

Mobile Health Applications to Tackle Obesity and Assist Weight-Management Goals among Adults

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Abstract. Today, there is not merely a public-health crisis regarding obesity, but a worldwide epidemic. To a degree, clinically significant reductions in weight can be pursued via intensive, conventional interventions to address behaviour. Nonetheless, limits on resources, and the associated costs, make this approach problematic in terms of scalability. As regards intervention content, and as a means of tackling these challenges, researchers have recently devoted more attention to mobile devices and the Internet. A range of behavioural factors generates obesity. Mobile health (mHealth) technologies target these factors and seek to change them, in order to foster healthier lifestyles. Given its portable and relatively inexpensive nature, mHealth comprises a potentially important means of mitigating the morbidity and mortality associated with obesity, as well as the social costs that the condition incurs. The present study seeks to interrogate the extant evidence for the efficacy of mHealth in mitigating the costs of obesity and effecting weight management. It also reviews some of the smartphone applications (apps) associated with the mHealth paradigm. These apps will be considered in terms of their challenges and implications, as well as their potential. In fact, extant research data do suggest that mHealth apps may be delivered remotely, at relatively little cost, as a means of managing adult obesity, and crucially, that they may be deployed more successfully than traditional care. In other words, mHealth evinces much potential, albeit with the caveat that the technology is still in its infancy. It may be some time before its full capacity as a means of reducing obesity is fully exploited. Substantial future research on this issue will be necessary, and it must address cost effectiveness, long-term outcomes, user engagement and the development of applications. Such research will, in due course, allow us to appraise the true feasibility of using mHealth apps as a permanent, and expanding, tool for obesity reduction and weight management.

Keywords: mHealth, Mobile Health, Obesity, Weight-Management.

1. Introduction

Since 1975, an obesity pandemic has been emerging in countries of high, middle and low income. Globally, according to the WHO, more than 340 million adolescents and children were obese or overweight in 2016 [1]. Meanwhile, around two billion adults were overweight, with a body mass index (BMI) exceeding 25 kg/ m², and of these, 650 million were clinically obese (BMI >30 kg/m²). This phenomenon entails heightened risk for cardiovascular illness, various cancers, diabetes mellitus, and other conditions. The global burden of obesity or excess weight is often described in terms of disability-adjusted life-years (DALYs) of the overweight. This unit of measurement is calculated by combining the years of life lost and years spent living with disability. Annually, throughout the world, some 4.7 million premature deaths may be attributed to obesity. The latter also accounts for 120 million global, adult DALYs [2]. This obesity crisis will place a mounting strain on healthcare resources, while simultaneously elevating morbidity and mortality.

According to Tremmel et al. [3], the annual costs of tackling the direct consequences of obesity are more than \$7.6 billion in the UK and \$147 billion in the US. In economic terms, obesity has reduced global GDP by around \$2 trillion, or 2.7%. While obesity rates have been rising throughout societies, levels are highest in the most disadvantaged groups. Thus, although obesity affects both rich and poor states, its consequences are felt most acutely by the economically marginalised [4]. Policy-based and environmental initiatives, such as the promotion of calorie deficits, have borne fruit in some countries, but they have not persuaded the morbidly obese to change their lifestyles. Because

of the complex burdens that the obesity pandemic brings, innovative treatment, care-delivery strategies and technological advancements are vital.

One of the more important of these technological advances is mHealth. This term refers to the use of mobile devices as a platform for the delivery of public-health practice and health care. The World Health Organisation describes mHealth as both a public-health and medical practice, and one that implicates mobile technologies, such as personal digital assistants, various wireless devices, patient-monitoring technology, and of course, smartphones [5]. Indeed, mHealth comprises at least six categories, namely, clinical-decision assistance, health awareness and promotion, diagnostic support/integrated care, education, the remote collection and analysis of data, and remote monitoring [6]. The market already contains a vast array of apps (software applications); moreover, because of their portability, versatility and popularity, mHealth devices evince considerable global potential for mitigating obesity. This review will seek to survey certain mobile-phone apps used in mHealth. It will also evaluate the evidence for their weight-management efficacy. The review will then discuss the implications and challenges of these apps.

2. Comparison of traditional obesity-management methods with mHealth

It is true that clinically significant degrees of weight loss have been achieved through intensive behavioural interventions. The latter may include (a) reductions in energy intake, (b) the self-evaluation of physical activity, diet and body mass, and (c) methodically heightened energy expenditure [7]. Furthermore, such intensive interventions often require the individual to acquire a useful set of skills, such as problem resolution, stress management and the control of stimuli, which leave him/her well placed to effect behavioural change in diverse circumstances. Regrettably, these interventions also evince certain drawbacks that impede population-level attainment: they are frequently inaccessible, expensive, and time consuming for provider and patient alike. At present, the starting point for many weight-loss-oriented interventions and programmes, in Europe and North America, is to propose a suitable mixture of exercise, counselling and dietary modification, tailored to the requirements of the individual. Such an approach exploits various theories around behavioural change [8]. Meanwhile, since interactive technology can be utilised both to monitor behaviour and to encourage changes in lifestyle, increasing attention has been paid to the potential of digital technology in guiding individuals towards better healthcare choices [9,10]. Moreover, via the use of communicative technologies and IT, rehabilitation, treatment and obesity prevention can be pursued via self-care in the community, in a manner that is both cost-efficient and acceptable in terms of outcomes [11]. Such self-care usually implies self-monitoring, especially when technology is involved. This is welcome in itself, as self-monitoring is often regarded as a sine qua none of successful behavioural weight-loss interventions [12].

3. Mobile-phone-app functions in mHealth

‘Electronic health’ refers to health-care provision and health surveillance, as provided via communication technology and IT. Mobile health, or mHealth, as referenced above, is a fast-growing sub-category of this phenomenon, and it allows widely disseminated mobile devices (such as phones or tablets) to deliver services and (thus) to augment public-health outcomes [5]. This approach is exciting, since mobile technology is increasingly powerful, and it is accessible to three quarters of the global population [13].

More than half of smartphone users used at least one mHealth app, and 80% of individuals show interest in tracking and reporting their mental wellbeing using their phone [14]. Between 2016 and 2020, the number of mHealth app downloads more than doubled, indicating a rising acceptance of their usage. Users of mHealth apps indicate that they use them to monitor their body and fitness data (27%), for health education purposes (20%), to assist in behaviour/lifestyle change (11%), and to improve medication and immunisation management (2%) [15]. According to one study, about 60%

of Americans have downloaded and regularly used mobile health applications. In their sample, users of mHealth applications were more modern, had a more significant social-economic status. Exercise and diet were the most commonly utilised app categories. mHealth apps can revolutionise the way healthcare settings are delivered by enabling the sharing of health information more rapidly [16]. Future general practices will be built on a standard set of synchronised care processes by a diverse collection of providers, requiring the integration of many information systems. Furthermore, patient empowerment will be emphasised in the future [17]. mHealth technology may help with these improvements. Additionally, there is considerable potential for innovative app technologies since they may help underserved groups. Rural inhabitants, people from developing countries, teenagers and youths, the elderly and the physically disabled are all covered [16,18]. Mobile health apps may be used regardless of geographic location, language competence, or other treatment barriers. They may be utilised to assist in clinical diagnosis, disease course assessment, integrated therapy settings, as a self-help tool while awaiting routine administration, or to avoid recurrence [19]. Diagnostics and change management may be assisted by either active or passive behavioural monitoring [20]. Additionally, they may complement traditional treatment by enabling access to less stigmatised restorative materials or medical therapy [21,22]. Additionally, people suffering from chronic diseases make up a significant portion of the target demographic. Individuals with chronic diseases may benefit substantially from lifestyle changes aimed at reversing the disease process. Additionally, mobile therapies (IMIs) may be cost-effective for individuals with special treatment needs and concomitant high medication fees [23].

4. Types of mHealth application for obesity management

Largely because mHealth is portable, cost-effective and accessible, its use continues to increase rapidly [24]. One simple method of dispensing health information, for example, is that of the SMS (short-message service) [13]. Similarly, since smartphones offer such eclectic functionality, and since their ownership is spreading so quickly across the world, they are increasingly being exploited to control and prevent obesity [25]. For general obesity management, a range of mobile applications have already been launched, and they make use of facilities such as microphones, movement sensors and cameras [26]. To give one example, via a combination of GPS and mobile-sensor technology, patients can be furnished with real-time feedback regarding step counts, objective completion, energy use, and speed of movement. The same technology can also be deployed to generate maps for exercise routes. Cameras, moreover, can be used to monitor diet by (e.g.) recognising foodstuffs and using the content of videos or photos to assess the calorific content of a particular meal. Automated processes also require minimal time and effort from the patient [27].

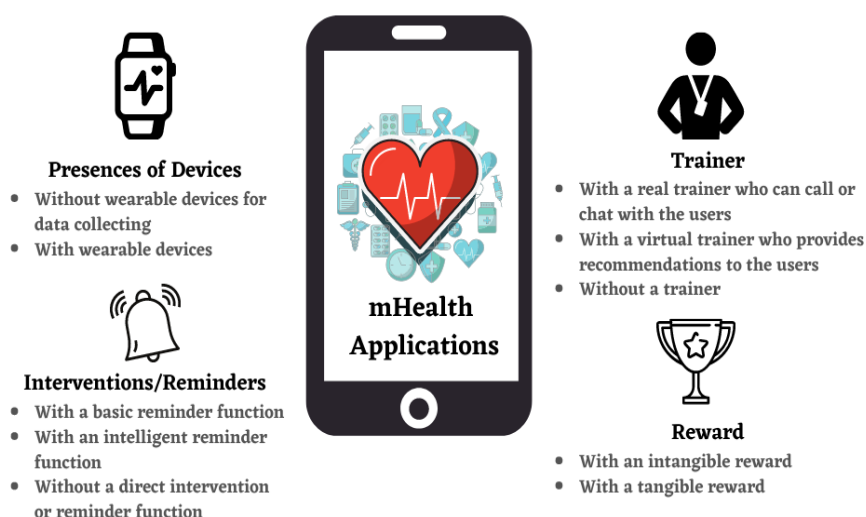


Figure 1. Common mHealth applications for obesity and weight management

For obese and overweight adults, mHealth app interventions comprise various strategies. A systematic review has provided a structured categorisation of these approaches [28]. This categorisation was designed to clarify the key features of each app (see Figure 1), even though certain apps may evince overlapping features. In the case of mHealth apps, three strategies are generally prioritised in terms of interventions against excess weight. These strategies are: dietary change, increased physical activity, and better sleep. Many mobile devices have pre-installed features such as accelerometers and algorithms to identify physical actions, such as sitting, standing or walking. They can also estimate energy expenditure and count an individual's steps [29]. Apps primarily monitor markers of progress. The latter include (e.g.) calories and nutrition ingested, steps taken in one day, and the intensity and duration of physical exertion. Indeed, by integrating behavioural data concerning activities, nutrition, etc., apps can make suggestions to encourage lifestyle modifications.

The design of mHealth has been influenced by public-health bodies and governments, as well as private companies. Nonetheless, most of the apps generated by the private sector have been constructed with little input from health professionals, meaning they do not reflect the latest expert knowledge in terms of obesity and overweight [30]. Furthermore, mHealth testing paradigms in the commercial sector often differ drastically from those in the research and clinical arenas. While mHealth apps potentially justify large-scale investment, those who provide funding for health-care provision must be assured that this is money well spent. If such platforms are purchased, they must prove effective, equitable, and accessible to those demographics most at risk [31]. Conversely, the success of such programmes from the perspective of commercial providers is more likely to be evaluated via market uptake, rather than actual weight-loss outcomes. Individual testimonials may be empirically useful, but any genuine impact requires mHealth to deliver results for most users, most of the time.

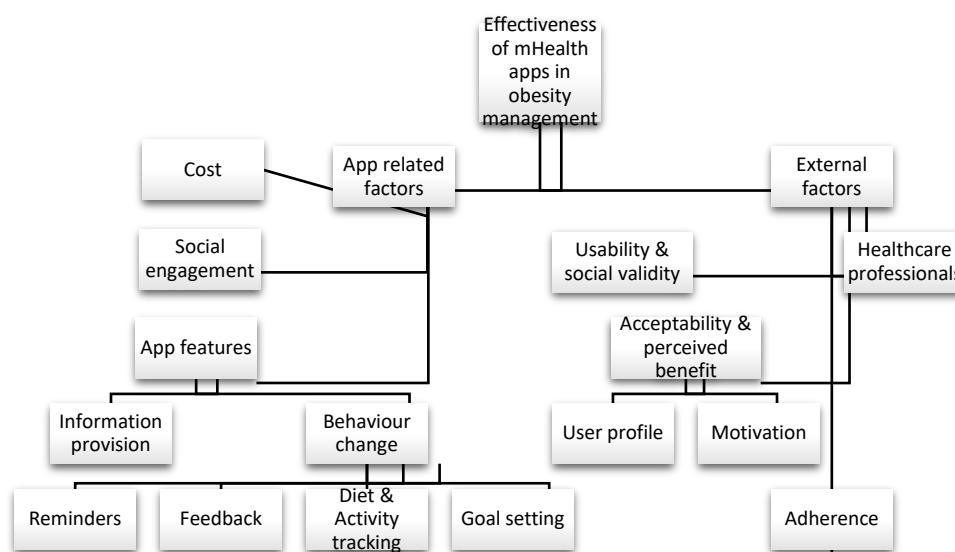


Figure 2. Factors influencing the effectiveness of mHealth apps in obesity-related management.

5. Existing evidence regarding mHealth apps in weight management

Hyperbole often overtakes reality when we assess the potential of mHealth apps to be the sole paradigm for weight-reduction interventions. One study [30] examined app stores in ten countries with a high prevalence of obesity, including Russia, the United Kingdom, Australia and the United States. Remarkably, out of 28,905 health-oriented apps, only 0.05% reflected input by health professionals in their design. Meanwhile, two methods have evolved to assess the efficacy of weight-loss apps. The first is randomised control trials, generally acknowledged to provide high-quality data. This method was deployed, for instance, to test the efficiency of the commercial app MyFitnessPal® soon after its introduction to the US primary-care environment. After six months of trials, disappointingly, there was no discernible outcome discrepancy between users and non-users [33].

Hence, the efficacy of the app appeared to be nil. Conversely, if a mHealth intervention has the same outcome efficacy as a face-to-face intervention, there is still the possible, supplementary benefit of reduced contact time and thus greater cost-effectiveness. Patrick et al. [34] provided the example of a text-message-based intervention for overweight adults that resulted in a weight loss of 1.97kg on average, over 16 weeks. The result was similar to an online weight reduction intervention, participants were found to result in a 0.9% of weight loss after 16 weeks programmed [35]. Finally, a research comparing mail, mobile phone apps, and in-person healthcare for weight loss in overweight and obesity individuals in a managed care environment showed mean weight decreases of 1.93 kg, 2.38 kg, and 1.47 kg, respectively, after six months, which are also broadly similar to the text-based the text-based study's findings [34].

The second method of assessment is more recent, and it involves private firms submitting apps for evaluation by trained researchers. Thus, the American developers of the popular commercial app Lose It!® submitted data to clinical researchers at Bethesda's National Cancer Institute (USA). Over 12 million individuals were subdivided into groups of 'power', 'basic' and 'occasional' users, depending on usage frequency. Indeed, a higher probability of losing 5% of body weight was duly evinced by those who used the app for over 40 days, compared with less frequent users [31].

6. Barriers and challenges when using mHealth apps in obesity management

A range of mobile platforms currently offer consumers commercially designed software applications to promote weight loss, and in fact, these apps are numerous. Many such applications are, however, available only on a commercial basis. There is empirical data to support the efficacy of some commercial weight-loss programmes, but many of the apps based on the latter have not been subjected to credible, long-term clinical trials. Furthermore, mobile weight-loss apps present a strikingly high attrition rate; i.e., many users simply give up. For current mobile technology, monitoring simple physical activities (walking, standing, etc.) is fairly straightforward, but the monitoring of diet is far more challenging. This may explain much of the attrition problem [12]. Users tend to be demotivated by apps that require active self-monitoring, and input becomes especially tedious if diets are complex [36]. Some apps have a limited range of nutritional options, making it difficult or impossible to enter data for exotic or ethnic dishes. By contrast, other apps are so complex that users merely become confused. Hence, research suggests that any app requiring manual data entry by users is of limited clinical value, and traditional paper-based approaches may be preferable. This is especially true for the elderly, who may be less technologically aware [37].

Low adherence patterns frustrate research into the efficacy of mHealth weight-loss apps, and they also generate biased results. Obviously, low adherence in any weight-loss initiative leads to a lack of efficacy, and it may reflect dissatisfaction with the initiative itself [12]. In order to address the limitations of apps and improve retention, some scholars recommend the use of more sophisticated algorithms. Hence (e.g.), the successful fulfilment of previous dietary objectives can lead to changes in daily or weekly targets [32]. A further problem is that the public is often drawn to apps endorsed by celebrities, but these products are seldom free. This reflects the power of popular culture, but while some may be attracted by the association of apps with famous people, large numbers of potential users may be put off by the prospect of fees. A paradox thus arises, whereby the public is less inclined to choose fee-based apps, while nonetheless crediting them with greater efficacy [38].

7. Further research

Although previous studies have developed some understanding of the efficacy of mHealth apps in tackling obesity, further research is needed. For example, the studies examined prior to the writing of this paper evinced meagre examination of mHealth anti-obesity interventions in terms of cost/benefit analyses. There was one exception, namely, a study that produced a higher estimated cost per kilogram lost, for each participating individual, for traditional interventions versus technology-

oriented approaches. In other words, the latter were more cost efficient. Nonetheless, there is a general absence of cost-benefit analysis among extant studies, reflecting a broader failure to address the costs around mHealth interventions, whether high or low. The focus thus far, indeed, has tended to be on efficacy rather than cost. Admittedly, several of the apps covered by prior studies demanded only minimal patient expenditure (often associated with SMS charges), while other apps were offered gratis. Indeed, among smartphone-based apps, a large proportion were linked to either minimal charges or none, implying easy availability for the population at large.

Nevertheless, the sparseness of data around the cost-efficiency of mHealth technology remains problematic. To reiterate, most studies thus far have prioritised outcome quality. Given the rapidly evolving nature of the market, such research is far from useless. Value for money and usability, however, remain important considerations, and further research is needed in these areas. Another important question to be addressed in future is whether the cost/benefit advantages of an exclusively mobile approach to obesity might be outweighed by those of combined mobile and conventional interventions.

Most studies indicate that mobile applications do have the potential to aid weight loss, provided the circumstances are suitable. Conversely, persistently low adherence levels hamper attempts both to deploy and to evaluate these apps. One key aspect of face-to-face weight management needs to be replicated in the digital sphere, i.e., the motivation and accountability provided by a personal coach. In future, these types of application should be expanded to other groups of people, such as post-menopausal women and those suffering from cancer or diabetes. There is empirical data to support the value of lifestyle modification as a first-line intervention, and such groups may be significantly advantaged by this approach [39]. Studies conducted within a rapidly aging population have noted the readiness of the elderly to engage in physical activities, especially if these have a social dimension. The wider population, at least, is increasingly technologically aware. Nevertheless, widespread adoption of modern technology has not been witnessed among senior cohorts. This remains true, despite the fact that they especially stand to benefit from interventions designed to enhance mental and physical well-being, or to improve the process of aging in a vibrant social setting [31].

At the European Obesity Summit of 2016, a presentation stated that five mobile-app stores (those of Google, Blackberry, Apple, Amazon and Windows) offered almost 29,000 weight-management apps. Remarkably, a mere 17 of these, or less than 0.5 percent, had been designed by individuals with documented clinical expertise [40]. This implies, not only a need for more credible apps, but also a requirement for rigorous studies to interrogate the products available in this fast-changing market.

8. Conclusion

Practical solutions are urgently needed in the face of the present, worldwide obesity crisis. Mobile applications for obesity-management mHealth represent one of many options that are now being explored. The question remains, however: precisely how may applications promote behavioural change? It has proven difficult to identify effective ways to do this, and it is challenging to motivate a subset of the population who have adhered poorly to these applications or have not found them effective. It is clear that research must be prioritised here, and clinical-care professionals must be consulted in the development of apps. Long-term collaboration, indeed, is required between IT engineers, IT specialists, computer modellers and clinicians. Undertaking the study could have valuable public health implications as it will facilitate the emergence of apps that offer tangible benefits for the world's obese and overweight populations.

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