

mHealth Interventions for Preventing and Managing Childhood Obesity: An Integrative Review of Efficacy, Parental Involvement, and Physical Activity Outcomes

Ranjana Dhiman^{1*}, Kanika Rai²

¹Chitkara University College of Nursing, Chitkara University, Himachal Pradesh, India

²Chitkara School of Health Sciences; Centre for Evidence based Practice in Healthcare, Chitkara University, Punjab, India

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ABSTRACT

Introduction: Childhood obesity is a rapidly expanding issue that has long-term repercussions. Innovative mHealth interventions, such as web-based programs and mobile applications, have been implemented to assist in the prevention and management of pediatric obesity. The present review primarily concentrates on the most recent evidence regarding the efficacy of mHealth innovations that contribute to reducing childhood obesity through the promotion of physical activity and parental support.

Methodology: A comprehensive analysis of 12 randomized controlled trials, 1 quasi-experimental research design, 1 mixed-method study, 6 meta-analysis, integrative review and systematic review (total n=20) was done to evaluate the effect of mHealth interventions on obesity among children.

Results: The review's results indicated that mHealth interventions are beneficial for the significant reductions in BMI z-scores, as well as for the enhancement of their physical activity and dietary habits e.g. BMI z-score SMD -0.35 to -0.21; $p < 0.05$; PA outcomes SMD ≈ 0.30 -0.40. The behaviour of the children is influenced by the involvement of the parents through the web or the use of innovations, which in turn facilitates lifestyle modifications. The likelihood of success is increased for programs that incorporate a variety of components, such as education, monitoring, and personalized feedback. But altogether, the whole evidence is limited by short follow-up durations and predominance of high-income country studies.

Conclusion: mHealth interventions, when multi-component and parent-involved, are effective and scalable for integration into primary care.

Keywords: Childhood Obesity, Overweight Children, Weight Control, mHealth Interventions, Mobile Applications

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***Correspondence:** Ranjana Dhiman (Email: ranjana.dhiman@chitkarauniversity.edu.in)

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INTRODUCTION

According to the 2022 World Obesity Atlas published by UNICEF, obesity is anticipated to affect one in ten adolescents worldwide.¹ It is also estimated that the prevalence of childhood obesity will be approximately 10.81% among children aged 5 to 9 and 6.23% among adolescents aged 10 to 19, consistent with estimated 12.7 million children aged 5 to 9 and 14.5 million adolescents aged 10 to 19 living with the obesity worldwide.² The combined rate of underweight and obesity was high in girls in 140 countries (70%) and boys in 137 countries (69%) between the years 1990 and 2022, although it also decreased in girls in 5 nations (3%) and among boys in 15 nations (8%). The combined prevalence of underweight and obesity was found to be high in South Asian nations such as India and Pakistan.³ Childhood obesity is one of the most pressing global health concerns of the 21st century, and it has an impact on all countries.¹

As per the report of the Comprehensive National Nutrition Survey (CNNS), the Indian projection for contributing to childhood obesity in the coming years is 11%. The prevalence of overweight among children and adolescents is ranged from 1.6% and 4.8% with higher rates observed in urban residents and people with high socioeconomic status. Additionally, key factors associated with overweight and obesity were found to be the presence of non-communicable diseases (NCD), deficiency of micronutrients, educational level of mothers, place of residence, age, and screen time.⁴

Mental and physical health effects are experienced by children who are overweight. Many contributing factors such as genes, less physical activity, stress, and harmful eating habits contributes to increased weight among children.⁵ Multi-component behavioral interventions consisting of physical activity, a healthy diet and a structured lifestyle are essential for the management of obesity among children.⁶

Children from low-income families are more susceptible to obesity in richer nations, while children from middle- and upper-income families are at a higher risk of developing obesity in developing countries.⁷ The web approach has the potential to enhance the skills of parents, as well as to manage healthy dietary habits, increase physical activity, prevent sedentary lifestyles, and promote a healthy lifestyle in their children.⁸

Mobile health applications or mHealth is the use of mobile and wireless technologies to support health objectives (WHO).⁹ The adoption of these digital health applications have enormous potential to enhance and streamline healthcare accessibility and offer life-saving assistance at a low cost in countries with limited healthcare personnel and resources, even in the most remote locations.^{10,11}

In contrast to previous reviews e.g. those by, Park et al. 2021 and Hammersley et al. 2016 which mostly

focused on the mHealth initiatives in High-income countries with limited inclusion from low and middle-income countries and less involvement of parents, the present review is focused on the evaluation of the effectiveness of health interventions that encompass all critical components of pediatric obesity management, such as identification, prevention, physical activity promotion, and parental involvement. It provides a comprehensive perspective by addressing both high-income countries (HICs) and low- and middle-income nations (LMICs) in a distinctive manner by including studies published between 2012-2025. In order to prevent paediatric obesity, particularly in underprivileged and resource-constrained contexts, policies and resource allocation must be informed by a comprehension of the impact of these digital tools.^{12,13}

METHODOLOGY

Search Strategy: Electronic literature search was conducted which includes several databases e.g. Pub Med, CINHALL, Scopus, Science Direct and PsycINFO were searched extensively for identifying the relevant papers published in English between January 2012 and 7 April 2025 and search was also expanded to include the grey literature such as Google scholar, Google and various websites in order to ensure the thoroughness.

In order to gather the related literature, snowball sampling was used via a citation tracking of included studies and prior reviews which involved reviewing through the study protocols to find subsequent publications which reports interventional results, searching the review articles which were already in existence to qualify the eligibility, and screening the reference list of review articles for additional citations. The MeSH and specific keywords were utilized in combination for search strategy shown in Table -1. With this methodological approach, 20 recent studies were found to be pertinent and were added in the review.

Table 1: Search String included in the review

Search Number	String
#1	"mHealth" OR "Mobile Health" OR "E-Health" AND "Impact" OR "Effectiveness"
#2	(Childhood Obesity) AND (Children) AND (Mobile Application)
#3	(Overweight Children) AND (mHealth) AND (Weight Control)
#4	(Mobile Health Interventions) AND (Child health outcomes)
#5	(Internet Based Program) AND (Weight Control)
#6	(Web Based Program) AND (Weight Control)

Search date: 7 April 2025; Filters applied: Publication year: 2012-2025 (language filters were not applied; manual selection of studies was done)

Selection Criteria: The two primary reviewers independently conducted the selection procedure and screened titles, papers, abstracts and full-length articles to determine the eligibility of the articles based on predefined criteria. Discrepancies were settled through consultation or discussions whenever required with a third reviewer.

Eligibility criteria: The review included research studies that met specific inclusion criteria. Eligible studies involved both preschool and school-aged children as the study population and focused on the management or prevention of childhood obesity using mHealth interventions, digital tools, wearable devices, or internet- and web-based programs. Articles were required to report outcomes related to body mass index, physical activity, dietary or sleep patterns, screen time, and parental involvement in health behaviours associated with obesity. Study designs considered appropriate included randomized controlled trials, mixed-method studies, quasi-experimental designs, systematic reviews, and meta-analyses published in peer-reviewed journals. Studies conducted in both low- and middle-income countries and high-income countries were included to ensure representation of diverse populations, contexts, and delivery platforms. To maintain relevance to contemporary mHealth technologies, only articles published after January 2012 were considered.

Studies were excluded if they did not focus on child-related outcomes and instead addressed adult populations, if the intervention for pediatric obesity demonstrated no positive outcomes, or if they were not published in English. Additionally, studies that did not present results and were limited to abstracts from editorials, conferences, or protocols were excluded, except in cases where the protocol design

was essential for understanding emerging tools.

The results did not adhere to the predetermined constraints. Rather, the present review compiled a comprehensive summary of all reported findings that were pertinent to the prevention and management of childhood obesity in relation to mHealth interventions, web or internet-based programs, and digital tools. The studies or interventions that involved parents, as well as those that promoted healthy behavior among obese children, were specifically examined. This included the reduction of screen time, the enhancement of physical activity, and the improvement of diet and sleep.

Data Extraction: A thorough systematic review was conducted by following the PRSIMA 2020 guidelines to assess the impact of mHealth interventions on childhood obesity, with a specific focus on physical activity, dietary or sleep pattern and involvement of parents. Studies published between January 2012 to 7 April 2025 were screened and assessed by two reviewers independently.

Through the electronic databases and grey literature and internet sources, a total of 518 records were obtained. After applying the predetermined inclusion and exclusion criteria and eliminating the duplicate entries, a total of 440 studies were excluded based on the title and abstract screening due to lack of focus specific to mHealth interventions, digital tools, irrelevance and not matching the target population.

For the eligibility, subsequently 78 full-text articles were then evaluated. After a thorough and careful review, a total of 58 articles were excluded for a variety of reasons such as improper study designs, non-target age specific population and insufficient data on outcomes related to mHealth interventions.

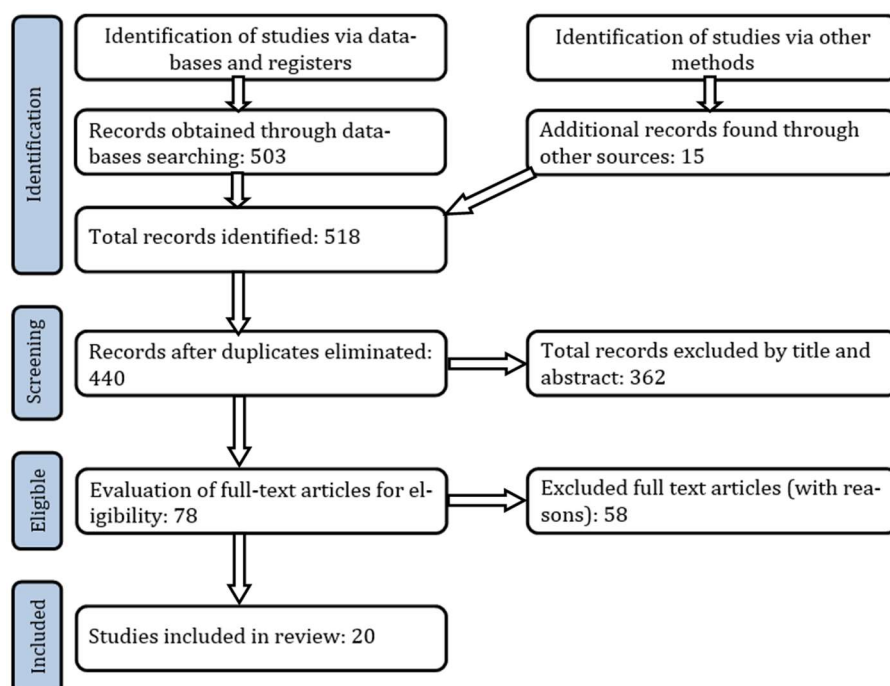


Figure 1: PRISMA Flowchart

Table 2: PEDro Analysis for the methodological quality of the literature included in the review

Research Studies	Total Score	Study's Methodological Quality	Pedro Item-wise number										
			1	2	3	4	5	6	7	8	9	10	11
Nystrom C et al., 2017 ¹⁴	8	Good	1	1	1	1	0	0	1	1	0	1	1
Moschonis G et al., 2019 ¹⁵	7	Good	1	1	0	1	0	0	0	1	1	1	1
Delisle Nystrom C et al., 2018 ¹⁶	8	Good	1	1	1	1	0	0	1	1	0	1	1
Likhitweerawong N et al., 2020 ¹⁷	7	Good	1	1	0	1	0	0	0	1	1	1	1
Dam R et al., 2019 ²⁰	5	Fair	1	0	1	1	0	0	1	0	0	1	0
Helle C et al., 2017 ²⁴	6	Good	1	1	0	1	0	0	1	0	0	1	1
Byrd-Bredbenner C et al., 2017 ²⁵	5	Fair	1	0	1	1	0	0	1	0	0	1	0
Elbert SP et al., 2016 ²⁶	6	Good	1	1	0	1	0	0	0	1	0	1	1
Rerksupphaphol L et al., 2017 ²⁷	7	Good	1	1	0	1	0	0	0	1	1	1	1
Hammersley ML et al., 2019 ³⁰	6	Good	1	1	0	1	0	0	1	0	0	1	1
Mahalakshmi B et al., 2024 ³²	7	Good	1	1	0	1	0	0	0	1	1	1	1
Yang HJ et al., 2017 ³³	5	Fair	1	0	1	0	0	1	0	0	0	1	1

Note: Review studies were categorized as Excellent (9-10), Good (6-8), Fair (4-5) and poor (<4)

Item score scale: Absent (0) and Present (1) Following are the PEDro scale criteria: Specified eligibility criteria (1), Random allocation (2), Concealed Allocation (3), Similarity at baseline on key measures (4), Blinding of all subjects (5), Therapist blinding who administered the therapy (6), Blinding of all assessors who measured at least one key measure (7), More than 85% follow-up at least one key measure (8), Intention to treat analysis (9), Between group comparison for at least one key outcome (10), Point estimates and measures of variability provided for at least one key measure (11)

Ultimately, 20 research studies were included in the final review after meeting all the eligibility criteria. These included a mix of Randomized control trials (RCTs), mixed method studies, quasi-experimental research designs, integrative review, systematic reviews and meta-analysis that were conducted in Low-and middle-income (LMICs) and High-income countries. The research study selection procedure is specified in the Figure 1 (PRISMA Flow Diagram).

All the article included in the review were assessed using PEDro Analysis for the methodological quality and given score (Table 2)

RESULTS

A total of 518 studies were identified through various databases and 20 research papers were selected as part of this review, including twelve randomized controlled trials, one quasi-experimental research design, one mixed-method study, six meta-analysis, integrative review and systematic review after applying the selection criteria. The present review encompassed a variety of studies that were relevant to various geographical regions, such as low-and middle-income countries and high-income countries, and those conducted on a large or diverse population of overweight children, as well as their parents and guardians, between the ages of 2 and 18.

The present review examines a wide variety of mobile health interventions that primarily focus on pediatric obesity. The chief focus was on the following subjects: parental involvement, behavior change communication, dietary practices, growth monitoring, and physical activity promotion. Web-based platforms, peripheral devices, and text-messaging programs were among the digital tools employed for smart phones. The selected articles were summarised in table 3. The results indicated that mHealth

services can affect the outcomes associated with pediatric obesity by promoting the involvement of caregivers, as discussed in various sections.

Impact of mHealth Interventions on childhood obesity:

The prevention of childhood obesity is considerably improved by mobile health interventions, which enhance food or dietary patterns, promote physical strength, and increase physical activity. Evidence from quasi-experimental studies and randomized controlled trials suggest that mobile health interventions not only enhance physical strength but also mitigate the risk factors associated with childhood obesity.^{14,15,16}

For instance, the trial MINISTOP found that mobile health interventions given to parents or guardians of obese children resulted in -0.11 BMI z-score, $p=0.04$ after a 12 month of intervention program.¹⁶ Other studies also reported the similar findings with mobile based applications promoted healthy dietary habits and increasing the physical activity thus ultimately lowering the body mass index.^{15,17}

Parental support and Participation in mHealth Initiatives:

The dietary behavior and lifestyle of children are significantly influenced by parental involvement.¹³ mHealth strategies provide scalable platforms to enhance engagement and parental support.¹⁸ Numerous research studies have demonstrated that mobile health applications, SMS reminders, and web-based programs can help parents promote healthier eating practices, increase physical activity, and ensure routine health checks.^{19,13}

Parents or guardians who are receiving the routine SMS and app-based messages showed better adherence vaccination regimes, dietary recommendations and growth monitoring of children.²⁰ The involvement of parents in childhood obesity prevention programs proved to be positive and very effective in tackling the obesity among the children.¹³

Table 3: Attributes of the studies that were incorporated in the review**3 (A): Studies related to impact of mHealth on prevention and treatment of childhood obesity**

Author & Year	Design/Type	Country	Sample Size	Intervention	Outcome	Effect size
Hammersley ML et al., 2016 ¹³	Meta-analysis	Global	8 studies	Parent-focused eHealth interventions	BMI	The intervention resulted in a 0.14 (95% CI: -0.27 to -0.01) reduction in BMI.
Nystrom CD et al., 2017 ¹⁴	Randomized controlled trial	Sweden	315	MINSTOP application promoting diet and physical activity	BMI Z-score, diet and PA	MINSTOP interventions reduced risks of childhood obesity among preschoolers by improving the diet and physical activity, which ultimately led to decreased BMI Z-score 0.24 (p<0.05) and improved dietary intake and physical activity.
Moschonis G et al., 2019 ¹⁵	Randomized controlled trial	Greece	65	Computerized decision-support tool for health professionals	Overweight prevalence	The health professionals can effectively treat and prevent the obesity with the usage of the computerized decision-support tool. Reduction has been seen up to 8.5% in overweight prevalence in the intervention group.
Delisle Nystrom C et al., 2018 ¹⁶	Randomized controlled trial	Sweden	315	MINISTOP app	BMI Z-score, diet, PA	Sustained positive effects of mHealth interventions showed through 12-month follow-up, which states the long-lasting benefits with improved BMI and PA.
Reddy P et al., 2021 ¹⁸	Review	Sub-Saharan Africa and Europe	7 studies	mHealth interventions and SMS	Sedentary time, physical activity	Reduced the sedentary time, raised the physical activity, and noted the context-specific success.
Turner T et al., 2015 ¹⁹	Systematic review	Global	32 studies	Wireless and mobile technologies	Obesity prevention/treatment	Offer promise in treating and preventing childhood obesity, although further research is needed and effect sizes not consistently reported.
Dam R et al., 2019 ²⁰	Mixed- method study	UK	63,337 Children, 18 parents & 11 staff	Web-based growth feedback program	Parental motivation and support	Through the usage of the program, parents reported increased motivation, and 55% of parents sought professional support post-feedback.
Antwi F et al., 2012 ²⁹	Systematic review	Global	Not specified	Web-based programs in schools	Childhood obesity prevalence	Effectiveness in decreasing the prevalence of childhood obesity among the school-going children was recorded through web-based programs and effect size was not specified.
Byrd-Bredbenner C et al., 2017 ²⁵	Randomized controlled trial	USA	489	Web-based Home Styles program	Family lifestyle changes	Positive behavioral changes have been seen but effect size was not mentioned.
Rerksupphaphol L et al., 2017 ²⁷	Randomized controlled trial	Thailand	217	Internet-based obesity program	BMI	BMI was reduced in Thai children e.g., a 1.18 kg/m ² (p<0.01) drop in BMI was seen through it.

Author & Year	Design/Type	Country	Sample Size	Intervention	Outcome	Effect size
Abraham AA et al., 2015 ²⁸	Randomized controlled trial	China	1,182	Internet-based curriculum with cell phone reminders	Lifestyle behavior	Improvement in lifestyle behavior among the obese Chinese teens has been seen (quantitative effect was not reported).
Hammersley ML et al., 2019 ³⁰	Randomized controlled trial	Australia	86	Time2bHealthy application for preschool children	Screen time, diet	The app Time2bHealthy enhanced preschool children's health behaviors. It cuts down the screen time by 30 min/day and increases the fruit intake by 1.3 servings/day.
Yang HJ et al., 2017 ³³	Non-randomized controlled trial	South Korea	733	Smartphone and wearable intervention	Obesity prevention	Planned study and results not reported

3(B): Studies related to effects of mHealth on physical activity and dietary pattern

Author & Year	Design/Type	Country	Sample Size	Intervention	Outcome	Effect size
Likhitweerawong N et al., 2020 ¹⁷	Randomized controlled trial	Thailand	77	OBEST app	BMI z-score	It resulted in a BMI z-score reduction of 0.18 (p<0.05) after almost 12 weeks in obese children.
Wang JW et al., 2024 ²¹	Meta-analysis	Global	28 RCT	mHealth applications	Physical activity	Improved 21.5 min/day moderate-to-vigorous physical fitness and activity.
Helle C et al., 2017 ²⁴	Randomized controlled trial	Norway	715	eHealth interventions promoted vegetable intake	Dietary intake	Vegetable intake increased by 0.4 servings per day (p<0.05), ultimately promoting good food habits from an early age.
Elbert SP et al., 2016 ²⁶	Randomized controlled trial	Netherland	1,269	mobile phone app delivering tailored health information	Vegetable and fruit consumption	Increased consumption of fruits and vegetable have been seen. Effect size was not reported.
Mahalakshmi B et al., 2024 ³²	Experimental study	India	60	Digital aerobic exercise guidance	waist circumference and BMI	The reductions of 3.2 cm in waist circumference and a BMI of 1.1 kg/m ² have been seen.

3 (C): Studies related to effects of mHealth on involvement of parents and their support

Author & Year	Design/Type	Country	Sample Size	Intervention	Outcome	Effect size
Elinder LS et al., 2018 ²²	Cluster randomized trial	Sweden	352	Parent support protocol with targets	BMI, Overweight prevention	It helps in decreasing the BMI by 0.25 units (expected) and prevents overweight among children in disadvantaged areas through parental support.
Zhou P et al., 2024 ³¹	Integrative review	Global	12 studies	Parent-based eHealth interventions	Sleep, PA, diet	An increase in sleep by 30 to 45 min/night, an increase in physical activity of 30 to 40 min/day, and increased dietary patterns among preschoolers were noted.

Promotion of physical activity through mHealth:

A meta-analysis found that children and adolescents who get mHealth interventions as part of a program to prevent obesity have greater step counts, aerobic capacity and physical fitness.²¹ A trial conducted on Thai school children showed that smartphone and tablet applications successfully enhance physical activity and decrease the obesity related risk factors.¹⁷ The interventions involving both the parents and the child showed even better results in increasing the physical activity levels and improving family-based exercise regimes.²²

Supporting Early Nutrition and Breastfeeding:

The foundation for healthy growth and obesity prevention is the exclusive breastfeeding and optimal early nutrition.²⁰ The rates of breastfeeding initiation and duration are substantially increased by mHealth interventions, mobile applications, SMS reminders, and mobile counselling.²³

For example, the counseling through mobile phone improves the mothers understanding regarding the exclusive breastfeeding and infant feeding practices in Nigeria and Bangladesh.²⁰ Further, the early dietary changes will contribute to long-run prevention of childhood obesity.²⁴

Monitoring child growth and development: Efficient growth monitoring enables the early detection of obesity risk or growth halting.²⁰ As a result of mobile-based applications, web-based feedback systems, and mHealth services such as growth monitoring applications, parents can now conduct routine assessments of their children's development or growth and promptly seek medical advice.²⁵

By highlighting growth trends, the web-based feedback increased the awareness of parents and also enhances their participation in prevention of childhood obesity as reported by a mixed method study.²⁰ Likewise, research conducted at Uganda and Kenya also found adherence to growth monitoring programs through mHealth interventions.²⁵

Lifestyle modifications and Dietary practices:

Few studies indicated that mHealth interventions were intended to alter dietary habits, such as increasing the consumption of fruits and vegetables and reducing the consumption of unhealthy snacking.^{24,26} The personalized interactive applications and text notifications have been demonstrated to be effective in enhancing dietary practices among children and adolescents, as indicated by a randomized controlled trial.²⁷

A study on obese Chinese adolescents that used internet-based curricula and cell phone reminders were significantly improves the dietary adherence and calorie intake.²⁸ Additionally, healthy food consumption was enhanced by an online obesity prevention program among Thai school children.²⁷

Acceptability and feasibility of Technology: Some of the studies also emphasize the feasibility and acceptability of mHealth interventions among the par-

ents and the children.^{2,28,29} The majority of individuals expressed high levels of satisfaction and engagement with web-based and mobile programs.^{28,29} SMS reminders are found to be very useful and convenient for parents to keep a check on health of their child.²

The wearable devices and smartphone applications could be used across different socio-economic contexts despite issues like access and digital literacy.^{18,21} All the things considered, the mHealth technology offers a promising platform for scaling childhood obesity interventions.

DISCUSSION

The present systematic review integrates evidence from 20 research studies that assess the influence of mHealth Interventions on the prevention of childhood obesity, parental support, and the promotion of physical activity. The results of the study demonstrate that the mHealth interventions or tools are effective in improving a variety of parameters that are associated with pediatric obesity, such as physical activity, dietary habits, and adherence to immunization, breastfeeding practices, and parental involvement. The majority of the studies included in the review lacked the cost-effectiveness data or had unreported data, which limits the ability to assess the worth of economic interventions. Cost-effectiveness analysis should be incorporated in the future studies to help guide resource allocation.

mHealth tools effectiveness on Childhood obesity and weight related outcomes:

Notably, significant BMI reductions observed in 8 of 12 RCTs that included structured parental involvement, which stresses the importance of family involvement in behavior change.²²⁻²⁶ However, the included studies may differ or heterogeneous in terms of duration of intervention (ranging from 3 to 12 months) and target population (2 to 18 years) which could influence the comparability of results. Majority of the studies were conducted in high-income countries which further limited the generalizability of findings to the low-and-middle income countries where healthcare infrastructure and digital access may vary. Additionally, the studies which focus on applications have high attrition rates e.g. the Times2bHealthy trail reported a dropout rate of 30% to 40%, indicating failure in sustaining user engagement over the time period.²⁹ The trial MINISTOP, showed consistent increase in weight status of pre-school age children at the 12-month follow up, suggesting that the services related to mHealth can have meaningful long-term impact if it designed with continuous support and engagement.¹⁶ The ability of parents and caregivers to promote healthy growth trajectories was enhanced by web-based feedback and mobile applications that further provides frequent monitoring and personalized feedback.^{15,20}

Involvement of Parents and their support: Paren-

tal involvement is one of the key elements underlying for successful interventions. For encouraging the parents to adopt healthy food habits and routine physical activity for their children, mHealth interventions often provide them with instructional materials, frequent feedbacks and reminders with decision support tools.^{13,20} The studies like Home Styles and Time2beHealthy serve as a best example of how web and app-based programs focusing parents can enhance the confidence and knowledge which leads to improved child dietary habits and good food choices for children.^{25,30} Furthermore, subgroup analyses comparing parent-only and child-plus-parent interventions indicate that clubbing approaches often result in better outcomes in child health and sustainable behavioral changes because parental modeling encourages children to follow healthy practices.

Promotion of Physical activity: Various studies found that mHealth interventions are useful in increasing the physical activity among the children.^{21,31,32} Children and adolescents are particularly fond of wearable devices and applications that incorporate games. This trend has also served to encourage them to engage in more physical activity, thereby increasing their energy expenditure and improving their physical fitness. The current study's exhaustive review indicated that the most advantageous outcomes were achieved through interventions that combined nutrition guidance with physical activity promotion.^{19,21} However, long-term management is still a challenging part among the adolescents, which highlights the necessity of continuous interventions or strategies.

Nutrition in Early Childhood and Breastfeeding: The function of mHealth in promoting exclusive breastfeeding and healthy supplementary feeding, two of the primary factors in preventing obesity since infancy, has been the subject of a limited number of studies.^{23,24} Timely SMS-based instructional messages and interactive platforms were implemented to facilitate the mother's access to current information regarding the initiation and continuance of breastfeeding. This approach was particularly effective in low-resource settings, where in-person counselling may be restricted. Nevertheless, the efficacy of the interventions may be inconsistent, indicating that mHealth strategies should be culturally appropriate and integrated with existing maternal and child health services to maximize their impact and reach.

IMPLICATIONS

The present systematic review identifies a multitude of substantial implications for future research and practice in the field of childhood obesity prevention and management through the use of mhealth interventions. Incorporating mHealth tools into the routine child care can improve the engagement, monitoring, and support for a healthy lifestyle from a

practical perspective. Health-care providers can actively engage parents by providing personalized feedback and educational materials through user-friendly mobile applications and wearable devices. In order to guarantee the efficacy and equitable distribution of interventions, it is crucial to adapt to the cultural context and take into account the accessibility of technology, given the diverse populations that are impacted by childhood obesity.

Additionally, interactive materials, tailored messaging, feedback, and app gamification can encourage participants to maintain a long-term level of engagement. Programs that are specifically designed to incorporate a variety of strategies, such as physical activities, diet, and behavioral aspects, can have a significant impact.

The current research is concentrated on short and medium-term outcomes; however, it is still necessary to investigate the impact of interventions on long-term sustainability.^{29,18} Although couple of studies also reported the ineffectiveness of interventions due to short durations of interventions, technological obstacles and low participants adherence including limited internet access and poor digital literacy.^{18,33} Expanding the scope of the research to encompass a variety of underrepresented and diverse populations can improve its generalizability and accessibility. Future research studies can be conducted to identify or incorporate the various components into mHealth technologies and to investigate how these components can be incorporated into the current health services.

To assess and identify the practical or actionable implementation solutions, future research should go beyond the general approaches to digital involvement of people. For instance, integrating mHealth into well-child visits via EHR-linked apps and using provider dashboards for feedback/goal-setting could help strengthen the communication between healthcare providers and the caregivers.

A clear focus on health equity is very much necessary (only ~2/20 studies from Sub-Saharan Africa) in low- and middle-income countries where digital connectivity, digital literacy, and internet availability continue to be major barriers. Interventions in the future should place first priority on cultural customization and accessibility to guarantee the impact and equitable reach.

Based on the suggestions of evidence synthesis, a minimum set of successful components e.g., parent training, goal setting, and real-time feedback, should be considered while creating mHealth programs for the prevention of obesity among children. These components could be seen as most linked with positive engagement and behavioral outcomes.

Furthermore, cost-effectiveness analysis may be regarded which may be advantageous for guiding policy decisions.

CONCLUSION

This review emphasizes that the effective management and prevention of pediatric obesity can be achieved through the combination of web-based programs, mHealth technologies, and wearable devices. Numerous studies have demonstrated that digital solutions that involve parents can have a beneficial impact on health-related behaviors, such as dietary habits, physical activity, and sleep patterns.

Although the results are encouraging, there are still obstacles to overcome and more data needed to identify the sustainability of results over time. Future research should give priority to well-designed longitudinal randomized controlled trials exceeding more than 24 months to determine the long-term effectiveness and maintenance of behavior change. The incorporation of artificial intelligence and machine learning holds great potential for the development of adaptable and customized mHealth therapies tailored to individual engagement. Further, these can help in improving the user adherence and accuracy of intervention.

In conclusion, mHealth interventions are not only a standalone solution, but also a scalable, affordable, and accessible complement to conventional pediatric obesity prevention initiatives. The ongoing improvements and refinements could be instrumental in the prevention of the increasing prevalence of obesity among children and the promotion of long-term health.

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