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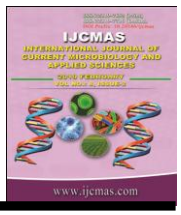

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The Promise and Peril of Health Apps in Diet, Physical Activity and Behaviour Modifications: A Systematic Review

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A B S T R A C T

Obesity, weight dysregulation and various degenerative diseases which are present at a huge scale are repercussions of low physical activity and unhealthy eating habits. Dietary risks, which include diets low in fruits, vegetables, and whole grains, but high in salt and fat, were found to be India's third leading risk factor for causing disease burden, after child and maternal malnutrition and air pollution; followed closely by high blood pressure and high blood sugar. According to NFHS-4 there is a consistent and steep increase in the prevalence of hypertension and diabetes with increase in body mass index (BMI) for both women and men. 29% of obese women and 38 % of obese men were hypertensive and Six percent of women and eight percent of men aged 15-49 had random blood glucose levels greater than 140 mg/dl. Mobile Health Apps have emerged as a tool which offers opportunities to encourage physical activity and induce healthy eating habits among its users. Thus, they stand a chance of reducing risk and prevalence of various diseases. The extent to which they include the evidence-based behavioural strategies need to be identified. This paper presents an in-depth study of prominent nutrition and fitness themed smartphone apps and their effect on diet, physical activity and behaviour modifications.

Introduction

Worldwide, overweight and obesity cause more deaths than underweight. The combined burden of these diet related risk and physical inactivity in low and middle-income country is similar to that caused by HIV/AIDS and tuberculosis (Global health risks: WHO 2009).In the past two decades, the obese population has almost doubled in India (Shannawaz and Arokiasamy, 2018). According to National Family Health Survey-4 there is a consistent and steep increase in the prevalence of hypertension and diabetes with increase in body mass index (BMI) for both women and men (National Family Health Survey (NFHS-4) 2015-16). 29% of obese women and 38 % of obese men were hypertensive and Six percent of women and eight percent of men aged 15-49 had random blood glucose levels greater than 140 mg/dl. (India: Health of the Nation's States—The India State-Level Disease Burden Initiative, 2017). An unhealthy lifestyle stamped by unhealthy eating habits, physical inactivity and sedentary behaviour, plays a significant

role in the development of obesity (Kushner and Choi, 2010; Ervin *et al.*, 1984; Berkey *et al.,* 2000). Now a days, adolescents are indulged in so many unhealthy eating habits such as low consumption of fruits, vegetables and dairy products as well as higher consumption of energy dense snacks and beverages rich in sugar and fat (Philips *et al.*, 2004; Nielsen and Popkin, 2004; Lasater *et al.*, 2011; Davis *et al.*, 2007; Martens *et al.*, 2005). It is well known fact that exercise is important for long term health. It helps in weight management and has been found to reduce the incidence of various chronic illnesses (Nocon *et al.*, 2008). Even though, so much awareness is being spread regarding the importance of physical activity, almost 30% of people around the globe still prefer to be physically inactive (Hallal *et al.*, 2012). Many innovative ways which interests the young adults are needed to promote physical activity and healthy lifestyle among them (Cock *et al.*, 2017). Some of the most influential measures being taken up by youngsters recently are eco keto diets, intermittent fasting, IV drops, cortisol conscious workouts, wearable tech and fitness gadgets, telehealth services, health apps, online health trackers etc.

The usage of mobile phones has increased rapidly in the recent decades especially among adults, adolescents and children (Gowin *et al.*, 2015; Burrows *et al.*, 2015; Brannonand Cushing, 2015). With these advancements, health related apps are now widely common (Gowin *et al.*, 2015; Krebs and Duncan, 2015; Middelweerd *et al.*, 2014; Azar *et al.*, 2013). Among these nutrition and fitness apps are the most popular ones. These apps cover the whole spectrum of health care chain, which generally include apps for health care professionals (apps to calculate medical formulas and drug dosages, to help in diagnosis of a disease), apps for medical and nursing students (including 3D visual anatomy tools and pdf versions of medical course books), apps for sports personnels, gamification apps to induce more of physical activity among the sedentary lifestyles of people (pokemonGo). Nutrition and fitness apps for health enthusiasts helps them to monitor their food intake, physical activity, provide information about the nutritional content of specific food items, send motivational messages or quotes, setting and monitoring the goals, and provide instructions or demo videos for physical exercises (Krebs and Duncan, 2015; Litman *et al.*, 2015; Bert *et al.*, 2014).

Apart from their role in nutrition and physical fitness, health apps promise to promote lifestyle changes and self-managements in chronic diseases like diabetes, cancer, paediatric obesity etc. (Arsand *et al.*, *2012*). Moreover, nutrition and fitness apps might be an engaging, affordable and promising way to promote behaviours of healthy lifestyle in India's youth (Burrows *et al.*, 2015; Brannon and Cushing, 2015; Schoffman *et al.*, 2013).

Role of health apps on diet, physical activity and behaviour modifications

Payne *et al.*, (2015) conducted an extensive review to describe the literature on mobile apps used in health behaviour interventions, the behavioural features and focus of health apps and to evaluate the potential of apps to disseminate health behaviour interventions. Self-monitoring was the most widely recognised trait, incorporated into 18 of the studies. The most utilised builds were signals to measure activity and give feedback (included in nine studies), trailed by social support (six studies).

Allen *et al.*, (2013), Brindal *et al.*, (2013), Carter *et al.*, (2013) and Hebden *et al.*, (2014) all reported higher amounts of weight loss or lower Body Mass Index's (BMI) in the

smartphone interventions, but the weight loss was not statistically significant, when compared to controls. Mattila *et al.,* (2013) and Litman *et al.,* (2015) noted that weight, body fat, and BMI all decreased, and there was a significant difference between sustained app users and non-sustained users.

Robinson *et al.,* (2013) noted decrease in body weight, but it was a secondary measure and few details of the weight loss were reported. Thomas *et al.,* (2013) reported significant decreases in body weight at 12-week follow-up, but not at 24 weeks. Turner-McGrievy and Tate (2011) and Turner-McGrievy *et al.,*(2013)reported no significant difference in weight loss between intervention groups in the 2011 study, while in the 2013 study; users experienced a significant drop in BMI at follow-up. Azar *et al.,* (2013) found that the regular usage of health apps was directly proportional to successful weight loss and weight loss maintenance through improved adherence of self-monitoring of dietary behaviours and choices.

Of the four interventions related to diabetes, three reported a positive change in glycated haemoglobin: Kirwan *et al.,* (2013) and Quinn *et al.,* (2011) showed a significant decrease in HbA1c levels, while Wayne *et al.,* (2014) showed a significant decrease only for those whose baseline HbA1c levels were above 7%.

A study was conducted by Allen *et al.,* (2013) to assess the feasibility, approachability and preliminary efficiency of theoretical based inventions related to behaviour delivered by the smartphones. They found that the individuals in the intensive counselling along with self-monitored mobile phone group and less intensive counselling along with self-monitored smartphone group lost more weight than the rest of the groups (5.4 kg and 3.3 kg, respectively). It was inferred that the weight reduction intervention gave initial strength to use a smartphone application for self-monitoring as an add on to counselling over behaviour.

The main way in reformulating the health behaviour knows why users stay consistent with applications related to fitness. The intentions behind the use of social media fitness tracking applications were investigated by Li *et al.,* (2018) by conducting a survey. They reported that the primary driving forces of continuous intention in individuals were social rank expectation and confirmation amongst the users of fitness-tracking apps.

A study was conducted by Stephans and Allens (2013) to find out the user satisfaction levels and efficiency of texting and smartphone applications involvement in promoting weight loss and exercising. 71% participants indicated statistically significant outcomes in at least one result of weight reduction, exercising, food intake, reduced BMI, reduced waist circumference, sugar sweetened drink consumption, screen time, and contentment or suitability outcomes. West *et al.,* (2017) reported that the participants described an increase in enthusiasm, desire and capability to modify their dietary intake in a healthy manner with the usage of app. Participants also reported improved self-efficiency, behaviour related to diet, and awareness about the ways for the consumption of healthy diet.

Krebs and Duncan (2015) evaluated the usage of health apps amongst the mobile phone users by conducting a survey on 1604 subjects. It was observed that the respondents who downloaded applications related to health had quite high amount of trust in its accuracy and data safety, majority of them felt that their health has been improved by the apps. Approximately half of the respondents (427/934, 45.7%) stopped using health apps

due to the burden of high entries, drop of interest, and hidden costs.

Dallinga *et al.,* (2015) illustrated the relationship between the usage of health apps and changes in physical activity, health and lifestyle behaviours of short and long distant runners. It was stated that the use of mobile health apps contributed to positive Running Physical Activity (RPA), felling healthier, changing lifestyle and self-image and in the promotion of running and preventing drop outs. According to the researchers, using apps add stimulus to the training programme as it provides an easy and accessible tool to promote physical activity and healthy lifestyle.

Wang *et al.,* (2016) studied the user's opinion on the effectiveness of using health apps and their impact on Physical Activity (PA) and improved diet. They reported that diet apps effectively assisted the users to eat more fruit and vegetables (133/186, 71.5%), eat lesser junk (117/186, 62.9%), choose healthier food products (117/186, 62.9%) and drink less sweetened beverages (106/186, 57.0%). Nearly half of diet app users found diet apps effective in assisting them to eat more low-fat dairy products (91/186, 48.9%) and fewer sausages (88/186, 47.3%). The majority of PA app users felt that PA apps effectively assisted them to exercise more often (144/192, 75.0%) and increase the intensity of exercises (139/192, 72.4%). More than half of the PA app users found that PA apps were effective in assisting them to increase time spent exercising (129/192, 67.2%) and diversify activities (106/192, 55.2%). They also reported that the people using both the apps found diet apps more effective in assisting them to eat less sausages than users who only used diet apps, $\chi 2$ 1=4.2, P=.04; and that the PA apps effectively assisted them to diversify activities than did those who used only PA apps, $\chi 2$ 1=12.2, P<.001.

Lieffers and Hanning (2012) compared the usage of nutrition apps with conventional methods of data calculations. They reported that data based apps such as PDA, DietMatePro, Calorie King Etc. were as effective as paper records or 24-hour recall interviews, and gave various advantages like less data entry and higher participant's satisfaction. They also reported that photography applications such as PDA, Wellnavi etc. approximates but do not replicate the intakes achieved with conventional weighed food records.

Direito *et al.,* (2014) stated that the presence of Behaviour Change Theories (BCTs) varied by app type and price; however, BCTs are associated with increased intervention effectiveness were in general more common in paid apps. Gowin *et al.,* (2015) portrayed how college students utilise health apps to change behaviour. They observed that majority of the participants downloaded the applications to achieve a goal and had a feeling that applications helped them meet it. Oyibo *et al.,* (2018) reported that health apps influenced all three factors of social psychological feature theory (SCT) determinants of behaviour: self-efficacy, self-regulation and outcome expectation. The result of strength on self-regulation ($\beta = 0.42$, $p < 0.001$) and outcome expectation ($\beta = 0.41$, $p < 0.001$) was stronger than on self-efficacy ($\beta = 0.13$, $p < 0.05$).

According to Bert *et al.,* (2013), the management of chronic degenerative diseases, the fight against obesity and voluptuary habits (such as smoking, alcohol and substance abuse), the promotion of healthy lifestyles, adequate nutrition and physical activity are all possible and achievable through the use of these apps. They inferred that it is of high importance to outline the crucial role of physicians in patient's management, and in this reference the smartphones should act as a

complementary element just to support the doctor in the health management of each individual patient.

Schoffman *et al.,* (2013), Conroy *et al.,* (2014), Middelweerd *et al.,* (2014) and Cock *et al.,* (2017) all reported that the beneficial impact of the health apps was limited by the lack of effective behaviour change techniques. Also, most of the apps were void of expert recommended strategies, so the app developers and public health practitioners need to work together to apply evidence based practices and recommendations in the apps to promote substantive behaviour changes.

Direito *et al.,* (2015) cited that although the fitness improved in fitness appsusers, but the results were not very different from the control group; therefore, concluding that these apps are insufficient when used as a stand-alone to promote physical activity and to increase fitness. However, when used as a part of multicomponent intervention, these apps may provide additional support and encouragement to the users (e.g., maintenance phase).

A study was carried out by Cowan *et al.,* (2013) to quantify the presence of health behaviour theory constructs in iPhone apps targeting physical activity. After analysing 127 apps from Apple health and fitness, they concluded that it was not unexpected that apps contained only minimal theoretical content, given that app developers come from a variety of backgrounds and many are not trained in the application of health behaviour theory. The relationship between price and theory score corroborates research indicated that higher quality apps were more expensive.

Eng and Lee (2013) discovered that various insulin estimation analysis apps which met criteria for being a remedially managed versatile application, however were not approved by Food and Drug Administration endorsement in spite of their accessibility to buyers. Far less apps were based on other endocrine ailments and included therapeutic reference for the field of endocrinology, access to endocrine journals, height markers and sedate trackers.

Lister *et al.,* (2014) observed that majority of the popular games in health apps were using principles of gamification, but very few of them adhered to industrial standards or professional guidelines provided. According to the researchers there was an association between behavioural theory and gamification ($P<.05$) but not with game elements. When analysed further gamification was only associated with composite motivational behaviour scores ($P<.001$), and not capacity or opportunity/trigger.

Weaver *et al.,* (2013) analysed the famous smartphone apps related to alcohol in order to find out youngster's point of view of such apps, their appropriateness and utilisation of health promotion related to alcohol. It was observed that out of 384 applications, 50% (192) were apps related to entertainment, 39% (148) came under Blood Alcohol Concentration (BAC) category, and 11%(44) were the one's which promoted health and/or abstinence to drinking related apps. According to them, these apps would be used as a form of entertainment, enhancing the consumption of alcohol amongst youngsters rather than reducing the drinking and taking risks. It was deduced that mostly the apps related to alcohol encouraged its intake. The apps which were used for the estimation of BAC were available at a huge scale but quite unreliable.

A study was conducted by Backinger and Augustson (2011) to analyse the various iPhone apps available in the App store that promise to promote smoking cessation. The

apps were found to have low levels of adherence to key guidelines in the index. They concluded that iPhone apps for smoking cessation rarely adhere to established guidelines for smoking cessation and it was recommended to revise the current apps so that they can promote evidence based practices and actually benefit the user.

In conclusion, the purpose of this review was to provide a description of app based intervention studies, their impact on physical activity and nutritional status, describe common behavioural features, and to explore the acceptability and potential for apps to change behaviour as currently dictated by the literature. In the small sample of reviewed studies, the majority of apps were viewed as acceptable, inclusive of theory, and efficacious at changing behaviour, and bringing about positive results on weight management. Moreover, the potential for scalable behaviour interventions through this technology is promising, but largely untapped.

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