence. For all these reasons, the EU-funded PEGASO project aims at developing a whole services ecosystem that should be able to motivate teenagers to learn and to apply a healthy life-style effortlessly in order to prevent diseases related to nutrition in adulthood, especially obesity [15]. In this ecosystem, a special role is played by the ICT system, which has been designed to use the smartphone as main interface for the interaction with the users. The smartphone has been chosen as main communication device because the current generation of teenagers already perceive it as a companion and this relationship is predicted to become stronger in the future [16]. In PEGASO, the smartphone provides a set of applications that enable users to access multiple services and games that aim to promote healthy lifestyles, in particular to motivate teenagers in performing physical activity and to adopt healthy dietary habits. In this ecosystem of interrelated applications and services, the food record application plays an important role in order to allow users to monitor and self-manage their alimentary patterns.

All these applications send the information to the cloud, where there is a semantic repository developed by experts in physiology, nutrition, and psychology that allows modelling the user's characteristics: this is called the Virtual Individual Model (VIM) [17]. The VIM allows structuring the information about the single individual about her characterisation of body structure, physiological status, physical activity behaviours, dietary patterns and psychosocial determinants. This information will be used to provide tailored interventions to the user applying the strategy that is estimate to have the biggest impact to change user's behaviour.

3 From Calories to Target Behaviours

Many food record applications for smartphones have been developed in the last years and they can be found in the most popular application stores, such as Apple Store and Google Play. All these applications provide the possibility to record information about eaten food and to count the relative amount of calories consumed. In the PEGASO project we developed a new kind of food record application for smartphone, which is able to monitor the dietary behaviours of adolescents and also to provide an immediate educational feedback based on dietary data inserted by the users.

This food record app has been designed to be used at different levels, depending on user compliance and usability, from the simplest level to the most complex and complete. Before filling in data, at the first log in, a demo will provide some information related with definition of specific dietary concepts and food categories user will find in different levels, in order to help her understand the purpose and the functionality of the food record app.

PEGASO nutritional theory, underlying the selection of parameters composing the VIM and the definition of target behaviours to be monitored and possibly changed, is consistent with the Food-Based Dietary Guidelines principles [18], commissioned to EFSA by EC, which derive from the Nutrient-based recommendations, explicitly referring to chemistry and human physiology of digestion.

The multidimensional analysis of alimentary behaviour built for the project is based on the nutritional principles agreed by the main international agencies and health organisations [19] and on evidences supporting the association of unhealthy

patterns of food assumptions [20]. It is able to encompass the energy content of foods, and also aspects of quality of foods and composition/frequency of meals, based on the relation with metabolic/physiological processes.

The list of dietary behaviours identified is: fruit consumption, vegetable consumption, sugar-sweetened drinks consumption, breakfast skipping, snacking habits, and fast-food intake.

This food record app consists of a detailed list of all foods (items) grouped into categories (groups) consumed by the user and recorded at the time the foods are eaten. Ideally, to record the intake following each meal or snack is better than waiting until the end of the day and trying to recall food items and amounts. This will prove to be more accurate and representative of the actual intake. Because a single day or few days of intake is unlikely to be representative of usual individual intake, the collection of multiple days of intake (preferable 3 week days plus week end) will be request in order to guarantee data completeness and reliability of the collected information.

The basis for placing a food item into 12 food groups was the similarity of nutrients, the typology and frequency of consumption together with the necessity to be well identifiable and recognisable by youths [21]. At each log in, the user will have to choose the type of meal (breakfast, lunch, dinner or morning/afternoon snack) after that she can add the different food groups in which her food/foods is/are included. This food record application is structured in three different levels, and each level provides to system different kinds of data and information. In order to capture the complexity of human diets in a single value, taking into account the interactions between nutrients, food preparation methods and eating patterns, the Diet Quality Indexes for adolescents (DQI-A) was used in order to give an immediate feedback to the user by means of pyramid and charts [22]. The major components of this DQI-A are dietary diversity, dietary quality, dietary equilibrium and meal patterns [23]. The diet diversity expresses the degree of variation of food intake in the diet; the diet equilibrium is calculated as the adequacy of intake of each food group based on known food group intake recommendations; the diet quality is expressed as whether the user makes the optimal food quality choices within a food groups.

4 User Experience Design

In order to develop an effective mobile food record application, it is necessary to implement a design that can sustain users' engagement over time. In order to understand what teenagers think about technology and health, and to empathically explore what are their desires and needs, we conducted several focus groups in three countries: Italy, Spain and UK. During these focus groups, we found out some crucial elements for the development of desirable food records: the use of the smartphone is perceived as a motivating means to acquire information about healthy lifestyles; the display of information should not be tiring, hence the use of multimedia, especially images, was suggested; the food record should be interesting and for this reason they suggested it could implement games in it (other researchers drew the same conclusion as in [24]). It is obvious that the user experience design is a crucial factor for the successful acceptance of the food record by the adolescents. Understanding that the gamification of the interface could be a winning choice [25], we conducted a workshop with 15 teenagers to generate ideas for the implementation of an engaging gamified food record application for smartphones. During this participatory design session, we explored

different possible solutions for the information entry and feedback taking into account both non-automatised approaches: tracking individual food items via a database and tracking food categories [26]. Moreover, we explored some game mechanisms that could be perceived as motivating and fun. Hence, we developed a prototype of a mobile food record based on the results coming from the focus groups and the workshop, and we integrated the strategy proposed by the experts in nutrition in order to allow for the monitoring of dietary patterns.

The prototype has been designed to evolve with the user: during the first period of use, the user interface allows the user only to select which food categories she ate during her last meal, Fig. 1 a), and the feedback just displays the diversity index, as depicted in Fig. 1 b). After some time and regular use, the user can access a more advanced interface, which allows specifying how many servings for each food category she ate during her last meal, Fig. 2 a); also the feedback becomes more complex: the user can monitor diversity index and the equilibrium index, with also a graphical representation of the eaten food amount with reference to the recommended daily quantity Fig. 2 b). It is also possible to monitor the dietary behaviour during the last week and during the last month. This evolving interface allows providing a sense of progression, which is a very motivating mechanism in videogames. The visualisation of the alimentary information has been chosen by the teenagers during the workshop (depicted in Fig. 1 and Fig.2): the food categories have been represented with pictures and the sole action required to entry the information is a simple tap; the feedback has been found particularly appealing because it was playful, and probably also the affective affordance of the smiley can enhance the engagement with the user. In addition, for every meal entry they can take a picture of the food and upload it.

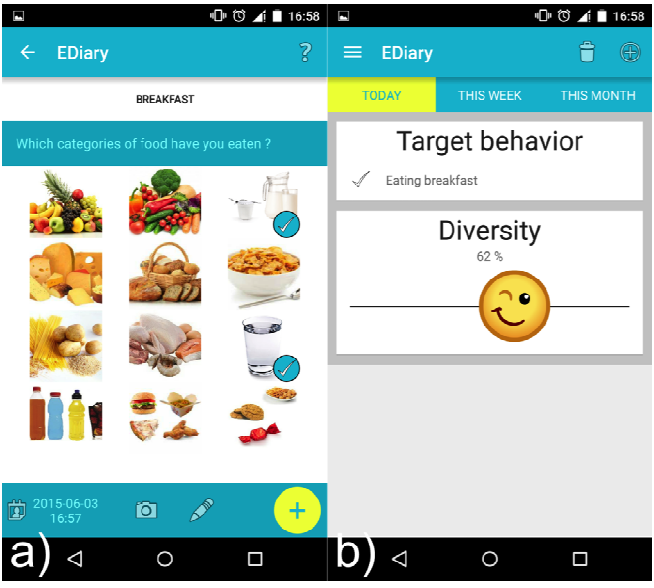

Fig. 1. The user interface in the beginner mode: a) shows the entry interface based on 12 food categories; b) shows the feedback about the diet diversity index and about the target behaviours.

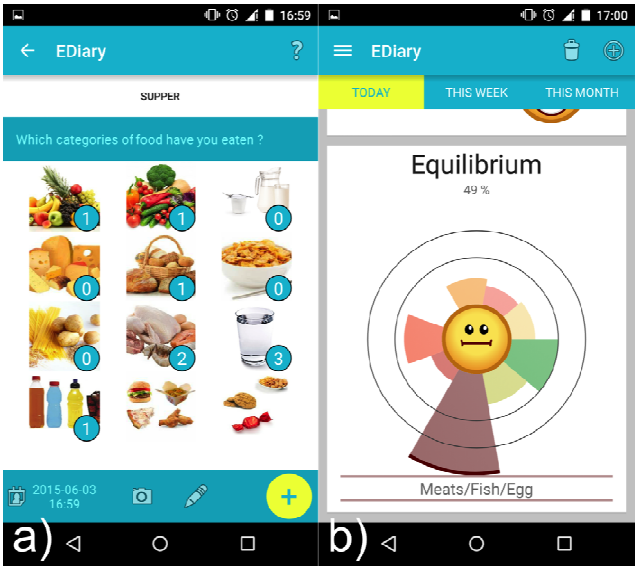

Fig. 2. The user interface in the expert mode: a) shows the entry interface based on 12 food categories with the possibility to specify the number of servings; b) shows the feedback about the diet equilibrium index (the radar chart shows the amount of each food category input and the circles the suggested daily quantity), obviously this interface comprehends also the diet diversity and the target behaviour feedback.

This food record shows also the adherence to the target dietary behaviour that the user chose to monitor. Providing a target behaviour consists of making the teenager to set a goal, which is the first step towards behaviour change. Moreover, it provides that possibility to focus on a goal, which is motivating, and the constant feedback allows her to improve her behaviour and provides the sense of progression.

Another game mechanism integrated in this prototype comes from the ideas generated during the workshop: the participants suggested that it could be motivating to receive games or other goods as a reward. Therefore, in this prototype, the regular use of the food record and the successful adherence to the target behaviour make the user to earn points; these points, associated to the user account, can be spent as a virtual currency in order to access special services or buy virtual items within the PEGASO ecosystem.

5 Conclusion

In this paper, we have presented the multidisciplinary approach adopted for the development of an innovative prototype of mobile food record. The presented approach substitutes the calories counting with the Diet Quality Indexes and enables the user to select a target behaviour supporting its change towards a healthy lifestyle. Moreover, we presented the results of the participatory design conducted with teenagers showing the integration of game mechanisms in the design of the prototype to make the user

experience more engaging. In addition, we reported the choices made for the interface design in order to enhance the usability for both food entry and for the feedback display.

Currently, we are organising a test with teenagers in UK, Italy and Spain to assess the usability of the current prototype, to understand their opinion about the interaction design and to understand if this is the right direction to follow. The feedback from these formative test sessions will be used to improve and finalise the current prototype for the final pilot studies that will be conducted next year.

Acknowledgements. The PEGASO project is co-funded by the European Commission under the 7th Framework Programme. The authors of the paper wish to thank all the project partners for their contribution to the work.

References

1. Ogden, C.L., Carroll, M.D., Curtin, L.R., Lamb, M.M., Flegal, K.M.: Prevalence of high body mass index in US children and adolescents, 2007-2008. Jama **303**(3), 242–249 (2010)
2. Thompson, F.E., Subar, A.F.: Dietary assessment methodology. Nutrition in the Prevention and Treatment of Disease **2**, 3–39 (2008)
3. Moreno, L.A., Kersting, M., De Henauw, S., Gonzalez-Gross, M., Sichert-Hellert, W., Matthys, C., Mesana, M.I., Ross, N.: How to measure dietary intake and food habits in adolescence: the European perspective. International Journal of Obesity **29**, S66–S77 (2005)
4. Livingstone, M.B.E., Robson, P.J., Wallace, J.M.W.: Issues in dietary intake assessment of children and adolescents. British Journal of Nutrition **92**(S2), S213–S222 (2004)
5. Boushey, C.J., Kerr, D.A., Wright, J., Lutes, K.D., Ebert, D.S., Delp, E.J.: Use of technology in children's dietary assessment. European Journal of Clinical Nutrition **63**, S50–S57 (2009)
6. Hu, F.B.: Dietary pattern analysis: a new direction in nutritional epidemiology. Current Opinion in Lipidology **13**(1), 3–9 (2002)
7. Nicklas, T.A., Baranowski, T., Cullen, K.W., Berenson, G.: Eating patterns, dietary quality and obesity. Journal of the American College of Nutrition **20**(6), 599–608 (2001)
8. Boeing, H., Bechthold, A., Bub, A., Ellinger, S., Haller, D., Kroke, A., Leschik-Bonnet, E., Müller, M.J., Oberritter, H., Schulze, M., Stehle, P., Watzl, B.: Critical review: vegetables and fruit in the prevention of chronic diseases. European Journal of Nutrition **51**(6), 637–663 (2012)
9. Szajewska, H., Ruszczyński, M.: Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe. Critical Reviews in Food Science and Nutrition **50**(2), 113–119 (2010)
10. Braithwaite, I., Stewart, A.W., Hancox, R.J., Beasley, R., Murphy, R., Mitchell, E.A., et al.: Fast-food consumption and body mass index in children and adolescents: an international cross-sectional study. BMJ Open **4**(12), e005813 (2014)
11. Larson, N., Neumark-Sztainer, D., Laska, M.N., Story, M.: Young adults and eating away from home: associations with dietary intake patterns and weight status differ by choice of restaurant. Journal of the American Dietetic Association **111**(11), 1696–1703 (2011)

12. Piernas, C., Popkin, B.M.: Snacking increased among US adults between 1977 and 2006. The Journal of Nutrition **140**(2), 325–332 (2010)
13. Salvy, S.J., De La Haye, K., Bowker, J.C., Hermans, R.C.: Influence of peers and friends on children's and adolescents' eating and activity behaviors. Physiology & Behavior **106**(3), 369–378 (2012)
14. World Health Organization: Obesity: preventing and managing the global epidemic. Report of a WHO consultation. WHO technical report series no. 894, WHO, Geneva (2000)
15. Carrino, S., Caon, M., Abou Khaled, O., Andreoni, G., Mugellini, E.: PEGASO: towards a life companion. In: Duffy, V.G. (ed.) DHM 2014. LNCS, vol. 8529, pp. 325–331. Springer, Heidelberg (2014)
16. Siewiorek, D.: Generation smartphone. Spectrum, IEEE **49**(9), 54–58 (2012)
17. Caon, M., Carrino, S., Lafortuna, C. L., Serrano, J.C., Coulson, N.S., Sacco, M., Khaled, O.A., Mugellini, E.: Tailoring motivational mechanisms to engage teenagers in healthy life-style: a concept. In: AHFE Conference on Advances in Human Aspects of Healthcare (2014)
18. EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA). Scientific Opinion on establishing Food-Based Dietary Guidelines. EFSA Journal **8**, 1460 (2010)
19. WHO European Region: Food Based Dietary Guidelines in the European Region. EUR/03/5045414 (2003)
20. Deshmukh-Taskar, P.R., Nicklas, T.A., O'Neil, C.E., Keast, D.R., Radcliffe, J.D., Cho, S.: The relationship of breakfast skipping and type of breakfast consumption with nutrient intake and weight status in children and adolescents: the National Health and Nutrition Examination Survey 1999-2006. J. Am. Diet. Assoc. **110**, 869–878 (2010)
21. Vyncke, K., Cruz Fernandez, E., Fajó-Pascual, M., Cuenca-García, M., De Keyzer, W., Gonzalez-Gross, M., Moreno, L.A., Beghin, L., Breidenassel, C., Kersting, M., Albers, U., Diethelm, K., Mouratidou, T., Grammatikaki, E., De Vriendt, T., Marcos, A., Bammann, K., Börnhorst, C., Leclercq, C., Manios, Y., Dallongeville, J., Vereecken, C., Maes, L., Gwozdz, W., Van Winckel, M., Gottrand, F., Sjöström, M., Díaz, L.E., Geelen, A., Hallström, L., Widhalm, K., Kafatos, A., Molnar, D., De Henauw, S., Huybrechts, I.: Validation of the Diet Quality Index for Adolescents by comparison with biomarkers, nutrient and food intakes: the HELENA study. British Journal of Nutrition **109**(11), 2067–2078 (2013)
22. Huybrechts, I., Vereecken, C., De Bacquer, D., et al.: Reproducibility and validity of a diet quality index for children assessed using a FFQ. British Journal of Nutrition **104**, 135–144 (2010)
23. Vereecken, C., De, H.S., Maes, L., Moreno, L., Manios, Y., Phillipp, K., Plada, M., De Bourdeaudhuij, I., HELENA Study Group: Reliability and validity of a healthy diet determinants questionnaire for adolescents. Public Health Nutr. **12**, 1830–1838 (2009)
24. Boushey, C.J., Harray, A.J., Kerr, D.A., Schap, T.E., Paterson, S., Aflague, T., Bosch Ruiz, M., Ahmad, Z., Delp, E.J.: How Willing Are Adolescents to Record Their Dietary Intake? The Mobile Food Record. JMIR mHealth and uHealth **3**(2), e47 (2015)
25. Lister, C., West, J.H., Cannon, B., Sax, T., Brodegard, D.: Just a Fad? Gamification in Health and Fitness Apps. JMIR Serious Games **2**(2), e9 (2014)
26. Consolvo, S., Klasnja, P., McDonald, D.W., Landay, J.A.: Designing for Healthy Lifestyles: Design Considerations for Mobile Technologies to Encourage Consumer Health and Wellness. Human-Computer Interaction **6**(3–4), 167–315 (2012)