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SYSTEMATIC REVIEW

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Wearable Devices Beyond Activity Trackers in Youth With Obesity: Summary of Options

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Abstract

Background: Current treatment protocols to prevent and treat pediatric obesity focus on prescriptive lifestyle interventions. However, treatment outcomes are modest due to poor adherence and heterogeneity in responses. Wearable technologies offer a unique solution as they provide real-time biofeedback that could improve adherence to and sustainability of lifestyle interventions. To date, all reviews on wearable devices in pediatric obesity cohorts have only explored biofeedback from physical activity trackers. Hence, we conducted a scoping review to (1) catalog other biofeedback wearable devices available in this cohort, (2) document various metrics collected from these devices, and (3) assess safety and adherence to these devices.

Methods: This scoping review was conducted adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews checklist. Fifteen eligible studies examined the use of biofeedback wearable devices beyond activity trackers in pediatric cohorts, with an emphasis on feasibility of these devices.

Results: Included studies varied in sample sizes (15–203) and in ages 6–21 years. Wearable devices are being used to capture various metrics of multicomponent weight loss interventions to provide more insights about glycemic variability, cardiometabolic function, sleep, nutrition, and body fat percentage. High safety and adherence rates were reported among these devices.

Conclusions: Available evidence suggests that wearable devices have several applications aside from activity tracking, which could modify health behaviors through real-time biofeedback. Overall, these devices appear to be safe and feasible so as to be employed in various settings in the pediatric age group to prevent and treat obesity.

Keywords: continuous glucose monitor; pediatric obesity; technology; wearable

Introduction

Obesity affects one in five children and adolescents in the United States.[1] Current pediatric obesity protocols focus on lifestyle changes that involve prescription to increase daily physical activity, modify nutritional intake, and develop complex behavioral skill sets required to modify eating behaviors and thus promote weight reduction over time.[2–11] There is great heterogeneity in adherence, engagement, and efficacy of lifestyle modification protocols in this age group.[12] Given the complexity of these recommendations, adherence is often suboptimal resulting in limited efficacy.[13] Despite the growing use of weight reduction medications and referral to bariatric surgery programs, their reach remains limited by access and clinician comfort with these treatment approaches for youth.

However, treatment modalities involving lifestyle changes such as modification of diet, exercise, and behavior continue to be more valuable as they provide

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adolescents with the skillset to maintain long-term sustainable weight loss. Hence, there is a need to better understand how to harness alternative lifestyle modifications through tools such as wearable technologies to augment the current clinical standards of care for obesity management in youth.

In the last two decades, there has been a rapid surge in the use of wearable devices to assist in behavior change and weight reduction in individuals living with obesity.[14,15] These technologies are commonly offered as a device that is worn each day and provide feedback of daily activities such as total step count, sleep quantity, heart rate, and energy expenditure.[16,17] The majority of the research on the efficacy of wearable devices in obesity management has examined whether these technologies, in isolation or as part of a multicomponent intervention, are effective at increasing physical activity.

Wang et al. have previously established that these physical activity trackers could be harnessed to promote weight loss in pediatric cohorts.[18] Beyond monitoring, wearable devices often incorporate behavior change techniques that increase motivation to be physically active through opportunities for self-monitoring, goal setting, real-time feedback, and competition.[19] Hence, retraining with healthy behaviors to not only improve physical activity but also cardiometabolic, glycemic, and sleep parameters could be the solution for promoting sustainable weight loss.

Among the currently available wearable devices beyond activity trackers, there has been a recently growing interest to explore continuous glucose monitors (CGM) outside of diabetes in weight reducing programs for individuals living with obesity.[20] The 24-hour glucose trends captured on CGM have become the gold standard technology for the management of diabetes in both adults and youth, given their ability to trend glycemic profiles in real time.

However, there could be a place for CGM use in other chronic disease conditions beyond diabetes. A recent article by Klonoff et al. explored the use of CGM in four other health conditions excluding diabetes, one of which included individuals with obesity.[21] A scoping review conducted by members of this study team in 2017 examined the use of CGM in obesity research and highlighted the paucity of data that existed at that time on the use of this wearable device as a component of obesity treatment across both adult and pediatric cohorts.[22] What remains unknown is whether real-time monitoring of cardiometabolic data, such a CGM, can result in weight reduction in youth with obesity.

To further explore this question, we conducted a scoping review to examine what biofeedback wearable devices have been utilized in youth with obesity beyond traditional activity tracking devices, with an emphasis on feasibility of alternative device use in this age group. No previous review has cataloged all metrics captured by these pediatric biofeedback wearable devices, nor has any review summarized data on their feasibility and safety. This information is needed to appraise the utility of biofeedback wearable devices in future pediatric obesity trials and mainstream pediatric obesity management.

The three specific aims of this review are to (1) catalog available biofeedback wearable devices utilized for promoting healthy behaviors in youth with obesity, (2) document various metrics collected from these devices that could be utilized in future intervention development, and (3) assess feasibility and adherence to these devices in this age group. This review will describe the use and results of biofeedback wearable devices for youth with obesity beyond physical activity trackers.

Methods

Eligibility Criteria

This scoping review considered studies that were randomized controlled trials (RCTs) and non-RCTs involving children and adolescents (ages 2–21 years old) with overweight or obesity (defined as BMI greater than the 85th percentile). Among the non-RCTs, we included quasi-experimental, observational, and cross-sectional studies. For the purpose of this review, quasi-experimental was defined as an experimental study design where the participants in a population were nonrandomly allocated to different groups that is, the method of allocating was not truly random. They were prospective in nature, whereas observational study designs included epidemiological, retrospective studies that assessed potential causation in exposure-outcome relationships. And cross-sectional study designs included studies that were descriptive only, not relational or causal.[23,24]

Research conducted in community, outpatient, inpatient, and/or primary care settings was included. Wearable device use was required to be part of the study, either as the main intervention or as a tool to collect research data. Studies were excluded if they did not use human participants or if all enrolled participants had diabetes. Studies with lean participants were included, as long as they also included participants with overweight/obesity. Furthermore, studies using a wearable, but not reporting data on adherence were included to highlight the use of the device.

Studies were excluded if a full text was not available in English, or if the wearable was used only for physical activity intervention. Studies were also excluded if articles did not report metrics for wearables used, or intervention setting or duration. No limitation was placed on length of follow-up or study duration. All studies identified in the search that met the eligibility criteria were included in this scoping review. The proposed scoping review was conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews (https://jbi.global/scoping-review-network/resources).

Identification of Relevant Studies

The search strategy was aimed at locating both published and unpublished studies. An initial limited search of PubMed and Cochrane Reviews was undertaken to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles, and the controlled vocabulary terms used to describe the articles were used to develop a full search strategy for web of sciences and Embase. The search strategy included all identified keywords such as—(Adolescen*[Title/Abstract] OR youth[Title/Abstract] OR ''young adult''[Title/Abstract] OR teen*[Title/Abstract] OR ''Adolescent''[Mesh] AND''wearable technology*''[Title/Abstract] OR ''biohacking devices''[Title/Abstract] OR biofeedbackTitle/Abstract] OR CGM[Title/Abstract] OR ''continuous glucose monitor''[Title/Abstract]OR''Wearable Electronic Devices''[Mesh]AND''weight loss''[Title/Abstract] OR obese*[Title/Abstract] OR ''Fat loss''[Title/Abstract] OR BMI[Title/Abstract] OR overweight[Title/Abstract]. Furthermore, other controlled vocabulary terms were adapted for each included database and/or information source. The reference lists of all studies were screened for additional eligible studies.

Only studies published in English were used. Studies published up to August 2022 were included. Databases searched included PubMed, Cochrane Reviews, Web of Science (Core Collection), Embase, CINAHL Database, Google Scholar, and clinicaltrials.gov. Sources of unpublished studies/gray literature searched included conference abstracts, poster presentations, and unpublished theses published online (searched using web browsers) or through repositories. Following the search, all identified citations were collated and uploaded into Rayyan (www.rayyan.ai), and duplicates removed. Titles and abstracts were then screened by authors S.N.C. and A.P.V. for assessment against the inclusion criteria for the review.

Potentially relevant sources were retrieved in full, and their citation details imported into the JBI System for the Unified Management, Assessment and Review of Information (JBI SUMARI; JBI, Adelaide, Australia). The full text of selected citations was assessed in detail against the inclusion criteria by S.N.C. and A.P.V. Reasons for exclusion of sources of evidence at full text that did not meet the inclusion criteria were recorded. There was no disagreement between the reviewers during the selection process. The results of the search and the study inclusion process are presented in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review flow diagram (Fig. 1).

Data Extraction

Data were extracted from articles included in the scoping review by two independent reviewers (S.N.C. and A.P.V.) using a data extraction tool developed by the reviewers. This form was based on the Joanna Briggs Institute extraction instrument for scoping reviews (Microsoft, Redmond, WA). The extracted data included the following specific details: authors, year of publication, location, study design, sample size, sample characteristics, intervention duration, wearable device use duration, research outcomes, weight loss metrics, and satisfaction/adherence.

The draft data extraction tool was modified and revised as necessary during the process of extracting data from each included evidence source. Any disagreement that arose between the reviewers was resolved through discussion. Data were collated, were summarized, and are reported in Table 1. Diligent efforts were made to reach out to the original authors to collect unreported data. Studies were excluded if the data required for analysis could not be obtained.

Data Synthesis

Results were synthesized by A.P.V. and S.N.C., following data extraction. No statistical analysis was pursued due to high heterogeneity in study outcome measures. Adherence to the wearable device was defined by determining the average time of use of the wearable during the intervention period. These data were either calculated from quantitative data reported in the results section of the study or based on summary adherence outcomes reported. Previous studies have reported that adherence rates of 80% or more are needed for optimal therapeutic efficacy of a lifestyle modification intervention.[40] Hence, high adherence was defined as rates >80% in our review.

Results

Fifteen studies met criteria for data extraction and are summarized in Table 1. All the studies were conducted in the last 20 years and included both males and females. There was large variability in sample size across studies (range: 15–203).

Wearables Used

Wearables as glycemic variability indicators: four studies reported utilizing CGMs for various purposes, including understanding glycemic variability, real-time biofeedback, and monitoring adherence to the nutrition intervention.[25,27,31,37] Naguib et al. reported all 13 of the ambulatory glucose profile standard measurements as a tool to understand adherence to a prescriptive dietary intervention.[37] In this study, CGM was employed to measure fasting and nonfasting glucose outcomes in youth with obesity, without diabetes. Participants reported that wearing the CGM promoted accountability and the data from the CGM motivated them to adhere to the prescribed dietary program. Two studies utilized CGM data as a less invasive method to assess beta cell dysfunction in youth at risk for diabetes. Zou et al. reported 24-hour mean glucose levels of children with obesity and compared it to capillary glucose and oral glucose tolerance test (OGTT).[25]

Table 1. Biofeedback Wearable Devices in Children and Youth: Beyond Physical Activity Trackers

Author (date, country)	Number of participants (N)	Participant age (years)	Cohort type (lean,[a] overweight, obese)	Design	Wearable (device, brand, company)	Technological component measured	Wear time	Minority/ethnic population included?	Validated device? (gold standard)	Adherence
Zou et al. (2008, China)[25]	84	6.2–15.7	Obese	Observational	Continuous Glucose Monitor, Medtronic, MiniMed Inc	Glycemic indices	1 Day	No	Yes (glucometer)	High
Bäcklund et al. (2010, Sweden)[26]	22	8–11	Overweight, obese	Observational	Accelerometer, Sense wear Pro2 Armband, BodyMedia	Daily caloric expenditure, sleep	14 Days	No	Yes (double labeled water)	High
Schiaffini et al. (2016, United States)[27]	30	10.67–14.9	Obese	Observational	Continuous Glucose Monitor, IPro2 Medtronic, MiniMed Inc	Glucose profile derangement	3 Days	No	Yes (glucometer)	High
Wilson et al. (2017, United States)[28]	20	15.6–18	Overweight, obese	Quasi-experimental (one group-pretest posttest)	Wearable digital tracker	Daily caloric expenditures	18 Weeks	Yes	No (double labeled water)	Not high
Zhou et al. (2019, China)[29]	52	9–10.9	Lean, obese	Cross-sectional	Wearable Camera, Narrative Clip 2; Memeto, Sweden	Macronutrient intake	3 Days	Yes	Yes, in adults (24-hour recall)	High
Ferrer et al. (2019, Spain)[30]	203	4.4–12.4	Lean, obese, overweight	Cross-sectional	Actigraph, GeneActiv tri-axis actigraph, Activinsights LTD	Sleep	7 Days	Yes	Yes, in adults, and for PA in pediatric population (polysomnography)	High
Ghane et al. (2019, United States)[31]	33	7–11	Overweight, obese	RCT	Continuous glucose Monitor, Freestyle Libre Pro, Abbott	Glycemic indices	6 Days	No	Yes, glucometer	High
Skjåkødegård et al. (2021, Norway)[32]	85	5.9–17.1	Obese	Cross-sectional	Actigraph, ACTi watch 2, Philips Respironics	Sleep	7 Days	No	Yes (polysomnography)	High

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Table 1. Biofeedback Wearable Devices in Children and Youth: Beyond Physical Activity Trackers *continued*

Author (date, country)	Number of participants (N)	Participant age (years)	Cohort type (lean,[a] overweight, obese)	Design	Wearable (device, brand, company)	Technological component measured	Wear time	Minority/ethnic population included?	Validated device? (gold standard)	Adherence
Jaques et al. (2021, New Zealand)[33]	15	11–15	Lean, obese, overweight	Observational	Wearable camera, Patrol Eyes SC-DV7 camera, Patrol Eyes	To understand perceived behavior changes using the wearable	4 Days	Yes	Yes (24-hour dietary recalls)	High
Tepe et al. (2021, Turkey)[34]	63	12–18	Obese	Observational	Ambulatory blood pressure monitor, Spacelabs OnTrack	Blood pressure monitoring	24 Hours	No	Yes (blood pressure monitor)	High
Idris et al. (2021, Australia)[35]	15	14.2–16.8	Lean, obese, overweight	Observational	Wearable EMG and camera developed by the research team	To capture unhealthy food consumption, eating behaviors	10 Hours	No	Yes (EMG)	Not reported
Jung et al. (2021, United States)[36]	203	18–66	Lean, obese, overweight	Observational	Wrist wearable BIA device developed by research team	Body fat percentage	One-time wear	No	Yes (dual-energy X-ray absorptiometry)	Not reported
Naguib et al. (2022, United States)[37]	43	13–21	Obese	RCT	Continuous Glucose monitor, freestyle Libre, Abbott	Glycemic variability, treatment adherence	8 Weeks	Yes	Yes (glucometer)	High
Goroso et al. (2021, Brazil)[38]	26	9–12	Lean, obese, overweight	Cross-sectional	Heart rate wristband, Miolink, Mioglobal Physical Enterprises, Inc	Heart rate variability	60 Days	No	No	High
Knijff et al. (2022, Netherlands)[39]	28	6–16	Lean, obese	Observational	Multisensor watch, Steel HR smartwatch, Withings	Heart rate, sleep	28 Days	Yes	Yes, in adults, children undergoing surgery (electrocardiogram)	High

[a]Lean participants: BMI 5th to 85th percentile.

BIA, bioimpedance analyzer; EMG, electromyography; HR, heart rate; PA, physical activity; RCT, randomized controlled trial.

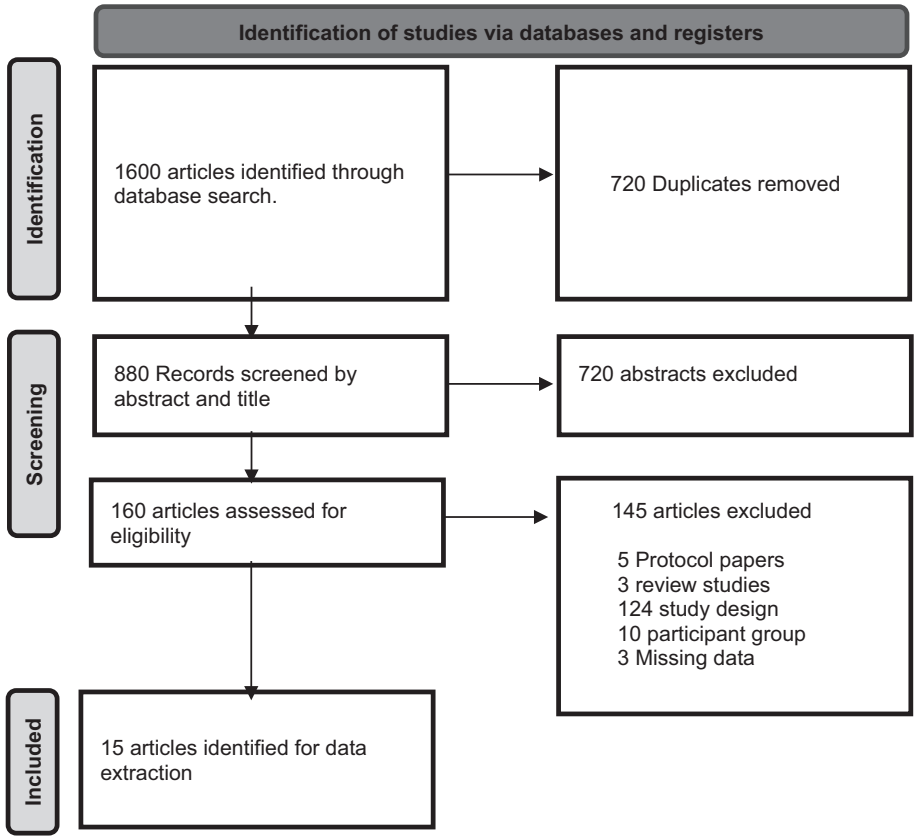

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses diagram.

Ghane et al. compared glucose area under the curve to OGTT results before and after a lifestyle modification program in youth with obesity.[31] Participants had access to their data throughout the program and reported that they viewed CGM use as very favorable and that it motivated them to participate in the lifestyle modification program.[31] Finally, Schiaffini et al. used minimum and maximum glucose level to show how glucose profile derangements were associated with hepatic fibrosis.[27] Researchers in this study used CGM as a diagnostic tool to identify liver pathologies, while participants underwent a lifestyle modification program for 3 days.[27]

Wearables as cardiometabolic indicators: six studies utilized wearable devices to measure cardiometabolic indicators.[26,28,34,36,38,39]

1. Energy expenditure: traditionally, energy expenditure is estimated by measuring macronutrient consumption, oxygen consumption, heat production, or carbon dioxide production by indirect calorimetry.[28] Two studies reported energy expenditure captured with a wearable device.[26,28] Bäckland et al. used the Sensewear Arm Band Pro 2 to measure the body temperature during active or sedentary windows, thus estimating energy expenditure. The wearable device in this study was used as a research outcome measure, as well as a tool to motivate physical activity in the participants. Wilson et al. utilized a wearable device estimating the energy expenditure for researchers to understand efficacy of a lifestyle modification program on overweight adolescents.[28] This study did not assess how the tracking device engaged with adolescents, but the researchers concluded that it helped to motivate weight loss.
2. Heart Rate: wearable devices can measure heart rate by photoplethysmography in which infrared light is reflected back from the skin by a green light emitting diode.[41] This technology was utilized in three studies to report heart rate.[34,38,39] Knijff et al. used the Steel HR wearable quantify longitudinal trends in HR, and tested whether access to that data affected daily movement.[39] Access to daily real-time data was not associated with improvements in daily movement or changes in nutrition; however, the study concluded that it could be useful as an outcome to measure acute changes in heart rate in response to a lifestyle modification program.[39]

Similarly, Goroso et al. used a wrist wearable monitor to measure HR variability as a research outcome in children with obesity.[38] At the end of the study, these data helped researchers and clinicians identify participants at risk for cardiovascular disease. Although they did not assess the subject's response to the wearable, they intended to provide participants with guidelines regarding the use of the wearable and evaluate whether it motivates physical activity among youth with obesity.[38]

3. Blood pressure Monitoring: Tepe et al. used ambulatory blood pressure monitors to capture abnormal blood pressure trends otherwise not identified by traditional

office blood pressure monitors.[34] The study members then concluded that this wearable's biofeedback could help clinicians diagnose hypertension otherwise masked by white coat hypertension.

4. Body fat Indicators: Jung et al. developed a novel wrist wearable bioimpedance analyzer and compared it to a standard bioimpedance measurement.[36] In this study, the wearable provided a more feasible and reliable tool to capture body fat percentage in the home setting. Researchers found potential use of this wearable to help both patients and clinicians track daily changes in composition.[36]

Wearables as daily function metrics indicators: six studies assessed wearables employed to understand daily function metrics:[29,30,32,33,35]

1. Macronutrient intake and specific food consumption:[29,33,35] Three studies reported using wearable camera to capture eating behaviors.[29,33,35] Jacques et al. used a wearable camera as an intervention for researchers to understand real-time dietary intake of participants.[33] These data were used to replace self-reports from participants to accurately measure the food intake. Most participants (80%) of their study wore the camera while eating and reported it having no impact on their eating habits (93%).

While 33% reported becoming more conscious about their eating as a result of the camera, only one modified their eating behavior while using the wearable. Researchers hence highlighted the potential of this wearable to bring changes to eating habits when worn for longer duration. Idris et al. used wearable electromyography (EMG) and camera as an intervention to understand chewing episodes and investigate eating behaviors. The results showed that the chewing pace and time of the group with obesity were slower compared with healthy weight, respectively.[35] Behaviors and macronutrient intake of study participants did not change with having the wearable on as the device was only used for one evening.

However, researchers hypothesized that wearable camera with an EMG could help modify eating behaviors when used for longer periods and ultimately with weight management in youth. Zhou et al. used the wearable camera to compare daily dietary intakes (energy, macronutrients, and micronutrients) obtained from dietary recalls with and without camera assistance in both healthy and obese children.[29] Using the wearable camera, researchers observed that beverages, snacks, fruits, and deserts were underreported rather than breakfast, lunch, or dinner by children. Furthermore, average eating time, mealtime duration, and proportion were found to be higher in children with obesity. Participants were very satisfied with the use of the device, but the study did not report any difference in macronutrient intake or behaviors, while using the wearable.[29]

2. Sleep: three studies assessed sleep in children with obesity.[30,32,39] Skjåkødegård et al. used an Actiwatch 2 as a wearable to provide feedback to researchers about how sleep relates to obesity and obesogenic behaviors in children.[32] The Actiwatch 2 utilizes a piezoelectric sensor to detect vertical accelerations and thereby define sleep and wake intervals.[42]

The results showed that youth with higher BMI had a later time of sleeping compared to youth without obesity. In this study, youth were not provided access to their sleep data until the end of the study. Ferrer et al. investigated the use of GeneActiv tri-axis actigraph to understand the relationship between sleep and macronutrient intake in children with obesity. The GeneActiv accelerometer continuously records activity, environmental temperature, and light exposure to quantify sleep.[43] The implementation of actigraphy in this research was to understand sleep parameters relating to quantity and quality in children with obesity.

Akin to the previous study, this wearable did not provide real-time feedback to participants, but collected valuable continuous information regarding the relationship of sleep and obesity. Knijff et al. used the Steel HR as a more feasible tool to catalog sleep patterns in youth with obesity at risk for disordered sleep. There was no measurable effect of wearing this device on sleep behaviors over the intervention period.[39]

Adherence to the Wearable Device

The majority of studies reported high adherence to the device $n = 12/15$.[25–27,30–32,37–39] Of these, five reported adherence in terms of days in which the participant wore the device out of the days prescribed,[26,30,33,39] four determined acceptability and feasibility of the device based on self-reported review of the experience of utilizing the device,[29,31,39] and three reported adherence by capturing retention rates over the study period.[25,26,37] One study reported data on dropout rate, concluding that dropout was due to mechanical irritation from the device. One study reported high tolerance[39] defined as median compliance 81%–100%. Taken together, adherence to wearable devices in youth with obesity ranged from 74% to 100%, with >90% ($\sim$98.9%) of youth completing the study interventions as prescribed.

Safety of the Wearable Device

No significant adverse event from devices was reported by any study. Five studies made no comment on adverse event collection.[27,31,34–36] Four studies did report barriers to device use adherence, including skin irritation and discomfort,[30,32,36,38] technological barriers (*i.e.*, trouble syncing data with device or error messages),[28,30,31] mechanical concerns (*i.e.*, device not being worn properly),[30] and privacy issues for the families.[33,34] Self-report across the studies showed that youth found the devices easy to use and comfortable to wear.

Discussion

Multiple systematic reviews, conducted in both adult ($n = 11$) and pediatric cohorts ($n = 4$), have shown that

wearable devices like activity trackers increase step counts and moderate-to-vigorous-intensity physical activity, and reduce sedentary behaviors.[16,40,44–65] Some of the adult studies ($n=4$) also reported that these activity trackers have been successful in promoting weight loss in both short term and long term.[16,46,48,50]

In pediatric cohorts, only one study by Wang et al., in 2022, has explored the effectiveness of physical activity trackers on obesity-related anthropometric outcomes in youth with obesity.[18] Their results showed that compared with a no-treatment control group, physical activity trackers had statistically significant beneficial effects on weight (reduction in BMI, BMI z-score) and body composition (reduction in total body fat) in the short term.[18] Taken together, despite mixed results concerning the long-term adherence to activity trackers, the evidence suggests that these technologies are feasible, safe, and effective at promoting increased physical activity, and thus weight reduction in individuals with obesity.[18]

As wearable device technology use grows, there comes an opportunity to expand the use of this technology beyond activity tracking to real-time cardiometabolic biofeedback tracking. The availability of real-time 24-hour cardiometabolic data may be a useful tool to promote sustained behavior change and thus improve health outcomes over time in youth living with obesity.[66,67] In an effort to expand and update the growing literature on this topic in pediatric cohorts, this review highlighted the availability, scope, and safety/feasibility of various wearable devices that capture cardiometabolic data beyond physical activity tracking in youth.

Similar to data in adults,[48,49] we identified several biofeedback devices being employed in children and youth with obesity that capture data across the following domains: (1) heart rate and blood pressure, (2) daily caloric expenditure, (3) glucose levels, (4) food intake, (5) sleep, and (6) body fat. We identified several implementation strategies for the use of a wearable device in obesity management protocols, both as an intervention tool and as an outcome measure. The various uses noted were as follows: (1) adherence monitors, (2) data collection for precision nutrition implementation, (3) behavior modification by biofeedback pattern trending, and (4) sleep monitoring. Not only can wearable devices capture a broad range of metrics across various cardiometabolic domains but also many articles compared these outcomes to the gold standard measurement strategy and reported validity.

While there had been limited clinical dissemination of these devices across pediatric weight management programs, many are available commercially and have FDA indication for use in this age group. In addition, it may be useful to understand that children have different physiological and health-related behaviors compared to adolescents, which may result in different responses. Creaser et al. explored how child and adolescent characteristics impact wearable use. They concluded that younger children were less likely to use a wearable likely due to their limited understanding about the device, while adolescents 10 years of age, compared to youth or older adolescents showed more motivation to use the devices, were more likely to use it. In addition, parents using the wearable increased motivation among children and adolescents alike to improve motivation.[68]

Future research is needed to investigate how these devices can be integrated into clinical care in a prescription-based option to support weight management in various pediatric age groups, and further assess if these tools could be utilized to replace other measurement tools as a more noninvasive, feasible, and accessible method to obtain this clinical information.

Based on our review, wearable devices appear to be safe in pediatric cohorts living with obesity. The overall retention rates across the various study protocols were much higher than those reported in pediatric weight management programs and pediatric obesity interventions. Thus, wearables could present a more acceptable strategy for youth and families seeking help with weight management.

Further investigations should consider cost-effectiveness analysis and overall satisfaction to determine how these devices can be disseminated into clinical practice. The utility of these devices in individuals with obesity may vary by age. Previous work in adult cohorts has shown that across adulthood, older adults have more challenges with utilizing wearable devices, and thus report lower satisfaction rates with these devices.[69,70] These findings of wearable device use across the lifespan highlight that these tools may have various effectiveness depending on the age of the individual, and thus, further research is needed to understand what baseline characteristics predict increased effectiveness over time.

Limitations

Although we used rigorous and transparent scoping review methods using several databases, it is possible that we may not have identified all studies, despite attempts to be as comprehensive as possible. Second, it was difficult to compare the findings of all 15 studies included due to differences in sample size, reported data type, and variations in study design, and thus precluded data synthesis to be conducted on this data pool. Furthermore, our primary focus was to collate available evidence about biofeedback wearables and given the limited number of studies is unable to make specific recommendations for clinical practice. Finally, we acknowledge that the included studies may lack generalizability due to demographic, ethnic, and age-related imbalances.

Conclusions

This scoping review highlights that biofeedback wearable devices have been utilized in various clinical and research settings as tools to facilitate behavior change and are acceptable for use in pediatric cohorts with obesity.

Further research is needed to investigate the efficacy of this growing category of technologies for weight reduction in this age group and to determine the best strategies for access and dissemination of these devices.

Impact Statement

Our review provides an in-depth summary of wearable devices that are available for use in pediatric cohorts with obesity. It will also allow readers to understand the utility of real-time biofeedback offered by devices for promoting adherence and individualized strategies so as to encourage sustained weight loss.

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Authors' Contributions

S.N.C., S.D.M., M.H., A.O.G., and A.P.V. conceptualized and designed the study, drafted the initial article, and reviewed and revised the article. All authors approved the final article as submitted and agree to be accountable for all aspects of the work.

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Author Disclosure Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

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