Vitality in Research Literature and Digital Services

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Abstract: *In this study, we reviewed mobile applications available in app stores and research literature to find out how they address the relationship between food, eating and vitality. The study was done in two phases, in 2015 and 2017, to review also the progress in the field during the two-year period. The research results indicated that research work and applications mostly focus on combating obesity and addressing specific health problems through nutrition. The topic of vitality through food and eating has not been widely studied and does not seem to have many applications supporting it.*

Keywords: *digital services, nutrition, vitality*

I.   Introduction

Public health concerns have raised the need for finding ways to support individual well-being, which can also be considered as the vitality of citizens. The concept of vitality can be understood in many ways. It encompasses different aspects of both physical and mental wellbeing. In this study, we see vitality as a combination of four factors: mental vitality, energy, physical vitality and appearance.

Different devices and applications for quantifying vitality-related facets of everyday life have been readily available to the public. In a way, the possibility to measure, monitor and record physiological signals and personal behavior has paved the way for a future where people have a bigger role in taking care of their health and wellbeing - maybe even enabling more tailored services and care from health care professionals [1]. Although vitality consists of more than just exercising and eating healthy food, these applications help people take care of themselves and are likely to give them a vitality boost.

What digital or mobile services are out there to help people balance their life and ensure their diet supports their vitality? We set out to answer this question through a review of mobile applications and an extensive literature study related to food, nutrition, eating and vitality. The first part of the study was done in 2015, and an updated version in late 2017 in order to find out what kinds of changes had occurred during the two years that had passed. Two years is a long time when it comes to the development and emergence of new digital services, and the goal was to find out whether any significant trends related to food, eating and vitality could be identified through the themes explored in literature as well as the proliferation of certain types of applications.

The world of academia naturally moves at a slower pace than that of application development. Trends often affect academic research with a slight delay, but applications can be produced quite quickly to answer the needs of the market. With the possibility to update and upgrade applications, it can be worthwhile for developers to release their products quite quickly.

II.   Results of the review

2.1 Application revieww

The application review was done through relevant categories in the two major application stores, Apple's App Store and Google's Play Store. Applications in the stores are divided into categories such as Beauty, Business, Comics, and Education. There are more than 20 categories in both of the major application stores. There are also health related categories, such as Health & Fitness, but not any single category that would cover all the aspects of vitality like mental vitality, energy, physical vitality and appearance. There have not been any significant changes in the popularity of the different categories during the past two years. In the iOS App Store, Games, Business, Education and Lifestyle together cover approximately 50 per cent of all applications. The vitality related categories like Health & Fitness and Food & Drink contain approximately 5 percent of all App Store applications. Some examples of health and fitness applications in the Google Play Store include Google Fit, Samsung Health, Polar Flow, and Huawei Health – manufacturers often offer applications to go together with their devices.

The digital services related to eating and vitality available in 2015 were mostly mobile applications related to diets and meal plans. The major part of these services were focused on helping people eat better – whether it

was to maintain a specific diet to ensure the right amount of nutrients or to help lose weight. Often, these digital services combined several elements and features.

In 2017, about 85 percent of all smartphones ran Google's Android operating system and about 14 percent Apple's iOS. The remaining one percent was divided between other mobile operating systems like Windows and Symbian. Q2 sales figures for 2017 show Android taking a further lead at 87.7 % with iOS at 12.1% [2]. At the end of 2015, Android had a market share of 80.7% while iOS was at 17.7%. [3]The number of applications in the Android and iOS application stores is growing at an increasing pace. For instance, in the Google Play Store, there were (situation in March 2018) over 3.7 million applications, and the number of available applications is currently expected to increase at a rate of 750,000 new additions every year [4]. That means more than 2,000 new applications are added each day. The growth continues and there is no indication that there will be any changes to this trend. The information for Apple's App Store is released periodically. In May 2017, there were 2.2 million apps in the store, meaning an addition of 200,000 applications since the previous figure was released in June 2016 [5].

Sleep quality also affects vitality. There is a great number of dedicated applications like Sleep Tracker to track sleeping patterns. Sleep Tracker also uses its sleep cycle alarm clock to wake up the user at the perfect time for them to feel refreshed.

According to Bakker etal.[6], the number of mental health applications developed and now available to smartphone users has increased in the recent years. Mental health smartphone applications nowadays also include the possibility to sense brain waves using low-cost EEG headbands or headsets. For example, NeuroSky's MindWave Mobile Tutorial uses a headset that helps users to meditate and calm down if they are anxious. Anxiety can be a factor contributing to a decrease in mental health and vitality.

During the last couple of years, insurance companies around the world have actively started creating vitality programs for their customers (for an example, see [7]). The idea is that the user can earn 'vitality points' for instance by buying healthy foods and getting physically active, going for a preventive screening etc. The earned points can then be used as rewards like getting discounts for healthy food or gym fees, free cinema tickets every week and so on. While getting the points the user's private data, such as location and the like is given automatically to the insurance company by using e.g. the internal sensors of the smartphone or data that has been logged by the service.

Any apps directly linking food, eating or nutrition to vitality were not found among those reviewed in our study.

2.2 Literature review

In 2015, the literature review looked at the existing body of research: what kinds of studies had been done involving digital or mobile services and food, did these studies take into account the vitality experienced by the study subjects, and, could elements related to vitality be recognized in the findings. The keywords used in the search were "digital service", "mobile service" or "mobile application" combined with the following search terms: food, nutrition, eating, restaurant, grocery store, food market, recipes and diet. The articles discussed several limited target groups, such as children, high school students, college students, working-age individuals and older adults. In 2015, 38 articles in total were reviewed. The study results of 2015 showed four main clusters of research topics related to digital and mobile services around food and eating: diet, self-management, guides, and health.

In 2017, an updated version of the literature study was performed using Google Scholar. The same keywords were used in both 2015 and 2017. This time, the search was restricted to manuscripts published in 2015 and later, i.e. the body of work that has become available after our previous study. Altogether, over 100 research papers were reviewed.

The articles reviewed for this study published between 2015 and 2017 can be divided roughly in the following main categories: highly technical solutions, wellness and healthy living, nutrition education and dietary behaviour, mobile or online grocery shopping, and restaurant services. Many articles combine several of these themes, using high-tech solutions to monitor dietary behaviour for instance. Other recurring themes are e.g. interventions or studies with specific user groups. The results presented here are focused on the second part of the study realized in the year 2017. Relevant changes during the two-year period are highlighted.

High-tech solutionsand technology are increasingly present in food-related research at the consumer interface. Internet of Things (IoT) and Big Data technologies and innovations shape also different aspects of the food supply and production chain. Food supply chains can be virtualized using IoT solutions, which in turn helps companies to optimize their processes [8]. Food ontologies are also needed for the Internet of Things in order to make sense of automatic methods used to recognize drinks and food [9]. Big Data can also be used to enable nudges or even so-called "hypernudges", e.g. to encourage people to make healthier food choices [10]. (3D) printing technologies for food fabrication [11, 12, 13] can be used to modify the texture, shape and even nutritional content of food products.

Many applications have been developed for research purposes to help people track and follow their own diets and intake of different foodstuffs, but they often require a lot of manual entry. This in turn can affect long-term motivation. Solutions to simplify entering the information to be tracked include e.g. Nombot [14], a chatbot service operating through the instant messaging service Telegram. As consumers as inundated with all these different information sources and applications regarding healthy living and eating, it is also important to understand the interaction between consumers and Digital Health Technologies in order to find out whether these technological solutions are in demand and whether they actually help people to make better and healthier food choices [15].

Doub et al. [16] performed a large-scale segmentation study, attempting to find out how mobile devices are used to support eating behavior. The study identified four segments of consumers, classified by their attitudes toward different aspects of technology, food and nutrition. Only 12 % of the participants in the study were classified as not being engaged with either technology or food. According to the study, young adults and parents are most likely to be highly engaged with food and mobile technology.

In addition to IoT and Big Data, Augmented Reality has also been one of the popular buzzwords in the 2010s. Through the improved capabilities of smartphones, Augmented Reality solutions have become more commonplace in mobile contexts. Augmented Reality technology has been used e.g. to assist consumers in making healthy choices when grocery shopping [17]. After smartphones, smartwatches have also gained popularity and can be used for many different applications. Radhakrishnan et al.[18, 19, 20]have written about smartwatch-based shopping gesture recognition, which could also be used to provide recommendations, assist shoppers and set up smart reminders. In-store mobile technology use has also been explored by Sciandra & Inman [21], who noticed that using mobile phones while shopping can result in more unplanned purchases and omitted items, especially when the mobile phone was used for activities unrelated to shopping.

Wellness and healthy living are favorite topics both in magazine and scientific journal articles. In this study, we decided to separate wellness and pursuing health through dietary choices from the perennially popular topic of weight loss. Although in a way striving for the same outcome, a healthy life, academic research on weight loss often focuses on obesity, whereas people of all weights and sizes can benefit from advice related to healthy eating. Academic research also evaluates existing health-related applications, looking typically at the features available in wellness applications[22] and even services designed for athletes [23]. Häkkilä et al. [17] found that although many applications offer features for sharing and interaction, gamification and built-in conversation do not have a major role in the applications. Although people are used to sharing many aspects of their lives, there is still room for improvement in this area. Hingle et al.[24] performed a review of mHealth applications. They found out that in many studies researchers have decided to develop their own applications that are only used when the study is active. According to the authors, this might be one of the reasons why mHealth applications have not had the effect they potentially could have. Hingle et al. add that early adopters of mHealth applications are those who are already engaged in the kind of behavior these applications promote rather than the people who have unhealthy, sedentary lifestyles. The authors argue that in order to make advances in the field, more collaboration between research and commercial application development is needed.

Vehmas et al.[25] found out that compared to other digital services, health and well-being related issues are more sensitive for the consumers. Even if consumers are using several different applications and sharing their pictures and feelings in social media, they are more reserved when dealing with private data. This needs to be taken into consideration when developing novel services in this domain. Vehmas et al. also pointed out the importance of user involvement in service development process. It enables the development of the services that are valuable for the users and motivate to utilize the services in the long run.

The sharing culture opens an interesting window into the lives of ordinary people for researchers. Holmberg et al.[26] performed a study exploring the pictures of food adolescents post on Instagram. In their study, they found that a majority of the images posted were of unhealthy food: high in calories, low in nutrients. As the pictures and themes were also influenced with marketing campaigns, the study concluded that this kind of culture has health implications when unhealthy foods are marketed to young people through the social networks they are using.

Although healthy behavior and diet are quite a universal concept, Ares et al.[27] performed a study trying to find out whether people in different cultures view food-related wellbeing in the same way. The study was a Likert evaluation done in seven different countries on four continents. The researchers found that the differences between countries were quite small when evaluating the effect of the food products to the physical and intellectual aspects of wellbeing. However, there were greater differences between the countries when evaluating the emotional and spiritual aspects of the products. This result shows that the guidelines for a healthy diet are quite similar across the globe, and as such, people view the food items that are good for your health in a similar fashion.

Nutrition education and behavior was the topic with easily the largest number of publications when searching for articles related to food, health and digital services. Studies related to nutrition, weight control,

controlled eating and the mobile applications designed for this purpose (as suggested by Hingle et al. [19]) were abundant. In many studies, nutrition education or dietary advice has been targeted for a specific user group or the purpose was to study the intake of one particular nutrient.

For instance, Sharma & Rani [28] conducted a study where IT professionals received nutrition education through an e-learning solution and interactive sessions. They found an increase in the nutrition knowledge and nutrient intake of their participants and concluded that professionals can benefit from nutrition knowledge to encourage healthy eating behaviors. While healthy adults [29] and professionals act as the subjects in many studies where the actual functions of the mobile application or service are tested, many dietary assessment studies focus on groups with special needs or interests. These groups include pregnant women [30, 31, 32], WIC (women, infants and children) federal assistance recipients in remote communities[33], young women[34], women from a lower socioeconomic background[35], community-dwelling adults[36], adolescents and young adults with Down syndrome[37], free-living adolescents[38, 39] and young adults[40,41, 42].

Smartphone applications and image recognition have been used in various studies [43, 44, 45] to help people keep up with their food diaries – as manually entering all meals has proven cumbersome. Hutchesson et al.[46] compared online food records with paper-based ones and found no difference in the accuracy, but there was a strong preference for the online version among their test group of young women. Thus, they concluded that online record keeping should be considered at least with this user group. Albar et al.[47] compared an online dietary assessment tool with a face-to-face interview and found the online tool to be as reliable as the multiple-pass recall administered by the interviewer.

West et al.[48] studied a group of people using diet or nutrition applications and the effect these applications had on diet-related behavior. According to their study, applications focused on diet or nutrition generally affect diet-related behavior. The study participants using a diet or nutrition application experienced an increase in their motivation, willingness and ability to improve their diet. Sarcona et al.[49] studied university students' use of mobile health applications and health-related lifestyle choices. They found that the users of mobile health applications had more positive eating behaviors than application nonusers. Those who used mobile health applications also felt better about themselves and even motivating others to be active and lose weight. Dallinga et al.[50] did a study on the correlation between application use, physical activity and a healthy lifestyle. They found that recreational runners who use an application to track their activity were more likely to be more active and have a healthier lifestyle than non-users.

Vandelanotte et al.[51] have done a review of eHealth and mHealth research regarding the improvement of physical activity and dietary behavior. They offer recommendations for future research: enhancing interactivity to engage the users better; examining the effectiveness of specific intervention components separately to find out the contribution of distinct elements; reporting the description of the intervention in more detail; considering the theoretical background related to engagement and persuasion; examining long-term maintenance of changes in behavior as temporary results are easier to achieve than long-term ones; improving external validity; applying different research designs; aiming to reach as many people as possible; and focusing on underserved populations.

Chen et al.[52] noticed that a majority of the diet and nutrition applications used in patient care have not been designed with the help of a dietician. In their study, they surveyed dietitians, who wanted credible apps, better usability and support for dieticians and patients alike. A collaborative and co-creative approach when developing new applications was suggested, as it would enable key stakeholders to get the most out of their apps.

Chen et al.[53] performed a study investigating the use of mHealth applications in dietetic practice with a survey of dieticians based in Australia, New Zealand and the UK. They wanted to use their study findings to make intervention recommendations. In their study, they found out that while applications are reportedly used often, they are not yet focused on behavioral changes. It is also important to remember that health and nutrition applications should be used to complement counselling by dieticians rather than replacing it.

During the course of the study, searches were also done related to mobile or online grocery shopping and restaurant services. Most of the articles related to these topics focused on the technological solutions to the transactions themselves rather than focusing on the content and nutrition of the food being purchased and its effect on people. In the restaurant world, research on digital services focuses mostly on systems helping customers order their food, either for home-delivery or in a restaurant setting. Some services aim to combine different aspects, e.g. by building a speech-based mobile application that can be used for restaurant order recognition as well as low-burden diet tracking to control obesity [54].

III.   Conclusions

The review of vitality-related mobile applications and research articles showed that no significant new trends or research topics emerged in the body of work between 2015 and 2017. The review process showed that there is a myriad of vitality-related mobile applications and research based on them. Often applications are developed for the purposes of an intervention without even planning to use them in the long run. Benefits could be gained through collaboration between academic research and experts, such as nutritionists, and professional application developers who know how to make applications engaging. There is a huge potential and business opportunities in health and well-being domains to create novel services for consumers. As mobile applications and e.g. image recognition have proven to be at least as reliable as paper-based methods for documenting eating behavior, it is highly likely that most future studies will proceed with digital data collection.

There is little or no focus on vitality in the research and applications related to food and eating. Most of the focus is on weight control and specific nutrients or specific user groups. While health is an important factor when it comes to evaluating the outcomes of studies and effectiveness of applications, the concept of overall vitality is seldom mentioned. There is a clear potential for further research on the relationship between food, nutrition and both mental and physical vitality. It seems clear that in the modern world, mobile and digital services are an integral part of following the progress and results of interventions and lifestyle changes. Adding engaging elements and content as well as the possibility for social interaction through professional application development can make it easier for people to keep up with a new diet regime or exercise plan. The findings of the present study propose that, in addition to research, the applications supporting vitality enhancement via improved eating and nutrition habits may have a positive impact on public health.

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