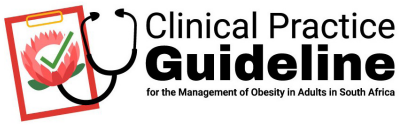
Emerging technologies and virtual medicine in obesity management



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KEY MESSAGES FOR HEALTHCARE PROVIDERS

- The Clinical Practice Guideline for the Management of Obesity in Adults in South Africa Committee and the authors of this chapter do not endorse any particular commercial products related to emerging technologies; however, the goal is to advise or caution on their use where clinically applicable. (See the chapters 'Medical nutrition therapy in obesity management', 'Effective psychological and behavioural interventions in obesity', and 'Physical activity in obesity management'.)
- The application of technological advances in the management of people living with obesity (PLWO) has shown beneficial outcomes in recent years through various ever-expanding diagnostic and interventional modalities. These include treatment and monitoring strategies delivered via portable or wearable devices (e.g. mobile phones, watches), integrated software platforms (e.g. websites/applications), and most recently artificial intelligence-based multidisciplinary integration of computer science and linguistics.[1-16]
- Technology-based interventions provide efficient, accessible, adaptable and possibly cost-effective options for the challenging management of PLWO. These strategies can enhance standards of conventional (in-person) care or can function independently to personalise diagnoses and interventions. Always consider the ethical and legal implications[17,18] of endorsing interventions beyond standard of care, based on available evidence-based information.
- The weight loss benefits of technology-based interventions in the management of PLWO have been shown in numerous evidence-based publications. Unfortunately, there is a paucity of data comparing conventional strategies in populations of PLWO versus these novel technologies. This lack limits definitive conclusions about their comparative benefits in PLWO. Furthermore, although weight loss and maintenance are important outcomes in obesity management interventions, they should not be the only parameters evaluated.
- Future research is required to evaluate the impact of technology-based obesity interventions on quality of life and prevention or treatment of obesity-related disorders or complications in various communities (affluent and resource-poor settings).
- Paradoxically, the increased use of technology to improve efficiency in activities of daily living could inadvertently contribute to more sedentary behaviour. However, if managed appropriately, emerging technologies can advance healthcare and enhance quality of life and longevity of PLWO.[5]

KEY MESSAGES FOR PEOPLE LIVING WITH OBESITY

- Technology-based strategies can help manage your health, both when used as personal stand-alone care and when combined with conventional (face-to-face) obesity management approaches.[16]
- There are multiple options for incorporating technology into your obesity management strategy, which include portable devices[16] (e.g. mobile smartphones), web-based platforms (e.g. websites), wearable tracking devices (e.g. smart watch/fitness tracker), and/or integrated applications software/artificial intelligence.[1,3,6,9-11,13]
- In many circumstances, you may find technology-based strategies more convenient and time efficient than traditional face-to-face encounters with your healthcare provider.

- Discuss with your healthcare provider what are appropriate options best suited for your clinical circumstances. Always consider protection of personal information legislation as regulated by local authorities (Protection of Personal Information Act [POPIA]).[17,18]

RECOMMENDATIONS

1. Implementation of strategies in the management of obesity can be delivered through web-based platforms (e.g. online education on medical nutrition therapy and physical activity) or mobile devices (e.g. daily weight reporting through a smartphone phone application) (Level 2a, Grade B).[1,12]
2. We suggest that healthcare providers incorporate individualised feedback and follow-up (e.g. personalised coaching or feedback via phone or email) into technology-based management strategies to improve weight loss outcomes (Level 4, Grade D).[10]
3. The use of wearable activity-tracking technology should be part of a comprehensive strategy for weight loss (Level 1a, Grade A).[5]

Introduction

- **Emerging technologies for healthcare** generally refer to digital health or telemedicine and are defined as the use of digital information and communication technologies, including smartphones, computers or devices to enhance the delivery of remote healthcare. According to the World Health Organization (WHO), these advances are used 'for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and the continuing education of health care workers, with the aim of advancing the health of individuals and communities'.[14] The WHO has called for prioritisation of the development and integration of digital interventions for health systems. Globally the uptake of digital health has been accelerated by the COVID-19 pandemic, creating an opportunity to promote strategies to manage people living with obesity (PLWO).[14,16]
- **Conventional obesity management** refers to face-to-face weight management strategies that include education regarding nutrition, exercise, and/or a behavioural change component.
- **Usual obesity management** refers to the deficiency of active or intentional weight management for PLWO. This includes typical primary care service delivery, where there are no dedicated visits, education or interventions planned for the management of obesity.[16]

Conventional management programmes have been shown to be effective in achieving short-term weight reductions in PLWO.[6,19] Many of the conventional programmes for management of PLWO have also been shown to be cost, labour and time intensive.[19,20] Attempts to reduce the frequency of encounters or interactions have shown negative results in terms of the management of PLWO and other secondary outcomes, for example cardiometabolic risk factors other than weight.[21] The challenge in management of PLWO is to maintain or improve upon proven programmes by retaining the supportive aspects of conventional interventions that include social and clinical support, accountability and personal feedback on an enduring, sustainable basis. These interventions should provide access equity and parity.

Advances in technology, as well as use of technologies that have long been employed in medical care, present an opportunity to maintain the key components of conventional programmes for management of PLWO while reducing cost and provider time inputs and improving convenience for PLWO, potentially resulting in improved adherence to treatment.[5,6,10] Technology-based strategies may also overcome the barrier of inadequate training in effective psychological and behavioural counselling commonly cited by healthcare providers (HCPs).[22] Additionally, technology-based strategies or advances may present an opportunity to address concerns related to weight loss maintenance, as several studies have shown high rates of weight regain after initial successful short-term weight loss.[23-25]

The universal nature of advancing technologies in everyday life, specifically the widespread use of mobile smartphones, presents new opportunities for programmes for management of PLWO that can be used in an increasing subset of the patient population.

Mobile smartphone users in South Africa (SA) are estimated at more than 20 million,[26] representing approximately a third of the population, and reflect an ever-expanding market. Access to the internet for the use of web-based platforms is increasingly prevalent; however, wide disparities in the availability and quality of internet access exist across regions.[27,28]

Regardless of geopolitical limitations, future aerospace platforms to enhance telecommunication may include satellite internet constellations such as Starlink,[29,30] which may improve global access to high-speed internet services.[28]

New technologies are increasingly being presented for application in healthcare, although it is unclear how best to use these technologies in the management of PLWO, or whether they will be widely accepted among the target population. Since the widespread use of technology for remote care of PLWO is still relatively new in healthcare, further research is needed to identify which technologies are best suited for specific clinical purposes and patient populations, and to determine for whom these solutions are appropriate and accessible. It is vital that such technologies are used to enhance care delivery and availability but do not limit access options for populations who experience socioeconomic barriers.

The role of HCPs is to determine which aspects of proven conventional programmes may potentially be replaced or improved by technologies that could offer convenient and cost-effective services. These interventions should be appropriately allocated for PLWO. HCPs should therefore determine the ways in which technology could be used to bridge care gaps resulting from lack of accessibility.

Technology-based interventions or diagnostic modalities should be used in the context of shared decision-making and in accordance with individualised preferences of PLWO. Management plans should integrate technology and could be co-designed with PLWO.[16]

Finally, conventional programmes could be complemented by the use of technologies to improve access plus convenience, to provide rewarding benefits or to improve outcomes in both initial weight loss and maintenance.[16]

Efficacy of technology in the management of people living with obesity

Technology-based interventions include those delivered through web-based platforms, or mobile or wearable smart-tracking devices. Web-based platforms that have been studied include those that provide education about nutrition and physical activity, self-monitoring of goal behaviours and goal setting. Strategies delivered through mobile

devices include text message advice and smartphone applications to monitor food calorie intake and changes in weight. Wearable tracking devices are even more convenient for real-time monitoring with the use of integrated pedometers, accelerometers and other sensors. Current evidence has shown that interventions for the management of PLWO that incorporate technology may lead to significant reductions in weight for PLWO, providing superior outcomes to usual care.[1,31] The majority of studies on this topic involve follow-up ranging from 6 weeks to 6 months.[1,5] It is important to note that, while the combination of technology-based management with conventional care augments weight management benefits, evidence regarding employing technological strategies as a substitute for conventional (face-to-face) programmes remains inconclusive.[5,31,32]

A meta-analysis of 23 randomised controlled trials examining web-based experimental versus non-web-based controls found that the utilisation of technology led to improved weight loss outcomes (–0.68 kg; p=0.03) over a period of 3 to 30 months. Secondary analyses revealed that the combination of web-based technology and conventional (face-to-face) care led to superior weight loss outcomes (–1.93 kg; 95% confidence interval [CI] –2.71 - –1.15; p<0.001) compared with web-based strategies without face-to-face care (–0.19 kg; 95% CI –0.87 - 0.49; p=0.59), and that this difference was statistically significant (p=0.003).[32]

Similarly, a second systematic review found that the incorporation of human contact or individualised feedback, through email or online discussion, into a web-based weight loss programme led to improved outcomes.[10]

A randomised trial comparing smartphone-based behavioural obesity treatment (SMART) with gold-standard behavioural treatment (GROUP) and a control group (CONTROL) included 276 adult participants with documented overweight/obesity. The estimated mean (95% CI) weight change over 18 months did not differ across the three groups studied: 5.9 kg (95% CI 4.5 - 7.4) in GROUP, 5.5 kg (95% CI 3.9 - 7.1) in SMART, and 6.4 kg (95% CI 3.7 - 9.2) in CONTROL. The conclusion was that mobile online delivery of behavioural treatment of PLWO can achieve weight loss outcomes that are at least as good as those obtained via the more intensive gold-standard group-based approach.[33]

A systematic review and meta-analysis of mobile health in a healthy overweight/obese Chinese population[34] concluded that intelligent modalities could be a promising approach for weight management.

A subsequent scoping review of combinations of personal and digital health in the management of PLWO concluded that the most common hybrid weight management intervention type was the combination of face-to-face and telehealth (i.e. phone call/text messaging) (40%), closely followed by a combination email intervention (30%) and mHealth apps intervention (30%).[35] Most of the face-to-face dietary interventions were delivered as group counselling (80%), while some were conducted as individual counselling (20%). Most studies observed a positive effect of the hybrid weight management intervention on body weight (weight lost 3.9 - 8.2 kg), body mass index (decreased 0.58 kg/m^2), waist circumference (decreased 2.25 cm) and physical activity level compared with standard care. Findings suggest a direct association between hybrid weight management interventions and weight loss.[35]

A systematic review and meta-analysis that examined the effectiveness of telemedicine interventions for the management of PLWO in US adults revealed a statistically significant mean difference of 0.93 in favour of telemedicine interventions for weight loss.[36]

These findings suggest that incorporating individualised care, whether through face-to-face encounters or technological means, may provide improved weight loss and possibly improved management of PLWO.

A major downfall of many conventional programmes is the high prevalence of weight regain over the long term following treatment.[24] Owing to the limited evidence and short-term follow-up of available studies, it remains to be seen whether technology-based strategies are effective in preventing weight regain and aiding with weight loss maintenance, or indeed effective at managing other obesity-related outcomes.[10,33,37,38]

Limitations and future directions

It is important to note that conventional management of PLWO, while having its limitations, has generally performed very well as a medical intervention. It is backed by strong evidence supporting its efficacy. Interventions that seek to replace this modality will need to be studied intensely and applied broadly in order to achieve results that could suggest replacing a widely accepted and rigorously proven intervention such as conventional management of PLWO.[6,19]

The Obesity Medicine Association clinical practice statement on 'Behavior, motivational interviewing, eating disorders, and obesity management technologies' is designed to assist clinicians in the care of patients with the disease of pre-obesity/obesity.[7] The implementation of appropriate evidence-based clinical practices in these areas may improve the health of patients, in particular those with adiposity-associated metabolic consequences.[7]

Recommendations for the use of technology in the management of PLWO are limited by a number of factors:

- A large proportion of studies on the topic do not implement any intervention for the control group or use wait-list controls.[1,31] This may falsely accentuate the positive effects of technology. Future studies should compare technological interventions with conventional (face-to-face) care in order to be able to form true conclusions about the potential superior benefits of technological interventions in management.[16]
- Technology studies often implement multiple interventions in the intervention group (e.g. mobile application in combination with a web-based programme), making it difficult to discern which particular intervention the effects of technology may be attributed to in the study.[1,31] Future studies should investigate each intervention in isolation in order to be able to draw strong conclusions about the various modalities, the method of delivery, and efficacy or effectiveness.[16]
- The majority of studies on the topic have relatively short follow-up times, ranging from 6 weeks to 6 months.[1,5] It is important that future studies allow for longer follow-up in order to be able to make conclusions surrounding weight regain and weight loss maintenance.[16]
- Studies evaluating the use of technology-based management in PLWO are methodologically flawed, which limits their external legitimacy.[16] For example, a large proportion of studies on the topic include only PLWO, excluding other obesity-related disorders including diabetes and hypertension. This is damaging to the generalisability of the results, as obesity is strongly associated with such clinically relevant conditions.[39,40]
- Additionally, many of the trials evaluating the efficacy of technology-based management of PLWO have recruited disproportionately more women than men.[10] More studies evaluating outcomes in men are needed to draw firm conclusions.

- A large proportion of studies investigating technology-based strategies for the management of PLWO exclude individuals who have recently engaged in obesity management programmes or strength and endurance training.[11,41,42] This inevitably preselects for PLWO who may be less informed about obesity as a chronic disease and in whom adherence to treatment and possible benefits may be undermined.
- Many of the studies supporting these recommendations included populations who do not live with obesity, and the results may therefore not be relevant to such populations.[1,5,43] Further evidence is needed to describe the acceptability and level of input from PLWO and HCPs for the various technology-based interventions.[8]

Although weight loss and weight loss maintenance components are important outcomes in obesity management interventions, they are not the only results to consider. For example, studies should assess the impact of technology-based obesity interventions on quality of life and prevention or management of obesity-related complications.[16]

As digital healthcare is a rapidly evolving field, a core set of parameters should be used to allow for a more powerful, standardised approach to evaluating these technologies, such as those provided by the WHO,[16,44] to enhance comparability between studies. Available appropriate reporting guidelines should also be utilised.[45]

Additional considerations and future prospects[16]

- Appropriate methods for evaluating digital technologies for the management of PLWO should be considered. These methods should include service outcomes (efficiency, safety, effectiveness, equity), PLWO outcomes (clinical and psychosocial), and implementation outcomes (acceptability to both PLWO and HCPs, adoption, training and support requirements, cost-effectiveness and sustainability).
- Gaps and deficits in the availability of resources, funding, equipment and/or proficiency of information and communication technologies may be critical factors in the successful local implementation of technology-based interventions or adjuncts to treatment. Resource-poor environments are more vulnerable when considering technological advances. However, these areas may benefit most from improvements in care delivery and sustainable support.
- A framework for the governance and regulation of digital technologies is vital. General data-protection regulations and additional relevant local and institutional processes and legislation relating to cybersecurity and the protection of patient data should be central to any inclusion of technology in healthcare. Always consider protection of personal information legislation as regulated by local authorities (in SA, the Protection of Personal Information Act [POPIA], Act No. 4 of 2013).[17,18]
- HCPs should consider the appropriateness of incorporating technology-based management of PLWO, where available, with subpopulations of the target user group. Low digital literacy and/or the potential additional burden of costs associated with internet connection may hinder successful engagement with technology-based approaches, especially in developing countries with unique healthcare challenges such as SA.
- Decisions on incorporating such approaches should be made with the PLWO, and alternatives made available for those for whom technology-based approaches are not accessible, feasible, comfortable or acceptable.
- To maximise the potential benefit of digital technologies, engaging key stakeholders such as HCPs and PLWO in the collaborative design and implementation of digital interventions is advised.
- Integration of AI software,[3,4,15] virtuous robotics[46] and chatbots could be considered in the management of patient-centred obesity care for PLWO.[47,48]
- Machine learning diagnostic tools for detecting and diagnosing PLWO may contribute to appropriate early intervention and augmentation of the natural clinical progression anticipated.[49]

Conclusion

The burgeoning fields of biomedical science and bioengineering technological advances are converging to expand diagnostic and therapeutic modalities to venture beyond science fiction into the science facts of our modern age.

While there is some evidence to support the use of technology for the management of PLWO, it does not support the replacement of conventional treatment approaches.[1,31] There is insufficient evidence comparing technology-based treatments for the management of PLWO with conventional (face-to-face) management, as discussed above.[5,31,32] Therefore, technology-based platforms may be offered in addition to conventional (face-to-face) management or in instances where conventional care is unavailable, not feasible or less preferred by the patient.

It is clear that technologies that employ a more personalised, patient-centred approach are superior to those that operate independent of user characteristics or feedback.[10,32] To clarify, technology-based interventions still have to account for the personal nature inherent in the delivery of general medical care. More work will need to be done to determine which technologies are appropriate for application to the management of PLWO and in which PLWO groups they will be most beneficial.[8,15]

Regulation and appropriate integration of artificial intelligence[50] as part of multidisciplinary management of obesity-associated health concerns are of paramount importance. The future of digital therapeutics should aim to deliver evidence-based interventions and diagnostic tools that incorporate quality software and biomedical engineering devices. These modalities should integrate personalised patient-centred healthcare with oversight by experienced clinicians. Caution is advised when utilising technological interventions without scientific due diligence.

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