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Reflections on the Effect of an m Health App in Behavioural Change for Childhood Weight Management

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Abstract

Childhood obesity is a growing problem facing the developed world. This manuscript reports user experiences of the *TreCLifeStyle* mHealth app to bring about behavioural change. It aims to understand the impact and influence of mHealth app with end-users to explore how a family transforms their daily eating habits. The study adopted qualitative approach and implemented among families with obese child in three rural cities of Trentino province, Italy. Eighteen dyad participants (n=18) were selected from six families (father-mother, n=12 and obese child, n=6) and delivered nutrition and physical activity knowledge content using *TreCLifeStyle* mHealth app. Qualitative field data measured the dietary food habit, daily physical activity, behavioural change among participants. The study result shows that end-users preferred version B of the *TreCLifeStyle* app due to the user-friendly and informative interface. End-users demonstrated positive impressions regarding engagement and changes in lifestyle. After the trial period, the families have progressively changed their lifestyle, becoming more aware of a healthy lifestyle. The study concludes that mHealth has the potential to improve the healthcare forobese children. Even though most mHealth apps have been designed based upon existing healthcare system, end-user engagement should be considered as filial duty in app designing process to make it more effective, intuitive and sustainable.

Keywords: Telemedicine; Paediatric Obesity; Exercise; Behavioural Change

Introduction

Mobile health technology (mHealth) is progressively becoming an effective and powerful tool for people with various health conditions and engaging them into a common platform [1]. The popularity of mobile phone usage in daily life activities gives access to the mHealth services to be a compatible medium for delivering healthcare intervention [2]. These interventions together with health information are demonstrated in behavioural change [3]. Understanding the growing demand from users, European Commission has published the Green Paper-2014 and recognized mHealth's potential for confronting the healthcare challenges in Europe [4,5]. Currently, more than 325,000 mHealth applications (apps) are available both on two leading platforms (iOS, Android) [6,7]. Even though mHealth technologies are growing fast, a little is known for their effectiveness and how best to design the apps [8]. Despite the use, adoption and impact of mHealth services have included the formerly neglected segments of the society, the effects of the technology in both industrial and non-industrial countries around the world are yet to be evaluated comprehensively [9]. In support of this argument, mHealth researchers emphasized on the involvement of end-users in the design process in order to comprehend the needs of users [10]. Recent recommendations suggest to the mHealth app designers' not to be much passionate in following existing healthcare systems which may not increase the user acceptance and service effectiveness [11].

The need for addressing the gap, our study has investigated the user experience and the development process of a nutrition education based mHealth app (*TreCLifeStyle*) in order to understand behavioural change of the end-user families in rural Italy.To do so, we present a best match case report along with empirical excerpts gathered during fieldwork. In this paper, we put forward the claim that considering and incorporating the end-users' experience in designing process could be an indicatory of effective mHealth app.

Materials and Methods

The field data have been collected through qualitative case study. Qualitative method assists us to understand the relevant 'why'

and 'how' questions to explore end-users experience, accessibility of the app, and impact on behavioural change factors. The mHealth app has been tested, initially, in two phases to gain empirical data [12,13]. Both phases lasted for eight consecutive weeks where version A (appA) was tested for the first four weeks and version B (appB) for the rest of the period. appA users shared their experience and suggested making it more elaborative regarding food items and measurements. The project was executed in Trento, a rural province of Italy, and case studies were collected to identify the impact of mHealth app involved in changing regular eating habits and daily physical activities. Like other mHealth apps, *TreCLifeStyle* provides pervasive services and additionally, it incorporates pop-up notification for the participants to assist in calculating their daily meals.

Participants were recruited through purposive sampling. The selection process also considered the person's preparedness and usage duration to be included as a case. In total, the study included n=18 participants from six families (father-mother, n=12 and obese child, n=6) of Trentino province, followed by primary inclusion criteria of who have one obese child in the family. There were six case studies reproduced from this study. The case studies selection process is context embedded and aims at providing evidence to be used to generate the coefficients for eventual quantitative extrapolations [12]. The following case study has been selected to exemplify the context of the study. In addition, the case contained substantial and spontaneous excerpts, and extended response from the respondent. An interdisciplinary team was formed including anthropology, medicine, public health, and sociology to conduct and analysing data. The research team often debated about how to interpret field data and this rich discussion provided a comprehensive sense of the data. Data were analysed thematically. The study has followed an appropriate informed consent or assent procedures for data collection and was approved by the institutional review board at the University of Trento for Smart Community Design and Management.

Overview of *TreCLifeStyle* mHealthapp

TreCLifeStyle mHealth app was launched as a part of the 'Key to Health' project, implemented by Fondizione Bruno Kessler, Italy. The project commenced a business welfare initiative included in the 2015-2018 Prevention Plan of the Provincial Government and Autonomous province of Trento, Italy as a pilot project to promote healthy lifestyle to prevent childhood obesity and build up social and communal awareness. The design of the *TreCLifeStyle* mobile app is originated from '*CartellaClinica del Cittadino*' web-based service; an online platform providing citizens accessibility to carry out a number of functionalities related to the personal health records (such as read, update, and delegation). Participants came to know that the project has potential to establish communication with medical institutions, their doctors, and other inhabitants [14].

Regarding the interface design of the mHealth app, developers followed the guidelines of persuasive technologies to improve the user experience and the motivation to change behaviour and daily habits. According to the instructions of the guidelines, developers have implemented a simple and intuitive interface, so the users can easily recognize the food pyramid. Once the user is signed in using the Jawbone bracelet, started receiving information about their physical activities such as step count. In a

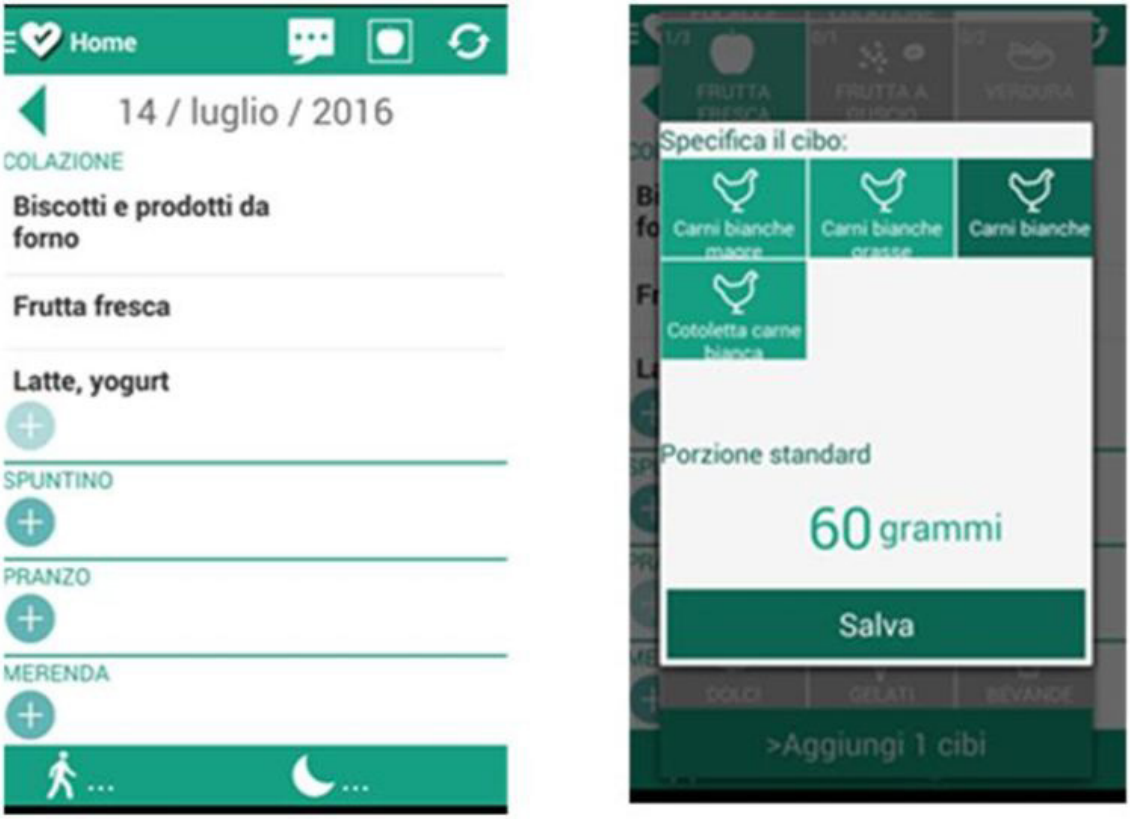

Figure 1: appA

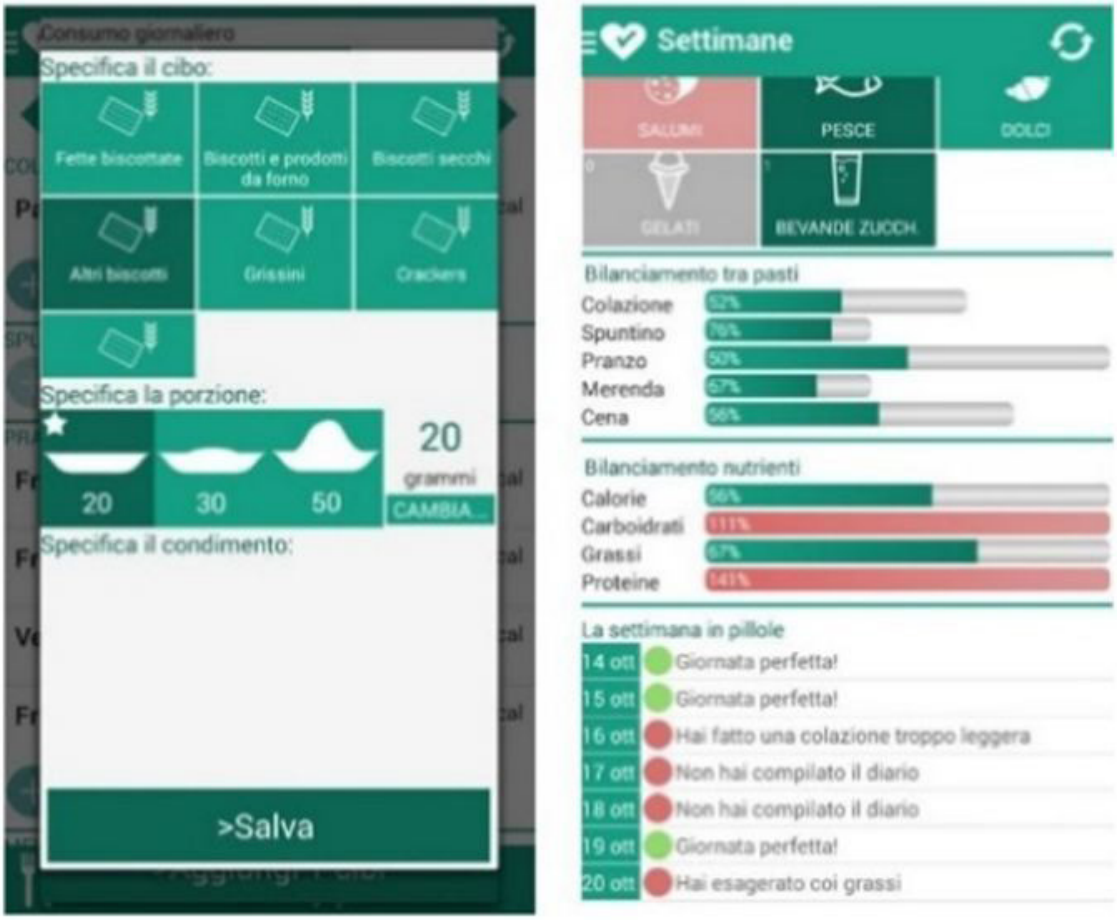

Figure 2: appB

similar way, users could make a comparison between the calories they consumed and the calories they ingested during meals of the day. It also helps to increase the awareness to change behaviour and lifestyle. The interface visualization of appA and appB has demonstrated in Figure 1 and 2. App A provides only information about weekly/daily consuming frequency of foods. Whereas appB suggests the user to change quantity of food and show statistics about the amount of daily calories and nutrients consumed.

Functionalities of the App

TreCLifeStyle mHealth app interfaces operate through some functionalities:

Food Diary: Users can add foods and select the portion that they want to eat and enlist the consumed quantity. The system automatically calculates the calories correspond to the food. Adapted food portions suggested to the daily energy requirement defined for the user (based on the age, weight and level of physical activity).

Statistics: The app displays detailed information about the quantity of food nutrients, balance of calorie among daily meals and percentage of nutrients needed.

Step count: Once the user connects the jawbone to the mobile app, they can monitor the number of daily steps.

Virtual coach: Information about goal achievement, feedback on lifestyle, progress and current stage of changing habits, personalized suggestions about healthy nutrition and other contextual messages are sent to the user to increase motivation to adopt a healthy lifestyle through pop-up notifications.

Detailed Activity of the Study

A step-by-step process and the activities have been undertaken in the study are presented through summative discussion in this section of the paper (Table 1). What were the primary tasks, how much time did the researchers invest, and how those tasks have been executed- are explained thoroughly in the tabulation.

Task	Duration	Description	Research activities
t0	1 hour	Meeting with paediatricians and parents in order to give them the trial material (smart phones, pedometers)	1) Parents signature on the agreement; 2) Questionnaire on the Mediterranean diet; 3) Interview on Behaviour Change Stage (BCS)
t1	3 weeks	Trial of the web and mobile app v.1*	1) UX questionnaire through the app: one question a day for 10 days
t2	1 hour	Meeting between researchers and parents to compiling the questionnaires (paediatricians' presence not needed); release of v.2*	1) Questionnaire on the Mediterranean diet; 2) UX questionnaire SUS (for mobile app and web); 3) Interview on Behaviour Change Stage (BCS)
t3	3 weeks	Trial of the web and mobile app v.2*	1) UX questionnaire through the app: one question a day for 10 days
t4	1 hour	Meeting between researchers and parents to compiling the questionnaires (paediatricians' presence not needed)	1) Case studies and more complex questionnaire on the Mediterranean diet; 2) UX questionnaire SUS (for mobile app and web); 3) Case studies on Behaviour Change Stage (BCS)
t5	6 weeks	Voluntary use of the app (users can choose which version)	Any questionnaire: users receive motivational and contextual messages
t6	1 hour	Final meeting with parents and paediatricians	Final interviews on the app *TreCLifeStyle* (comparison between appA and appB) in their daily life during the pilot study

v.1 (appA) = through the app you can choose the meal without specifying the quantity. No information about calories.
v.2 (appB) = through the app you can specify meals and condiments. User can specify the portion and receive information on calories. The app gives daily and weekly statistics on the calories

Table 1: Detailed Activities of the Study

Results

The *TreCLifeStyle* mHealth app users were able in tracking weekly dietary records to ensure family nutrition by following a daily food chart. The app especially helped the child to maintain a regular diet even in absence of their parents. Initially, the primary features of the app interface were resembled for both A and B version. After getting user feedback, some additional features have been added in appB to compare user experiences and to measure precise preferences. The app interfaces (both versions) have allowed the user to see a range of food items. Moreover, they received feedback regarding food consumption pop-up notification in mobile phone at least once a week regarding food consumption. These notifications provided information on missing food in each meal and suggested how much food they need to eat. The user of appA can see the most commonly prescribed food chart and select different types of food based on nutritional value of every meal. The inability to insert additional food and to measure nutritional value of the food has been identified as a limitation of appA by the user. For instance, during the evaluation of both apps, the user has agreed to proceed with version B instead of A due to more informative and user-friendly interface. Afterwards the modified interface of appB gives a precise data on calorie consumption in every meal. Moreover, it contains a wide range of food items which gave more freedom to the users.

The *TreCLifeStyle* app helped the user's family to be more consistent in changing daily food choice, consumption and to do regular physical activities. Finally, the users have become cognizant about their daily food proportion, daily calorie consumption and burn as well as gained practical knowledge on the nutritional value of each food item. This awareness could help users to recognize whether the foods are healthy and lead them to healthy choices. However, the appB users faced some initial difficulties to adapt with the 'virtual coaching approach' and 'monitoring behaviour' used for raising parents' awareness on children's dietary behaviour. Despite these challenges, the family members have demonstrated positive behaviours and provided valuable recommendations that can lead to further improvement of the app.

A Case Study

The mother of a seven-year-old child was the user of the *TreCLifeStyle* mHealth app and gave her opinions after two months of use. The mother was happy to see the calories of each meal and the proportion she provides in her child's meal. She pointed out that appB is relatively easier to calculate the proportion of consuming and missing calories in every meal of the child.

"I prefer the second version (appB), because it is very precise and gives particular information about calories the other version (appA) did not give such information. In addition, appA does not indicate whether to add a food such as a small piece of chocolate or half a slice of ham, and it does not show the food quantity either." (Field data 2015-16)

The family used the app frequently and the mother kept following the diet record regularly as accurately as possible. While sharing her comparative experience regarding appA and appB, she deemed,

"In appA, there was a calorie problem ... sometimes the interfaces make me confused. However, the second version (appB) is better... we receive more information on real energy intake so we can also compare the consumed and burned calories through the pedometer of the appB." (Field data 2015-16)

As soon as the child started following the app, he has changed his breakfast menu; for instance, now he drinks milk or eats yogurt with cereals, while before he ate '*marmellata*' (jam) with '*fettebiscottate*' (crispy toasts), the mother added. Sometimes he takes the snack made with, in general, fruits or vegetables or yogurt or '*Panini*' (sandwiches). After school, he comes back home for lunch prepared by the grandmother who was already informed that the child is involved with such a study. The child says,

"my grandmother knows the portion of foods, i.e. 70-75g of pasta for lunch, and she knows if I eat potatoes, I have to eat a small portion of bread instead of pasta." (Field data 2015-16)

The mother also shared, when the app gives "*red*" feedback or notification, indicating lack of required food, the child eats that missing food in the same evening or the day after. Moreover, the child goes to the garden with cousins to play and do some physical activities (such as "*saltosuelastico*"- jumping on an elastic/trampoline) as a part of calorie burn, if the weather is good.

Discussion

The high penetration of mobile devices leads to seamless access to mHealth technology both in rural and urban regions of Europe. In line with that this study found a growing potentiality of mHealth app in rural settings. However, a range of research studies argued that demographic, cultural, economic, and social differences are can influence the users to accept new techno-services in rural areas [15-17]. The study outcomes allied with previous mHealth research that offers both wired devices and wireless personal digital assistants to assess physical activities, sedentary behaviour, and dietary patterns [18-21]. However, due to the limited numbers of participants and shortcoming funding scope, this study could be considered as a starting point for mHealth app evaluation that needs to be expanded.

The *TreCLifeStyle* app helped the user's family to be steadier in changing daily food choice, consumption, and do regular physical activities. The users have become cognizant about their daily food proportion, daily calorie consumption and burn as well as gained practical knowledge on the nutritional value of each food item. This awareness could help users to recognize whether the foods are healthy and lead them to healthy choices. However, the appB users faced some initial difficulties to adapt with the 'virtual coaching approach' and 'monitoring behaviour' used for raising parents' awareness on children's dietary behaviour. Despite confronting these challenges, the family members have demonstrated positive behaviours and provided valuable recommendations that can lead to further improvement of the app.

The study results demonstrate that rural users are much enthusiastic to adopt wired mHealth services. In support to our research findings, we found that behavioural changes only occur once the user became enthusiastic and motivated to use the new system over a certain period [22,23]. The service providers of *TreCLifeStyle* app have integrated different kind of impetus features to ensure the long-term motivation of end-users according to the contextual necessities. It is important to note that a suitable interface design is crucial to making user-friendly mHealth apps to fulfil the technical aspects and user requirements. To address the needs of both perspectives, this study emphasizes habitual design, which is another significant component of healthy behaviour change support system [24]. Habitual design is an integral part of human-centric or persuasive computing that includes procedures and strategies to develop or disrupt behavioural practice that may lead to behavioural changes [25,26]. It offers guidance to the user in changing their behaviour, as we found in the case study, and could be effective for improving long-term and ongoing acceptance and performance of the mHealth app's intended practices [16,27]. Therefore, the acceptance of new technical systems and circumstantial demands can have a significant impact on behaviours as manifested in this study [28]. However, we did not find any effective approaches that accentuate both technical and socio-cultural requirements for developing mHealth apps in previous research. Thus, there is a significant demand of it in future research.

mHealth has the potential to improve healthcare and create new opportunities as a service to the community, to app designers, and policy-makers, even though it is not yet a major component of existing health systems [29,30]. Some mHealth researches, for delivering health information, have shown promising outcomes, especially using a mobile platform [31]. A review of cost effectiveness by Harris *et al.* concluded that interventions promoting dietary behaviour change do not create clinically significant changes; while another review by Tang *et al.* found that weight loss intervention effectively improved self-direction. Similarly, reviews on both dietary and physical activity interventions revealed strong positive behaviour change outcomes. Cushing and Steele have demonstrated more closely findings in their meta-analysis of mHealth interventions in paediatric health promotions and behavioural change monitoring. Despite possible benefits, Kohl *et al.* identified that low participant engagement is the key limitation of mHealth intervention [32-36]. They suggested that future research ought to detect the most effective components within mHealth intervention rather conduct more 'effective studies'. Our study objectives have tried to contribute into the gaps in mHealth research. Consequently, the *TreCLifeStyle* app offered some unique features in relation to dietary and physical activity to act as behaviour change due to mHealth intervention.

Although this case study demonstrates a substantial amount of progress in respect to effectiveness of mHealth app in behaviour

change, we believe, sufficient research is absent in understanding on the impact of specific mHealth intervention components. This study also suggests initiating research in the usage, accessibility, applicability, and feasibility of Internet-based mHealth interventions and programs, and how they differ to standalone phone applications. In a nutshell, more wide-ranging studies are essential to determine whether mHealth initiatives can exceedingly provide cost-effective solutions for the end-users to foster universal health coverage.

Conclusion

Even though the uptake and dissemination of the mHealth services still remain considerable challenges [37,38]. Our study showed that end-users are willing to adopt mHealth apps to change lifestyle behaviours. This study offers an example to the stakeholders and mHealth service providers demonstrating that socio-cultural aspects and user needs cannot be isolated from the app design process. High quality service and ease of access to applications will be more effective once the service providers start considering user-engagement, end-users' experience and the contextual requirements during designing through evaluation process [39-41]. In addition, a comprehensive mHealth policy framework needs to be developed to incorporate mHealth services in a more effective, accountable and accessible way for end-users. This case report emphasizes the importance of articulating and integrating users' experiences into the app development process from conceptualization to implementation level [42]. We conclude to recommend that the service providers should realise the burgeoning importance of mHealth services for the society. And they need to consider mHealth as a crucial means intackling and mitigating the limitations associated with traditional and highly expensive in-patient treatments.

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