Utility of Fitbit devices among children and adolescents with chronic health conditions: a scoping review

Alexandra M. Kasparian1,2, Sherif M. Badawy3,4^*

1Department of Biology, Lafayette College, Easton, PA, USA; 2Department of Physician Assistant Studies, George Washington University School of Medicine and Health Sciences, Washington, DC, USA; 3Department of Pediatrics, Northwestern University Feinberg School of Medicine, Chicago, IL, USA; 4Division of Hematology, Oncology and Stem Cell Transplantation, Ann & Robert H. Lurie Children’s Hospital of Chicago, Chicago, IL, USA

Contributions: (I) Conception and design: SM Badawy; (II) Administrative support: SM Badawy; (III) Provision of study materials or patients: SM Badawy; (IV) Collection and assembly of data: AM Kasparian; (V) Data analysis and interpretation: AM Kasparian; (VI) Manuscript writing: Both authors (VII) Final approval of manuscript: Both authors.

Correspondence to: Sherif M. Badawy, MD, MS. Lurie Children's Hospital of Chicago, 225 E. Chicago Avenue, Box #30, Chicago, IL 60611, USA. Email: sbadawy@luriechildrens.org.

Background: While Fitbit® devices were initially intended for leisurely, consumer use, there has been recent interest among scientific and medical communities in the prospective use of Fitbit devices for clinical and research purposes. Those who have chronic health conditions are often required to spend considerable amounts of money and time undergoing physiological tests and activity monitoring to support, stabilize, and manage their health. This disease burden is only amplified in pediatric populations. Devices that are used to collect these data can be invasive, uncomfortable, and disconcerting. Using the Fitbit tracker to acquire such biometric data could ease this burden. Our scoping review seeks to summarize the research that has been conducted on the utilization of Fitbit devices in studies of children and adolescents with chronic health conditions and the feasibility, accuracy, and potential benefits of doing so.

Methods: Searches were conducted on PubMed for articles relating pediatric health to Fitbit device usage (using a Boolean search strategy). The eligibility criteria included trials being clinical and/or randomized controlled and articles being in English. Once articles were obtained, they underwent screening and exclusion processes and were charted for their titles, authors, objectives, results, and respective chronic illnesses. In the subsequent full-text review, further charting was conducted, collecting study designs, Fitbit parameters, feasibility, accuracy, and related health and clinical outcomes.

Results: Fitbit trackers were unanimously demonstrated to be feasible devices in this population for physical activity monitoring and were determined to be potentially beneficial in measuring and improving overall wellbeing and physical health in children with chronic illness. Nevertheless, sufficient evidence was not found in support of Fitbit accuracy. Additional biases were identified against the population of children with chronic health conditions that may further enable inaccurate data.

Conclusions: While Fitbit devices may be beneficial for those interested in improving physical health, discretion is advised for those seeking to collect accurate and/or medically necessitated data. Given the existing literature evaluated, medical-grade technologies are preferred in instances of the latter, as Fitbit devices have not been found to provide reliably accurate data.

Keywords: Fitbit; children; chronic health conditions; physical activity; clinical outcomes

Received: 06 September 2021; Accepted: 09 May 2022; Published: 20 July 2022.

doi: 10.21037/mhealth-21-28

View this article at: https://dx.doi.org/10.21037/mhealth-21-28

^ ORCID: 0000-0002-4739-265X.
Introduction

Chronic health conditions in children and youth have become increasingly prevalent over the past half century, resulting from a variety of etiologies including perinatal changes in mothers, children’s diets, increases in sedentary leisure activities (such as television and video games), and generalized environmental changes (1). Definitions of chronic health conditions are varied, however for the purposes of our study, we will utilize that of the World Health Organization. They define chronic health conditions as non-communicable diseases (NCDs), or those that “tend to be of long duration and are the result of a combination of genetic, physiological, environmental, and behavioral factors. The main types of NCD are cardiovascular diseases (such as heart attacks and stroke), cancers, chronic respiratory conditions (such as chronic obstructive pulmonary disease and asthma and diabetes)” (2).

In 1960, just 1.8% of children had a health condition that impacted daily living (3); this soared to greater than 8% in 2010 (4), representing a 400% increase in chronic health conditions in children (particularly asthma, mental health conditions, obesity, and neurodevelopmental disorders) (5). This remarkable increase in the prevalence of chronic health conditions is multifactorial and is likely due to scientific advances in widely available diagnostic tools. Although children suffering from chronic illnesses have been found to have worse overall health than peers without such conditions, recent research has demonstrated similar levels of general life satisfaction across both pediatric groups (6).

This, however, is not true for health-related quality of life (HRQOL). A study of children with prevailing chronic health conditions [asthma, eczema, dyslexia, attention-deficit hyperactivity disorder (ADHD), and migraines] were demonstrated to have lower HRQOL than children without chronic illness (7). Moreover, children with chronic diseases have an increased risk of anxiety and depression (8). These diseases affect not only children themselves, but also their families. Parents of children with chronic diseases have been found to more frequently suffer from anxiety and depression, and those with children having congenital diseases saw increased risks of cardiovascular diseases and mortality (9).

To study and improve physical health in children with chronic illnesses, interventions and health management programs have been implemented and researched. Given that overall health of children with chronic illnesses is worse than that of their peers, many studies have utilized measures of physical health (such as steps taken, calories burned, heart rate, etc.) as markers of health in children with chronic health conditions (10). For this reason, and because a direct relationship has been found between increased physical activity and improved HRQOL in children and adolescents with chronic diseases (7), researchers have implemented interventions to improve children’s physical health. Some have been purely family-based (11) while others are school-based (12). In our paper, we consider another type of intervention for children with chronic health conditions: technology-based—specifically the use of Fitbit devices. Family- and education-based interventions have been successful in improving health because they function within children’s mainstays: school and home. However, with increased technological literacy among children and young people, technology (solely and in conjunction with other interventions) is being examined for future use in pediatric healthcare; this would not only bring a sense of familiarity, but also comfort and empowerment.

There is a potential for consumer wearable devices (such as those made by Fitbit) to be useful in future clinical practice, given technological advancements and the growing popularity of individualized health programs (10). Research has been conducted on the feasibility and means of developing medical-grade wearable devices to monitor vital signs (13), and wearable devices have in turn been demonstrated to be feasible for monitoring physical activity in children with chronic conditions (14). In adults with chronic conditions, commercial wearable technology has been reported to be beneficial as a motivator and for increasing physical activity (15), but health outcomes related to respective chronic illnesses have yet to be found (16). Among wearable technology brands, Fitbit has been studied the most frequently (17), guiding its selection for further research in this paper. In spite of demonstrated potential for improving health outcomes in children with chronic conditions (18,19), discrepancies exist within the body of research on Fitbit wearables regarding their accuracy and validity as measurement devices. For the purposes of this review, the terms “health outcomes” and “clinical outcomes” will be used interchangeably, and they will be regarded as “measurable changes in health, function or quality of life” (20). While some studies have demonstrated the reliability of Fitbit trackers in monitoring children’s activity (21-24), others have shown that Fitbit devices can be inaccurate (25). There has also been an increased interest in alternative, remote means of health management, given that methods of monitoring health in children are
often invasive, uncomfortable, and expensive (26). Both in design and public perception, Fitbit devices overcome these barriers to care and may further benefit their users in medical circumstances by providing immediate health data to individuals and empowering young people to understand, manage, and improve their health.

Our review contributes to the literature as the first scoping review—to our knowledge—to characterize and evaluate the body of existing literature regarding the use of Fitbit devices in children with chronic health conditions in such a comprehensive analysis (assessing accuracy, feasibility, feedback, and clinical/health outcomes). The primary aims of this study are thus to survey relevant studies about Fitbit devices and establish further points of analysis using trends in collected data. These have been identified as (I) studies’ objectives and methods in relation to utilizing Fitbit devices, (II) the accuracy, acceptability, feasibility, and advantages/disadvantages of Fitbit devices, and (III) clinical and health outcomes related to using Fitbit devices. The assessment of these three points regarding Fitbit use will lead to some determination of how Fitbit trackers could and should be utilized by children with chronic health conditions, whether in clinical or recreational settings. This research may be additionally beneficial in identifying gaps in the existing research on the use of Fitbit devices in children. We present the following article in accordance with the PRISMA-ScR reporting checklist (available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-28/rc).

### Methods

There was no protocol for this review, nor is this scoping review registered. The methodology for data collection was adapted from “Guidance for conducting systematic scoping reviews” from the Joanna Briggs Institute (27). Searches for articles to be included in our study were conducted from November 27, 2020 to December 28, 2020 using PubMed and a Boolean search strategy with the operator “AND”. This was done to ensure that the data search included solely articles relevant to our inclusion criteria. The specific search terms utilized to identify articles relating Fitbit use and pediatric populations can be found in Table 1. Eligibility criteria included journal articles being clinical and/or randomized controlled trials and the publication language being English. No exclusions were implemented based on publication status nor year of publication; while publication year restrictions are typically incorporated to ensure research relevance/accuracy, it is by nature of the scoping review to evaluate the entire relevant body of literature. Thus, all publication years were considered. The titles, authors, objectives, and results of identified articles were charted onto an Excel spreadsheet. It was soon noted that many articles related to a chronic illness, so this was also charted for each article and added to the inclusion criteria. The list of articles was screened for duplicates, which were removed. Each article was then downloaded in full-text form to be assessed and filtered for inclusion using the inclusion criteria. This article selection process is visualized in further detail in Figure 1.

The inclusion criteria for our study required that articles must have studied (I) explicitly pediatric populations (mean age <24), (II) those with a chronic illness, and (III) populations that wore some Fitbit device for some duration during the study. The participant age range included in this review is in accordance with the World Health Organization and the United Nations, who have termed “young people” as up to 24 years of age (28). Any papers not meeting all three criteria were excluded. The remaining full-text articles were then read and charted in greater detail, assessing for key information including study design, Fitbit feasibility and accuracy, and health/clinical outcomes of Fitbit use (Table 2). The article search, collection, filtering, data extraction, and data collection were carried out by the first author under supervision of the corresponding author. This single reviewer process reduced bias by eliminating concern for inter-rater reliability.

### Results

Twenty-five studies met our criteria of having used a Fitbit device in research of children with chronic health conditions. Within these papers, 11 chronic diseases were studied and/or were incorporated into the research, such as cancer, asthma, congenital heart disease (CHD), and obesity. While each study incorporated Fitbit devices into
their research for a different reason and collected a different dataset, patterns were identified in studies’ research objectives and what they sought to gain from researching or using Fitbit devices.

**Study characteristics, objectives, and methodology**

The average participant age was 12 years, and the total participant age range was 3–35 (3 studies used participants 21 or older). The number of study participants ranged from 9–180 with an average of 51. Studies on average had a higher percentage of females than males, the average percentage of male participants being 47.3. Study lengths ranged from 1 day to 1 year and averaged at 17 weeks long (Table 3).

While a variety of Fitbit products were studied, the Fitbit Flex and other wrist-based models were most common (the Fitbit Zip and One are not wrist-based). Nineteen of the
studies measured steps, 9 collected sleep data, 8 used the distance-traveled metric, 7 collected energy expenditure/calories burned, and 4 collected heart rate data (Table 4).

The studies’ goals were categorized within three overarching themes (non-mutually exclusive). The first was the intention of using Fitbit trackers to obtain clinical outcomes [in regard to physical and/or mental health (including quality of life)]. These studies typically implemented often-successful interventions with Fitbit devices to achieve desired outcomes. Another common research goal was to uncover physical and psychological effects of the respective chronic illnesses of their participants. The last shared objective was to research the effectiveness, accuracy, and feasibility of utilizing Fitbit devices in disease study and treatment. Table 5 represents under which theme(s) studies of each chronic health conditions fell, along with the number of studies researching each chronic illness.

The majority of evaluated papers were aimed at utilizing a Fitbit device to assess health related to a chronic illness and/or improve health outcomes for those suffering. Ten studies sought to improve health of children with chronic
| Source (chronic illness) | Objectives | Fitbit data collected | Fitbit accuracy | Study design |
|-------------------------|------------|----------------------|----------------|--------------|
| Bian et al., 2017 (asthma) (29) | Explore correlation between self-rated sleep data, Fitbit sleep and PA data, and asthma impact | Steps, calories, distance, heart rate, sleep data (time in bed, awakenings) | Poor long-term sleep and PA accuracy; accurate step accuracy (cited Klassen et al., 2016) | 8 weeks wearing Fitbit; questionnaires; monetary compensation |
| Buchele Harris et al., 2015 (ADHD) (47) | Determine intervention impacts on attention | Steps, calories, distance, heart rate | Not reported | 4-week intervention; wore Fitbit, daily 6-minute CBPA break in intervention group; attention tests |
| Chen et al., 2017 (obesity) (18) | Evaluate intervention effects and feasibility on physical activity | Steps, calories, distance, activity, sleep minutes | Not reported | 6 months wearing Fitbit; 3-month intervention program; text messages |
| DeBoer et al., 2017 (diabetes) (38) | Assess safety and effectiveness of artificial pancreas system | Total steps, steps/min, heart rate | Not reported | Given artificial pancreas system and usual insulin pump/glucose monitor; hypoglycemic events and glucose levels monitored; wore Fitbit |
| Do et al., 2020 (epilepsy) (43) | Assess sleep quality and relationship between sleep, activity, and psychosocial well-being | Steps/day, sleep efficiency, total sleep time | Sleep overreported | Baseline biometric data collected; questionnaires; 12-week intervention; 16 weeks wearing Fitbit |
| Dugger et al., 2020 (obesity) (37) | Report obesogenic behaviors leading to BMI increase | Steps, moderate/vigorous physical activity, sedentary time, total sleep, sleep onset and offset time | Reliable and valid for heart rate and sleep (cited de Zambotti et al., 2016 and 2018 and Liang et al., 2018); data comparable to polysomnography | 10 weeks wearing Fitbit; either 6-week health/academic program, 4–6 weeks academic program, or no program |
| Hakim et al., 2018 (sleep apnea) (34) | Compare Fitbit measurements to polysomnography | Total sleep time, total wake time, number awakenings | Total sleep time overestimated; total waking time underestimated | 1 night wearing Fitbit during polysomnography |
| Hasan et al., 2020 (VTE) (39) | Assess adherence to prescribed physical activity after VTE; evaluate QOL and biomarker changes pre- and post-intervention | Steps, distance, active minutes, hourly activity | May underestimate total activity | 16 weeks wearing Fitbit; formed physical activity and education groups; PA group had 4 weeks normal PA, 8 weeks coached PA, 4 weeks choice PA |
| Hemphill et al., 2020 (CHD) (46) | Measure change in physical activity due to COVID-19 | Steps | Not reported | Data collected from previously ongoing study; 24 months wearing Fitbit |
| Hooke et al., 2016 (cancer) (45) | Explore if Fitbit coaching increases steps per day | Steps/day | Not reported | 2-week intervention; wore Fitbit and Fitbit coaching; daily emails and Fitbit feedback |
| Jacobsen et al., 2015 (CHD) (19) | Evaluate feasibility, benefits, and safety of physical activity intervention | Steps | Fitbit data matched daily activity logs | 12-week intervention; physical activity program; wore Fitbit; participant and parent surveys |
| Jaimini et al., 2018 (asthma) (48) | Assess effects of asthma on patients using intervention physiological data | Activity, sleep | Not reported | 1- or 3-month intervention; wore Fitbit, Microlife Peak Flow Meter, and Foobot collecting data; mobile app questionnaires |
| Source (chronic illness) | Objectives | Fitbit data collected | Fitbit accuracy | Study design |
|--------------------------|------------|----------------------|-----------------|--------------|
| Kuan et al., 2020 (CHD) (40) | Evaluate seasonal variation in physical activity | Steps/day | Steps overestimated | 1 year wearing Fitbit; wore hip monitor 7 days, physical activity questionnaire |
| Le et al., 2016 (cancer) (41) | Assess feasibility and health impact of intervention | Steps, calories, distance, overall movement, flights stairs | Not reported | 6-month intervention; wore Fitbit daily; surveys and physical evaluations |
| Mendoza et al., 2017 (cancer) (35) | Promote physical activity in cancer survivors via intervention; assess Fitbit feasibility | Steps, energy expended, distance, minutes of high activity | Not reported | 10-week intervention; wore Fitbit, Facebook support group; post-intervention health and feasibility questionnaires |
| Mittlesteadt et al., 2020 (epilepsy) (30) | Investigate Fitbit ability to detect seizure events | Heart rate | Data collected is second-order; unreliable sleep data; physiological data underestimated (cited Montgomery-Downs et al., 2012 and Benedetto et al., 2018) | Wore Fitbit; compared data to EEG data to assess seizure detection |
| Ovans et al., 2018 (cancer) (32) | Assess impact of intervention on physical activity, quality of life, and fatigue | Steps/day | Accurate and reliable physical activity tracking (cited Diaz et al., 2015) | 12-week intervention; wore Fitbit; physical therapy sessions |
| Sala et al., 2019 (cerebral palsy) (31) | Assess Fitbit accuracy in ambulation (wrist and hip) | Steps, distance | Wrist Fitbit steps inaccurate, hip Fitbit steps accurate | Wore Fitbit on wrist and hip; stood for 3 minutes, ambulated, sat for 3 minutes |
| Schoenfelder et al., 2015 (ADHD) (49) | Assess intervention feasibility/acceptability | Steps, energy expended, distance | Accurate step measurements (cited Evenson et al.) | 4 weeks wearing Fitbit; joined Facebook group; text messages and questionnaires |
| Shelley et al., 2018 (cystic fibrosis) (36) | Explore physical activity perceptions and assess Fitbit acceptability | Not reported | Not reported | Wore Fitbit; interviews |
| Turel et al., 2016 (obesity) (50) | Examine association between obesity and cardiometabolic deficit to suggest intervention(s) | Sleep duration, time asleep, time awake | Sleep duration accurate | Surveys; wore Fitbit; blood test; studied Fitbit sleep measurement validity |
| van der Kamp et al., 2020 (asthma) (42) | Assess daily physical activity in children with exercise-induced bronchoconstriction | Steps, minutes in different activity intensities | Possible inexactness due to infrequent collection rate | 1 week wearing Fitbit; daily questionnaires |
| Venkataramanan et al., 2019 (asthma) (51) | Determine triggers to asthma using intervention physiological data | Activity, sleep | Stated Fitbit reliability | 1- or 3-month intervention; wore Fitbit, Microlife Peak Flow Meter, and Foobot collecting data; mobile app questionnaires |
| Voss et al., 2017 (CHD) (33) | Assess validity of Fitbit data collection compared to ActiGraph | Steps minutes in different activity intensities | Steps accurate; assumed inaccurate distance | Wore ActiGraph for 7 days; wore Fitbit for 7 days; statistical analysis |
| Yurkiewicz et al., 2018 (cancer) (44) | Investigate effect of wearable devices on health-related quality of life | Steps, calories, sleep | Not reported | 6 months wearing Fitbit, pre- and post-wearing surveys |

PA, physical activity; ADHD, attention-deficit hyperactivity disorder; CHD, congenital heart disease; BMI, body mass index; QOL, quality of life; VTE, venous thromboembolism.
illnesses, 9 studies’ objectives were to evaluate the impacts of such health conditions on health, and 2 studies aimed to do both; this summed to 21 of 25 articles with the goal of evaluating and/or enhancing participant health (the remaining four studies’ objectives were to assess Fitbit accuracy). Seventeen of these 21 articles assessed participants’ physical activity levels with Fitbit devices and/or attempted to improve physical activity. Of the 17 studies, 8 implemented health-improving interventions. Two additional studies developed interventions to study effects of their respective chronic illness. Thus, in total, 10 of 25 studies utilized interventions in their research (Table 4).

**Fitbit accuracy, acceptability, feasibility, and (dis)advantages**

In addition to using Fitbit wearables to understand and improve the effects of chronic illness on health, the quality of Fitbit trackers and their data collection was assessed for accuracy, feasibility, acceptability, and advantages/disadvantages. Four studies’ objectives surrounded this evaluation, and 23 of 25 studies commented on one of these items. Out of the total 15 articles that addressed Fitbit accuracy, 9 claimed or demonstrated that Fitbit devices were inaccurate, 8 stated or cited that Fitbit devices were accurate, and 2 papers demonstrated both inaccuracy and accuracy of Fitbit devices (Table 4). In relation to feasibility and acceptability, 13 papers made positive remarks; 9 studies demonstrated that Fitbit trackers were acceptable, and 6 that they were feasible (Table 4). Acceptability and feasibility were assessed by screening articles for (I) claims made by authors that Fitbit devices were feasible and/or acceptable and (II) author reports of compliance and/or adherence to wearing them. Nine of 25 studies indicated that Fitbit devices were advantageous, due to being cost-effective (29-33), non-obtrusive/discrete as a measurement device (29,30), accessible/popular (30,33-36), a source of continuous and long-term measurement (29,36,37), and user friendly (33,35). One study further claimed there are no adverse effects of Fitbit devices (32). Nine of 25 studies contrarily discussed disadvantages of Fitbit devices, including not being designed for children (38), being difficult to use (39,40), causing rash and eczema (40), falling off during exercise (41), having limited data collection abilities (30,37,42), and having a likelihood of non-compliance in adolescents (30,33) (Table 6).

Six articles provided participant positive feedback on Fitbit use. In terms of device helpfulness, one study found that 100% of participants appreciated Fitbit wearables for their ability to track physical activity, and 88% found the Fitbit helpful for tracking dietary intake (43). Another study’s participants said they would recommend Fitbits to fellow survivors (relating to cancer), with 20% recommending use during treatment therapy and 80% post-
| Source (chronic illness) | Demonstrated feasibility and acceptability | Advantages (A), disadvantages (D), feedback (F) | Activity changes | Clinical/health outcomes |
|--------------------------|-------------------------------------------|-----------------------------------------------|-----------------|------------------------|
| Bian et al., 2017 (asthma) (29) | Not reported | A: continuous, non-obstructive, low-cost | No change | Found potential inverse relationship between sleep quality and pediatric asthma impact—means worse sleep greater asthma impact; Fitbit potential to predict asthma symptoms |
| Buchele Harris et al., 2015 (ADHD) (47) | Not reported | Not reported | Activity increase | Improved processing speed, focused attention, concentration, attention span |
| Chen et al., 2017 (obesity) (18) | Not reported | F: 91% participants shared Fitbit data with healthcare providers | Activity increase | Improved BMI, diastolic BP, PA, TV/computer time, consumption of fruit, vegetables, soda/sweet drinks, self-efficacy, and dietary self-efficacy; potential to improve health outcomes and reduce obesity/overweightness |
| DeBoer et al., 2017 (diabetes) (38) | Not reported | D: not designed for children (limitation) | Activity increased with artificial pancreas system | Not reported |
| Do et al., 2020 (epilepsy) (43) | Feasible | F: 75% used app throughout day, 100% found Fitbit helpful in PA tracking, 88% found Fitbit helpful in diet tracking | Older participants with initially low activity more likely to increase activity | Improved sleep quality; demonstrated children with epilepsy have comparable sleep and activity patterns to children without epilepsy despite reported fatigue/sleep problems |
| Dugger et al., 2020 (obesity) (37) | Not reported | A: long wear-time; D: consumer device limits data | Activity (sp. MVPA) increase; sedentary time decrease | Decrease in obesogenic behaviors (improved sleep, screen time, diet, PA) |
| hakim et al., 2018 (sleep apnea) (34) | Not reported | A: accessible | No change | Not reported |
| Hasan et al., 2020 (VTE) (39) | Not reported | D: hard to use | No change | Improved PTS scores; lower frequency of PTS development; lower QOL |
| Hemphill et al., 2020 (CHD) (46) | Not reported | Not reported | Activity decrease | Demonstrated possibly detrimental effects of decreased PA in at-risk population; severe impacts dependent on pandemic length; mean steps in 2019/2020 below Canadian national standard |
| Hooke et al., 2016 (cancer) (45) | Feasible | F: families enjoyed and interested in future purchase | Increased steps per day during intervention | Increased steps associated with decreased fatigue |
| Jacobsen et al., 2015 (CHD) (19) | Not reported | Not reported | Exercise capacity increase; VO2max increase | Parents reported improved HRQOL, social, school, psychosocial, and physical function |
| Jaimini et al., 2018 (asthma) (48) | 66% intervention compliance, thus suitable | Not reported | No change | Improved asthma control levels |
| Kuan et al., 2020 (CHD) (40) | Initially high acceptability; 60% adherence at completion | D: technical difficulties; skin irritations including rash and eczema | No change | Demonstrated PA increase in late spring/ autumn, decrease in winter/summer; most common activities were walking and running; 11% participants met PA guidelines |
| Le et al., 2016 (cancer) (41) | Feasible | D: fell off during exercise; F: suggested better attachment; would recommend Fitbit to survivors; 20% suggested Fitbit use in therapy; 80% after therapy | Increased MVPA by average 50 min/week | Increased number of participants meeting CDC PA recommendations |

Table 6 (continued)
| Source (chronic illness) | Demonstrated feasibility and acceptability | Advantages (A), disadvantages (D), feedback (F) | Activity changes | Clinical/health outcomes |
|-------------------------|-------------------------------------------|-----------------------------------------------|------------------|-------------------------|
| Mendoza et al., 2017 (cancer) (35) | Acceptable | A: popular device, well-designed, affordable, easy, and can set goals | Activity increase | Increased motivation |
| Mittlesteadt et al., 2020 (epilepsy) (30) | Compliance ensured via monitoring | A: well-known, affordable, discreet; D: syncing issues, non-compliance, wrist too small, second-order data; F: family interest in consumer device to detect seizures | No change | Not reported |
| Ovans et al., 2018 (cancer) (32) | Intervention feasible | A: no adverse effects, cost-effective | Non-significant increase in average steps | Increased level of perceived wellness; decreased fatigue, increased quality of life |
| Sala et al., 2019 (cerebral palsy) (31) | Intervention feasible | A: low-cost | No change | Not reported |
| Schoenfelder et al., 2015 (ADHD) (49) | Feasible and acceptable, high adherence | Not reported | Activity increase; increase in average steps | Increased awareness of activity and ADHD symptoms; decreased average ADHD symptoms |
| Shelley et al., 2018 (cystic fibrosis) (36) | Acceptable and compliant | A: feels like regular watch, comfortable, sleek, compliance, continuity, potential activity motivator | No change | Not reported |
| Turel et al., 2016 (obesity) (50) | Not reported | Not reported | No change | Found negative correlation between videogame addiction and sleep time, negative correlation between low sleep time and obesity; demonstrated obesity correlated to high BP, low HDL’s, high triglycerides, high insulin resistance; demonstrated adverse link between health and videogames |
| van der Kamp et al., 2020 (asthma) (42) | 10% participants low compliance | D: low data collection frequency | Found children with EIB have less (intense) activity than those without EIB | Not reported |
| Venkataramanan et al., 2019 (asthma) (51) | 63% intervention adherence | D: low charge could reduce measurements | Sedentary time decrease | Determined asthma triggers were pollen and PM2.5 (particulate matter) |
| Voss et al., 2017 (CHD) (33) | Feasible and acceptable | A: at-home PA, fashionable, easy use/user-friendly, cost-effective, accessible, wrist-based technology preferred; D: non-compliance with wristwear common in adolescents; made for adults, thus pediatric accuracy unclear | No change | Demonstrated PA guideline to be ~12,500 steps/day; found participant MVPA comparable to national average; demonstrated boys more active than girls |
| Yurkiewicz et al., 2018 (cancer) (44) | Acceptable | F: 85% enjoyed wearing | Majority felt more active | Increased number of participants meeting CDC PA recommendations |

ADHD, attention-deficit hyperactivity disorder; CHD, congenital heart disease; BMI, body mass index; PA, physical activity; PTS, postthrombotic syndrome; QOL, quality of life; MVPA, moderate to vigorous physical activity; VTE, venous thromboembolism; EIB, exercise-induced bronchoconstriction; CDC, Centers for Disease Control and Prevention.
therapy (41). In terms of satisfaction, 85% of participants of one study enjoyed wearing a Fitbit tracker (44). Families of participants were additionally interested in Fitbit devices for personal use (30,45), and some satisfied participants further shared their Fitbit data with their healthcare providers (18). Finally, one study suggested development of better attachment for Fitbit devices to prevent them from falling off (Table 6).

**Fitbit health and clinical outcomes**

Positive changes in participant activity levels were found as a result of Fitbit use. Twelve of the 25 articles reported an activity increase either after the study or after Fitbit use, including one study where participants claimed to have felt more active (44). One study apart from these twelve demonstrated a likelihood of participant activity increase (43). Another article sought out an activity change in its study objective, but such change was not demonstrated (39). Yet, two studies measured a decrease in sedentary time (37,45); one study did find an activity decrease; however, this was hypothesized (46). Additionally, one study found that its participants with a chronic illness had less intense and lower amounts of activity than those without a chronic illness (42) (Table 6).

Twelve studies found clinical and health benefits in their participants, as sought out by their study objectives. Of these, four compared measured physical activity levels to national standards, where it was found that two of four participants met recommendations. Three studies additionally found possible correlations between their individualized study parameter(s) and health outcomes, and one study also demonstrated negative health outcomes (39).

**Discussion**

Twenty-five papers that studied Fitbit use in pediatric populations with a variety of chronic health conditions were identified, each with unique study designs and research objectives. Many of the analyzed studies had research objectives related to using Fitbit devices to improve participant health and gain positive clinical outcomes, the majority of which achieved such goals. The Fitbit was demonstrated to be a feasible device for collecting data in the populations studied. This was supported by participant and family feedback, yet the studies examined presented equal amounts of advantages and disadvantages of Fitbit devices. Despite having mostly positive effects on participants’ clinical outcomes, the data collected from these articles indicate that Fitbits are not reliably accurate devices for measuring physiological data. Many Fitbit parameters were reported as accurate in the studies analyzed, and in other reviews beyond the scope of this study (assessing adults); yet, many studies within our dataset (as well as in those beyond) have found otherwise.

**Fitbit inaccuracy**

Given the data collected, it is not possible to conclude that Fitbit devices are accurate tools for collecting physiological data in children with chronic illnesses. No consensus was drawn by the articles reviewed relating to Fitbit accuracy. 40% claimed accuracy while 60% claimed not; some of these statements were demonstrated as primary findings, and others via citations of prior research. Those claiming accuracy were in physical activity, steps, heart rate, and sleep. It is difficult to confidently know whether claims of accuracy themselves are well-supported, given that some were simply made with neither justification nor citation. This hesitation did not apply for demonstrations of inaccuracy, which were evidence-based. Discrepancies have also been noted in research on Fitbit accuracy in children without chronic health conditions. One study of children aged 9–11 showed accuracy of the Fitbit Charge HR for measuring moderate to vigorous physical activity (MVPA) and sleep and inaccuracy for steps, heart rate, and energy expenditure (52). Another study also on children aged 8–12 with the same device demonstrated strong reliability for MVPA as well as sedentary and light-intensity activity, but conversely found that step counts were relatively/slightly inaccurate (53). However, a third study of preschoolers wearing the Fitbit Flex found a low accuracy of MVPA while sedentary activity was accurately measured (54). While these do not represent the body of research on the accuracy of Fitbit devices in pediatric populations, they serve as an exemplar of the disagreements among findings and researchers on this topic.

We acknowledge that these findings on the accuracy of Fitbit trackers differ from those in the larger body of studies of adult populations, many of which have demonstrated stronger evidence supporting Fitbit accuracy. For example, clinical research on adults has demonstrated accuracy in measuring low levels of physical activity and steps in both healthy populations and those suffering from stroke, brain injuries, chronic obstructive pulmonary disease, and Parkinson’s disease (55,56). While it is important to
recognize that Fitbit devices have been demonstrated to be accurate in other clinical research, it must too be considered that these exist beyond the scope of our paper and are not implicated by the biases present in this review.

What further complicates the study of Fitbit accuracy is the lack of knowledge of Fitbit devices’ ability to collect accelerometer data and/or demographic information to project physical activity data (steps, distance, energy expenditure/calories burned, etc.) (53). This is enabled by Fitbit’s proprietary rights. Still, Fitbit’s website provides some basic information on data collection. All Fitbit devices have a triaxial accelerometer to collect step counts as well as to determine length, intensity, and frequency of movements. The calculation of steps then enables the distance traveled metric to be provided, which is a function of steps and stride length (calculated via height and weight). The energy expenditure calculation utilizes one’s basal metabolic rate (as a function of height, weight, sex, and age) and physical activity data to project calories burned. Not all Fitbit devices collect heart rate data, but those that do incorporate these measurements to help calculate energy as well (57). Regarding sleep data, Fitbit trackers utilize lack of movement and heart rate variability patterns to determine when one is sleeping and their stage of sleep (58). This mechanistic description of Fitbit devices’ measurements is certainly not to scientific standards, nor to those of devices accepted by the medical community for biometric data collection, such as the ActiGraph.

**Fitbit feasibility**

The term “feasible” was broadly used in these studies across a variety of contexts. Some did so in reference to Fitbit devices’ use in clinical trials as a measurement device, and others in terms of wearability for patients/participants. Nevertheless, all studies that evaluated the feasibility and acceptability of Fitbit trackers had unanimous agreement that they were feasible and acceptable. These conclusions were in line with participants’ and families’ feedback, where participants found Fitbit devices helpful in measuring physical activity and diet tracking, made suggestions to others with their respective chronic illness to utilize Fitbit devices, generally enjoyed their experience wearing them, and even shared their results and data with their providers. In addition to the physical benefits of the Fitbit, many participants experienced perceived benefits of Fitbit use. Perception is important to consider because if those wearing Fitbit trackers were skeptical, they may have experienced decreased effectiveness. Fitbit use has additionally been shown to be perceived as feasible in young adults aged 20–39 (specifically cancer patients) as well as having the potential for promoting physical activity and health improvements (59). This provides promise for the future of Fitbit use in pediatric populations with chronic health conditions, as positive long-term effects, actual and perceived, of Fitbit use have been demonstrated.

Many participants of the studies evaluated in this review also cited affordability, availability, ease of use, non-invasiveness, and continuity of data collection as advantages of Fitbit devices; there is in turn much appeal in wrist-based technologies for those requiring frequent physiological assessments. This is especially true for pediatric populations, where data collection can feel frightening and difficult in hospitals or via invasive techniques. Thus, Fitbit products, if accurate, could enable doing so in comfort. Alternatively, if what patients require is physical health improvement, Fitbit devices have been demonstrated to be an easy and potentially beneficial tool.

**Fitbit effects on health**

Of the studies that sought to gain clinical outcomes or health information using Fitbit trackers, their goals were unanimously achieved. Such changes were often observed across many aspects of life, such as increases in physical activity and feelings of being active, decreases in sedentary activity, improved HRQOL, and increased motivation. But additionally, outcomes were measured that were specific to respective illnesses, including improved attention (ADHD), improved BMI and decreased obesogenic behaviors (obesity), and improved asthma control (asthma). Health-related information gained through Fitbit use included identifying that participants met national standards for number of daily steps and correlations between certain behaviors/activities and health. This data does not suggest that Fitbit use is correlated with improved health, however Fitbit devices were successful as a motivational tool for health improvement, and, when combined with health-promoting interventions, are likely to have significant and positive effects. Of course, the range of benefits may vary depending on the chronic illness, patient, and/or desired outcome. For example, while Fitbit usage was beneficial for patients with epilepsy in improving sleep quality, Fitbit devices have concurrently found unable to detect epileptic episodes (43). Consistently measured, though, was increased physical activity (MVPA and daily steps) after Fitbit use.
Because positive outcomes were achieved using Fitbit trackers with little to no negative consequences of wear, it is reasonable to state from this data that Fitbit devices are acceptable for recreational use and are potentially beneficial for improving generalized wellbeing and physical activity in children with chronic health conditions.

This determination is consistent with prior studies on adults. One study of Fitbit-based interventions in adults also measured increases in step counts, MVPA, and a decrease in weight, concluding that Fitbit devices had potential for promoting physical activity and weight maintenance (60). It has also been found that Fitbit use on purely recreational bases had no indication of being beneficial to those with chronic illnesses aside from acting as a motivator for physical activity (16).

Biases

An important notion to be cognizant of in a technological study such as this present review is the impact of device users’ perceptions of the data outputted. Fitbit devices enable their wearers to retrieve and perceive their own data, which provides strong potential for misinterpretation, and/or invalid or non-objective data; individuals in the studies analyzed may have wrongly believed they were in good health or improving, or vice versa, and this may have affected how they perceived or behaved in clinical settings. This feedback visualization thus plays a role in our assessment of Fitbit experiences (feasibility, acceptability, advantages, and disadvantages) and clinical effects.

For the population studied in this review, children with chronic conditions, the accuracy of Fitbit devices is more questionable than for those without such health considerations. Some chronic health conditions, such as asthma, sleep apnea, and cystic fibrosis, affect the ability to carry out daily functions. However, Fitbit devices do not incorporate such factors into estimates of biometric information. Rather, these products base estimates on predetermined physiological data from (likely) able-bodied individuals and their respective heights, weights, sexes, and ages. Additionally, studies of Fitbit reliability more often assess Fitbit devices in terms of “free-living” conditions, “normal” walking, and other terms representing able-bodied people (26). This limits research of Fitbit accuracy for those whose conditions affect daily activities such as walking because less baseline and/or comparative data is available. Thus, a bias is likely present, resulting in inaccurate values produced by Fitbit trackers and an incomplete body of research on Fitbits for those with chronic illnesses.

Another bias is that these devices do not have child-specific data collection mechanisms (61). No study to date has directly compared accuracy of Fitbit devices between adults and children, however one thesis from the University of Delaware analyzed Fitbit accuracy in both populations of adults and children (62). The study concluded that the Fitbit Zip was acceptable for both children and adults in measuring sedentary and physical activity as well as step counts. Yet, as a relatively early study on Fitbit devices, its conclusions may not be as well-supported as recent papers. It has also been found that children walk faster than adults, accumulate more steps than adults, and have different cadences and frequencies of movements (63).

These findings inform our data analysis, given that our review includes study participants in all stages of young life; it is presumable that the data collected by younger participants would be less accurate than that collected by those older. Additionally, having a large age range may give way to greater deviations in data, whereas data in a narrower range (such as ages 0–18 or solely preschool and school age) might present more uniformly. It would be extremely difficult to assess the relative strengths of studies’ datasets; moreover, that is beyond the scope of this paper. Rather, it is important to simply acknowledge age as a bias in our analysis.

Considering these factors—the disagreement among papers within this review, the lack of clarity on Fitbit products’ mechanisms of biometric measurements, and the biases in Fitbit devices against those being studied in this review—Fitbit trackers are not reliably accurate devices for collecting physiological data in pediatric populations with chronic health conditions.

Strengths and limitations

There are several strengths of our study. Primarily, this is a seminal review within the field of research of children with chronic conditions, as such a multi-faceted approach (assessing health outcomes and intervention feasibility and accuracy) has yet to be considered. This is also true within the field of Fitbit research, as studies often either have assessed accuracy or effects on health outcomes, but rarely the combination of the two. Moreover, this is a preliminary study of Fitbit accuracy and outcomes specifically in pediatric populations. Another strength of this review is in it being a scoping review. Following the framework of a scoping, rather than a systematic, review enabled our study
to analyze a broader range of articles with a variety of study designs. This was particularly beneficial in our study given that the intent of our paper was to assess the range of studies available on Fitbits in children with chronic conditions and evaluate evidence given the information collected. Lastly, a strength of our study is versatility of data and conclusions. The information collected from the articles studied may be utilized by medical professionals, meta-researchers, patients and families, Fitbit® and wearable technology companies, and more. By enabling a broad audience to utilize our review, this paper can inform future research in many fields as well as benefit those knowledgeable about/suffering from chronic health conditions.

The most significant limitation of our study is subjectiveness of the characteristics of Fitbit use we sought to assess. This is particularly true for feasibility and accuracy, where there were no universal nor defined thresholds for these parameters. It is unclear if Fitbit use being feasible means that participants consistently wore it or that they simply did not negatively comment upon it. Additionally, it is possible that the data presented on feasibility does not wholly represent all children studied; if some researchers did not ask participants to characterize their experience of Fitbit use, feasibility could not be assessed. The same could be true for accuracy: if Fitbit data was not compared against another measure, it is not possible to have assessed accuracy. Accuracy is also not universally defined, nor is an acceptable amount of error. This limits the accuracy of our conclusions because of discrepancies between studies; if one study stated that their data was overall inaccurate because only 80% of data was accurate, but another study decided that their 60% accuracy was relatively accurate, there would be a discrepancy in accuracy and the comparison of the data as inaccurate versus accurate would be poorly informed. Finally, it is worth noting that few of the studies included a mixed sample of adolescents and young adult patients who were younger or older than 24 years old, which is important to consider while interpreting the findings in our review.

Suggestions for future research

There is a paucity of research on Fitbit utilization by children with chronic health conditions, thus this preliminary study in this field serves to pioneer further related research. To our knowledge, no research has been conducted on the use of the Fitbit Ace [the brand’s child-gearied (ages 8+) device] and its effectiveness/accuracy. Learning more about this device could be instrumental in implementing stronger technologies, practices, and interventions to improve the health of pediatric populations with chronic conditions. Additionally, studies could research the effectiveness of Fitbit-based interventions in comparison to medically accepted devices and health promotion programs to determine if the effects of Fitbit use are comparable; perhaps even if Fitbit devices are not as accurate, there may be unidentified benefits that can be achieved from Fitbit usage. Similarly, another path for future research could be to assess if the potential health benefits of Fitbit devices outweigh the potential inaccuracies of such devices. This would align with the clinical findings of our study; since Fitbit devices have been shown to be strong activity motivators for users as well as beneficial in increasing physical activity, it would be of interest to understand what other clinical benefits of Fitbit products may exist and if these would persuade clinicians to suggest Fitbit devices to patients.

Conclusions

Fitbit devices have the potential for producing positive clinical outcomes in children with chronic health conditions, more so in terms of generalized physical health but possibly for disease-specific outcomes as well. Fitbit trackers have also been demonstrated to be a feasible tool for collection of biometric data, as reported by both children and their parents. Nonetheless, the data collected from the studies evaluated and additionally available literature cannot support reliable accuracy of Fitbit devices, especially in clinical settings. Our recommendation is that Fitbit use among children with chronic health conditions is viable for recreational use and in attempts to improve physical health (either alone or in conjunction with a program or intervention). If one needs and has access to medically accepted technology for biometric data collection, Fitbit devices should not be used in place of such tools. However, if access to medical facilities and equipment is limited, and the reason for utilizing Fitbit devices is not a critical nor severe health concern, Fitbit devices are a reasonable means of measuring one’s own physical health on a basic level.

Acknowledgments

Funding: This project was supported by a grant (K23HL150232, PI: Badawy) from the National Heart, Lung, and Blood Institute of the National Institutes of Health. The content is solely the responsibility of the...
authors and does not necessarily represent the National Institutes of Health.

Footnote

Reporting Checklist: The authors have completed the PRISMA-ScR reporting checklist. Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-28/rc

Peer Review File: Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-28/prf

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-21-28/coi). SMB serves as an unpaid editorial board member of mHealth from May 2019 to April 2023. SMB reports funding from National Heart, Lung, and Blood Institute of the National Institutes of Health (K23HL150232, PI: Badawy). The other author has no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: https://creativecommons.org/licenses/by-nc-nd/4.0/.

References

1. Perrin JM, Bloom SR, Gortmaker SL. The increase of childhood chronic conditions in the United States. JAMA 2007;297:2755-9.
2. World Health Organization. Noncommunicable diseases. Geneva: World Health Organization; 13 Apr 2021. Available online: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
3. Newacheck PW, Budetti PP, McManus P. Trends in childhood disability. Am J Public Health 1984;74:232-6.
4. Van Cleave J, Gortmaker SL, Perrin JM. Dynamics of obesity and chronic health conditions among children and youth. JAMA 2010;303:623-30.
5. Perrin JM, Anderson LE, Van Cleave J. The rise in chronic conditions among infants, children, and youth can be met with continued health system innovations. Health Aff (Millwood) 2014;33:2099-105.
6. Blackwell CK, Elliott AJ, Ganiban J, et al. General Health and Life Satisfaction in Children With Chronic Illness. Pediatrics 2019;143:e20182988.
7. Bai G, Herten MH, Landgraf JM, et al. Childhood chronic conditions and health-related quality of life: Findings from a large population-based study. PLoS One 2017;12:e0178539.
8. LaGrant B, Marquis BO, Berg AT, et al. Depression and anxiety in children with epilepsy and other chronic health conditions: National estimates of prevalence and risk factors. Epilepsy Behav 2020;103:106828.
9. Cohn LN, Pechlivanoglou P, Lee Y, et al. Health Outcomes of Parents of Children with Chronic Illness: A Systematic Review and Meta-Analysis. J Pediatr 2020;218:166-177.e2.
10. Lu L, Zhang J, Xie Y, et al. Wearable Health Devices in Health Care: Narrative Systematic Review. JMIR Mhealth Uhealth 2020;8:e18907.
11. Canter KS, Christofferson J, Scialla MA, et al. Technology-Focused Family Interventions in Pediatric Chronic Illness: A Systematic Review. J Clin Psychol Med Settings 2019;26:68-87.
12. Dobbins M, Husson H, DeCorby K, et al. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. Cochrane Database Syst Rev 2013;(2):CD007651.
13. Khan Y, Ostfeld AE, Lochner CM, et al. Monitoring of Vital Signs with Flexible and Wearable Medical Devices. Adv Mater 2016;28:4373-95.
14. McErlean F, Davies EH, Ollivier C, et al. Wearable technologies for children with chronic illness: A Proof-of-Concept Study. medRxiv. doi: http://dx.doi.org/10.1101/2020.10.25.20219139.
15. Franssen WMA, Franssen GHL, Spaas J, et al. Can consumer wearable activity tracker-based interventions improve physical activity and cardiometabolic health in patients with chronic diseases? A systematic review and meta-analysis of randomised controlled trials. Int J Behav Nutr Phys Act 2020;17:57.
16. Jo A, Coronel BD, Coakes CE, et al. Is There a Benefit
to Patients Using Wearable Devices Such as Fitbit or Health Apps on Mobiles? A Systematic Review. Am J Med 2019;132:1394-1400.e1.
17. Fuller D, Colwell E, Low J, et al. Reliability and Validity of Commercially Available Wearable Devices for Measuring Steps, Energy Expenditure, and Heart Rate: Systematic Review. JMIR Mhealth Uhealth 2020;8:e18694.
18. Chen JL, Guedes CM, Cooper BA, et al. Short-Term Efficacy of an Innovative Mobile Phone Technology-Based Intervention for Weight Management for Overweight and Obese Adolescents: Pilot Study. Interact J Med Res 2017;6:e12.
19. Jacobsen RM, Ginde S, Mussatto K, et al. Can a Home-based Cardiac Physical Activity Program Improve the Physical Function Quality of Life in Children with Fontan Circulation? Congenit Heart Dis 2016;11:175-82.
20. Great Ormond Street Hospital for Children (GOSH). Clinical outcomes. London: Great Ormond Street Hospital for Children NHS Foundation Trust; 2022. Available online: https://www.gosh.nhs.uk/conditions-and-treatments/clinical-outcomes/
21. Brazendale K, Decker L, Hunt ET, et al. Validity and Wearability of Consumer-based Fitness Trackers in Free-living Children. Int J Exerc Sci 2019;12:471-82.
22. Venetsanou F, Emmanouilidou K, Soutos K, et al. Towards a Functional Approach to the Assessment of Daily Life Physical Activity in Children: Are the PAQ-C and Fitbit Flex-2 Technically Adequate? Int J Environ Res Public Health 2020;17:8503.
23. Müller J, Hoch AM, Zoller V, et al. Feasibility of Physical Activity Assessment with Wearable Devices in Children Aged 4-10 Years–A Pilot Study. Front Pediatr 2018;6:5.
24. Ridgers ND, McNarry MA, Mackintosh KA. Feasibility and Effectiveness of Using Wearable Activity Trackers in Youth: A Systematic Review. JMIR Mhealth Uhealth 2016;4:e129.
25. Feehan LM, Geldman J, Sayre EC, et al. Accuracy of Fitbit Devices: Systematic Review and Narrative Syntheses of Quantitative Data. JMIR Mhealth Uhealth 2018;6:e10527.
26. Sasangohar F, Davis E, Kash BA, et al. Remote Patient Monitoring and Telemedicine in Neonatal and Pediatric Settings: Scoping Literature Review. J Med Internet Res 2018;20:e295.
27. Peters MD, Godfrey CM, Khalil H, et al. Guidance for conducting systematic scoping reviews. Int J Evid Based Healthc 2015;13:141-6.
28. World Health Organization. The Second Decade: Improving Adolescent Health. Geneva: World Health Organization; 2001. 24 p. No.: 98.18 Rev 1.
29. Bian J, Guo Y, Xie M, et al. Exploring the Association Between Self-Reported Asthma Impact and Fitbit-Derived Sleep Quality and Physical Activity Measures in Adolescents. JMIR Mhealth Uhealth 2017;5:e105.
30. Mittlesteadt J, Bambach S, Dawes A, et. Evaluation of an Activity Tracker to Detect Seizures Using Machine Learning. J Child Neurol 2020;35:873-8.
31. Sala DA, Grissom HE, Delsole EM, et al. Measuring ambulation with wrist-based and hip-based activity trackers for children with cerebral palsy. Dev Med Child Neurol 2019;61:1309-13.
32. Ovans JA, Hooke MC, Bendel AE, et al. Physical Therapist Coaching to Improve Physical Activity in Children With Brain Tumors: A Pilot Study. Pediatr Phys Ther 2018;30:310-7.
33. Voss C, Gardner RF, Dean PH, et al. Validity of Commercial Activity Trackers in Children With Congenital Heart Disease. Can J Cardiol 2017;33:799-805.
34. Hakim M, Miller R, Hakim M, Tumin D, et al. Comparison of the Fitbit® Charge and polysomnography for measuring sleep quality in children with sleep disordered breathing. Minerva Pediatr (Torino) 2022;74:259-63.
35. Mendoza JA, Baker KS, Moreno MA, et al. A Fitbit and Facebook mHealth intervention for promoting physical activity among adolescent and young adult childhood cancer survivors: A pilot study. Pediatr Blood Cancer 2017;64. doi: http://dx.doi.org/10.1002/pbc.26610.
36. Shelley J, Fairclough SJ, Knowles ZR, et al. A formative study exploring perceptions of physical activity and physical activity monitoring among children and young people with cystic fibrosis and health care professionals. BMC Pediatr 2018;18:335.
37. Dugger R, Brazendale K, Hunt ET, et al. The impact of summer programming on the obesogenic behaviors of children: behavioral outcomes from a quasi-experimental pilot trial. Pilot Feasibility Stud 2020;6:78.
38. DeBoer MD, Breton MD, Wakeman C, et al. Performance of an Artificial Pancreas System for Young Children with Type 1 Diabetes. Diabetes Technol Ther 2017;19:293-8.
39. Hasan R, Hanna M, Zhang S, et al. Physical activity in children at risk of postthrombotic sequelae: a pilot randomized controlled trial. Blood Adv 2020;4:3767-75.
40. Kuan MTY, Voss C, Lopez J, et. al. Children with congenital heart disease exhibit seasonal variation in physical activity. PLoS One 2020;15:e0241187.
41. Le A, Mitchell HR, Zheng DJ, et al. A home-based
physical activity intervention using activity trackers in survivors of childhood cancer: A pilot study. Pediatr Blood Cancer 2017;64:387-94.
42. van der Kamp MR, Thio BJ, Tabak M, et al. Does exercise-induced bronchoconstriction affect physical activity patterns in asthmatic children? J Child Health Care 2020;24:577-88.
43. Do J, Webster RJ, Longmuir PE, et al. Physically active children with epilepsy have good objective sleep duration and efficiency despite subjective reports of fatigue and sleep problems. Epilepsy Behav 2020;104:106853.
44. Yurkiewicz IR, Simon P, Liedtke M, et al. Effect of Fitbit and iPad Wearable Technology in Health-Related Quality of Life in Adolescent and Young Adult Cancer Patients. J Adolesc Young Adult Oncol 2018;7:579-83.
45. Hooke MC, Gilchrist L, Tanner L, et al. Use of a Fitness Tracker to Promote Physical Activity in Children With Acute Lymphoblastic Leukemia. Pediatr Blood Cancer 2016;63:684-9.
46. Hemphill NM, Kuan MTY, Harris KC. Reduced Physical Activity During COVID-19 Pandemic in Children With Congenital Heart Disease. Can J Cardiol 2020;36:1130-4.
47. Buchele Harris H, Cortina KS, Tempkin T, et al. Impact of Coordinated-Bilateral Physical Activities on Attention and Concentration in School-Aged Children. Biomed Res Int 2018;2018:2539748.
51. Venkataramanan R, Thirunarayan K, Kalra M, et al. Determination of Personalized Asthma Triggers From Multimodal Sensing and a Mobile App: Observational Study. JMIR Pediatr Parent 2019;2:e14300.
52. Godino JG, Wing D, de Zambotti M, et al. Performance of a commercial multi-sensor wearable (Fitbit Charge HR) in measuring physical activity and sleep in healthy children. PLoS One 2020;15:e0237719.
53. Kang S, Kim Y, Byun W, et al. Comparison of a Wearable Tracker with Actigraph for Classifying Physical Activity Intensity and Heart Rate in Children. Int J Environ Res Public Health 2019;16:2663.
54. Byun W, Kim Y, Brusseau TA. The Use of a Fitbit Device for Assessing Physical Activity and Sedentary Behavior in Preschoolers. J Pediatr 2018;199:35-40.
55. Shin G, Jarrahi MH, Fei Y, et al. Wearable activity trackers, accuracy, adoption, acceptance and health impact: A systematic literature review. J Biomed Inform 2019;93:103153.
56. Lai B, Sasaki JE, Jeng B, et al. Accuracy and Precision of Three Consumer-Grade Motion Sensors During Overground and Treadmill Walking in People With Parkinson Disease: Cross-Sectional Comparative Study. JMIR Rehabil Assist Technol 2020;7:e14059.
57. Fitbit. How does my Fitbit device calculate my daily activity? San Francisco, USA: Fitbit. Available online: https://help.fitbit.com/articles/en_US/Help_article/1141.htm
58. Fitbit. What should I know about Fitbit sleep stages? San Francisco, USA: Fitbit. Available online: https://help.fitbit.com/articles/en_US/Help_article/2163.htm.
59. Miropolsky EM, Scott Baker K, Abbey-Lambertz M, et al. Participant Perceptions on a Fitbit and Facebook Intervention for Young Adult Cancer Survivors: A Qualitative Study. J Adolesc Young Adult Oncol 2020;9:410-7.
60. Ringeval M, Wagner G, Denford J, et al. Fitbit-Based Interventions for Healthy Lifestyle Outcomes: Systematic Review and Meta-Analysis. J Med Internet Res 2020;22:e23954.
61. Wallen MP, Gomersall SR, Keating SE, et al. Accuracy of Heart Rate Watches: Implications for Weight Management. PLoS One 2016;11:e0154420.
62. Giannini A. Comparison of the Fitbit Zip to the Actical Accelerometer in Children and Adults. Newark (DE): University of Delaware; 2013: 61.
63. Aloba A, Luc A, Woodward J, et al. Quantifying Differences Between Child and Adult Motion Based on Gait Features. International Conference on Human-Computer Interaction: Proceedings of International Conference on Human-Computer Interaction; Universal Access in Human-Computer Interaction; 2019 July 29-31; Orlando, FL, USA. Berlin: Springer; 2011: 385-402.

doi: 10.21037/mhealth-21-28
Cite this article as: Kasparian AM, Badawy SM. Utility of Fitbit devices among children and adolescents with chronic health conditions: a scoping review. mHealth 2022;8:26.