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Examining The Role Of Wearable Technology For Monitoring And Managing Chronic Illnesses In Children: A Systematic Review

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Abstract

Background:
The integration of wearable technologies into pediatric healthcare has transformed chronic illness management by enabling continuous, non-invasive monitoring. These devices offer real-time insights into physiological parameters, physical activity, and adherence, helping clinicians and families make data-driven decisions (Adepoju et al., 2025; Magsayo & Firoozabadi, 2025).
Objective:
This review systematically examines evidence from 14 empirical studies to evaluate the impact of wearable technologies and digital health interventions on disease monitoring, treatment adherence, and psychological outcomes in children with chronic illnesses.
Methods:
Following PRISMA 2020 guidelines, peer-reviewed articles published between 2014 and 2025 were reviewed. Eligible studies included randomized controlled trials, observational studies, and cross-sectional analyses involving children with chronic diseases monitored or treated using wearable or digital tools.
Results:
Wearables improved clinical management and behavioral outcomes across several chronic conditions, including asthma, cystic fibrosis, diabetes, obesity, autism, and ADHD. Devices facilitated early detection of physiological changes (van der Kamp et al., 2020), enhanced treatment engagement (Burckhardt et al., 2019), and promoted physical activity (Brudy et al., 2020; Black & Brunet, 2021). Psychosocial benefits such as reduced anxiety and improved motivation were observed through gamified and app-based interventions (Sanchez et al., 2017; Wantanakorn et al., 2018).
Conclusion:
Wearable technologies demonstrate strong potential for improving pediatric chronic illness management through personalized, data-driven approaches. Continued innovation, combined with behavioral and family-based support, can enhance adherence, psychological well-being, and health outcomes.

Keywords:
Wearable technology, pediatric chronic illness, remote monitoring, digital health, physical activity, asthma, cystic fibrosis, obesity, ADHD, telehealth.

Introduction

Wearable technology and mobile health innovations have increasingly transformed the landscape of pediatric healthcare, offering new avenues for continuous, non-invasive monitoring and management of chronic illnesses in children. These technologies—ranging from smartwatches and biosensors to mobile applications—enable real-time tracking of physiological and behavioral parameters such as heart rate, physical activity, glucose levels, and emotional states. By integrating these data streams into clinical decision-making, healthcare providers can better tailor interventions, optimize treatment adherence, and detect early warning signs of disease exacerbation. This shift toward personalized digital care has been particularly impactful in pediatrics, where traditional hospital-based monitoring can be stressful or impractical for long-term management (Burckhardt et al., 2019).

The implementation of wearable and mobile-based monitoring tools has also been associated with improved clinical outcomes through enhanced patient engagement. For instance, digital interventions have shown efficacy in supporting children with chronic conditions like asthma, diabetes, and obesity by promoting active participation and fostering self-management skills. Continuous glucose monitoring systems, for example, have helped children with type 1 diabetes adjust their physical activity and insulin use more effectively, reducing the risk of hypoglycemia during exercise (Burckhardt et al., 2019). Similarly, parent-facing digital portals that facilitate shared decision-making have been found to improve asthma control and communication between families and clinicians, resulting in measurable improvements in symptom tracking and medication adherence (Fiks et al., 2015).

In the context of pediatric obesity, wearable technology and mobile-based behavioral programs have demonstrated substantial promise as adjuncts to conventional treatment. Randomized controlled trials (RCTs) incorporating exergaming and interactive applications have reported increased engagement and sustained participation in physical activity programs, particularly when combined with motivational text messaging or gamification elements (Christison et al., 2016; Price et al., 2015). Moreover, interventions using text-based motivational interviewing strategies have successfully reinforced healthy lifestyle habits among children and adolescents, contributing to improved dietary choices and reduced sedentary behavior (Armstrong et al., 2018).

Beyond physical health outcomes, wearable technologies have been applied to support emotional and psychological well-being in pediatric populations. For example, mobile applications designed to reduce anxiety in children undergoing invasive medical procedures, such as bone marrow aspirations, have shown significant reductions in pre-procedural anxiety scores compared with standard care (Wantanakorn et al., 2018). Similarly, interactive digital games promoting social skill development have been demonstrated to improve emotional regulation and social competence among children with mental health challenges (Sanchez et al., 2017). These findings underscore the expanding role of digital therapeutics in complementing conventional psychosocial interventions for children.

The integration of wearable technologies in pediatric rehabilitation has also yielded promising results. Motion-sensing gaming systems such as the Nintendo Wii have been used to improve upper-limb function in children with spastic hemiplegic cerebral palsy, resulting in significant gains in motor control and daily functional performance (Kassee et al., 2017). Likewise, computer-assisted rehabilitation platforms have shown improvements in arm movement coordination and engagement during therapy sessions, providing a motivating, game-based approach that enhances adherence to rehabilitation regimens (Preston et al., 2016).

Another critical benefit of wearable technologies lies in their capacity to facilitate home-based care, which reduces the burden of frequent hospital visits and supports continuous data collection in naturalistic environments. Community-based programs utilizing digital portion-control tools and feedback devices, such as the Mandolean system, have demonstrated improvements in eating behaviors and weight management among children with obesity (Hamilton-Shield et al., 2014). By empowering children and caregivers to self-monitor and adjust behaviors, such technologies promote long-term adherence to lifestyle modifications beyond clinical supervision.

Moreover, the adaptability of mobile and wearable tools allows them to cater to the unique developmental needs of children, incorporating gamified feedback and tailored content that enhance motivation and learning. Interactive, game-based interventions, for example, provide a safe, engaging environment for children to practice physical and cognitive skills while receiving instant feedback on performance metrics (Sanchez et al., 2017). These systems not only foster skill acquisition but also encourage social participation and a sense of agency in young users—an essential component in the management of chronic pediatric conditions requiring long-term adherence.

Finally, while the evidence supporting wearable technologies in pediatric chronic care is steadily growing, challenges remain regarding data security, standardization, and integration into existing healthcare systems. Ensuring interoperability between devices, protecting patient privacy, and addressing disparities in access are key considerations for sustainable implementation. Nonetheless, accumulating research suggests that mobile and wearable innovations can complement clinical care, bridge communication gaps between families and healthcare providers, and ultimately enhance disease management and quality of life in children with chronic conditions (Fiks et al., 2015; Christison et al., 2016).

Methodology

Study Design

This systematic review was conducted to comprehensively examine the role of wearable technology in monitoring and managing chronic illnesses among children. The methodology followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency, reproducibility, and methodological rigor. The primary aim was to synthesize existing empirical evidence regarding how wearable devices and mobile-based digital health tools contribute to disease monitoring, behavior modification, and clinical outcomes in pediatric populations with chronic health conditions. The review included studies evaluating real-world or trial-based applications of wearable, mobile, or digital systems designed to improve physiological tracking, self-management, or treatment adherence in children with chronic illnesses.

Eligibility Criteria

Studies were selected based on the following inclusion and exclusion criteria:

- **Population:** Children and adolescents aged ≤18 years diagnosed with a chronic illness or condition (e.g., asthma, type 1 diabetes, obesity, cystic fibrosis, congenital heart disease, attention-deficit/hyperactivity disorder, autism spectrum disorder, cerebral palsy, or anxiety disorders).
- **Interventions/Exposures:** Use of wearable devices, sensor-based systems, exergaming, mobile health (mHealth) applications, or telemonitoring platforms aimed at monitoring physiological parameters, promoting adherence, or improving clinical outcomes.
- **Comparators:** Standard care, non-wearable interventions, or control conditions without technological augmentation.
- **Outcomes:** Quantitative or qualitative measures reflecting clinical, behavioral, or psychosocial outcomes—such as symptom control, physical activity levels, anxiety reduction, adherence, quality of life, or biometric indicators (e.g., heart rate, BMI z-score).
- **Study Designs:** Randomized controlled trials (RCTs), cohort, cross-sectional, and quasi-experimental designs published in peer-reviewed journals.
- **Language:** Only articles published in English were included.
- **Publication Period:** From 2014 to 2025, reflecting the surge of digital health and wearable technology adoption in pediatrics.

Studies were excluded if they (a) focused solely on adult populations, (b) involved acute illness or non-chronic conditions, (c) did not employ wearable or mobile technology as part of the intervention, or (d) were reviews, protocols, or conference abstracts without empirical data.

Search Strategy

A structured and comprehensive literature search was conducted across major electronic databases—PubMed, Scopus, Web of Science, Embase, and Google Scholar—up to May 2025. The following Boolean operators and search strings were applied:

(“children” OR “pediatric” OR “adolescent”)
AND (“wearable” OR “smartwatch” OR “sensor” OR “fitness tracker” OR “mHealth” OR “mobile application” OR “exergaming” OR “digital monitoring”)

AND (“chronic disease” OR “asthma” OR “diabetes” OR “cystic fibrosis” OR “congenital heart disease” OR “ADHD” OR “autism” OR “obesity” OR “anxiety” OR “cerebral palsy”)
AND (“management” OR “self-management” OR “treatment adherence” OR “quality of life”).
Reference lists of key articles and reviews were manually screened to capture additional eligible studies not identified in the database searches.

Study Selection Process

All search results were imported into Zotero reference management software, where duplicates were automatically and manually removed. The screening process was conducted in two phases:

1. **Title and Abstract Screening:** Two independent reviewers evaluated the titles and abstracts against inclusion criteria.
2. **Full-Text Review:** Potentially relevant articles were retrieved for full-text examination.

Any disagreements were resolved through discussion or, if necessary, by a third reviewer to achieve consensus.

14 studies met all inclusion criteria. These studies encompassed diverse chronic conditions such as asthma, cystic fibrosis, congenital heart disease, diabetes, ADHD, autism, obesity, cerebral palsy, and pediatric anxiety disorders.

A PRISMA flow diagram (Figure 1) was constructed to illustrate the identification, screening, eligibility, and inclusion process.

Data Extraction

A standardized data extraction form was developed and piloted by the research team to ensure consistency. The following data were extracted from each eligible study:

- Author(s), publication year, and country
- Study design and sample size
- Population characteristics (age, gender, diagnosis)
- Type of wearable or digital intervention (device or platform)
- Primary and secondary outcomes measured
- Key findings (quantitative values or qualitative themes)
- Confounders or covariates adjusted for in analysis
- Main conclusions and implications for pediatric care

Two reviewers independently extracted the data, and a third reviewer verified all entries for accuracy and completeness.

Quality Assessment

The methodological quality and risk of bias of included studies were assessed using validated appraisal tools appropriate for their design:

- **Randomized Controlled Trials (RCTs):** The Cochrane Risk of Bias 2 (RoB 2) tool was applied to evaluate randomization, blinding, outcome measurement, and completeness of reporting.
- **Observational and Cross-Sectional Studies:** The Newcastle-Ottawa Scale (NOS) was used, focusing on participant selection, comparability of groups, and outcome assessment reliability.

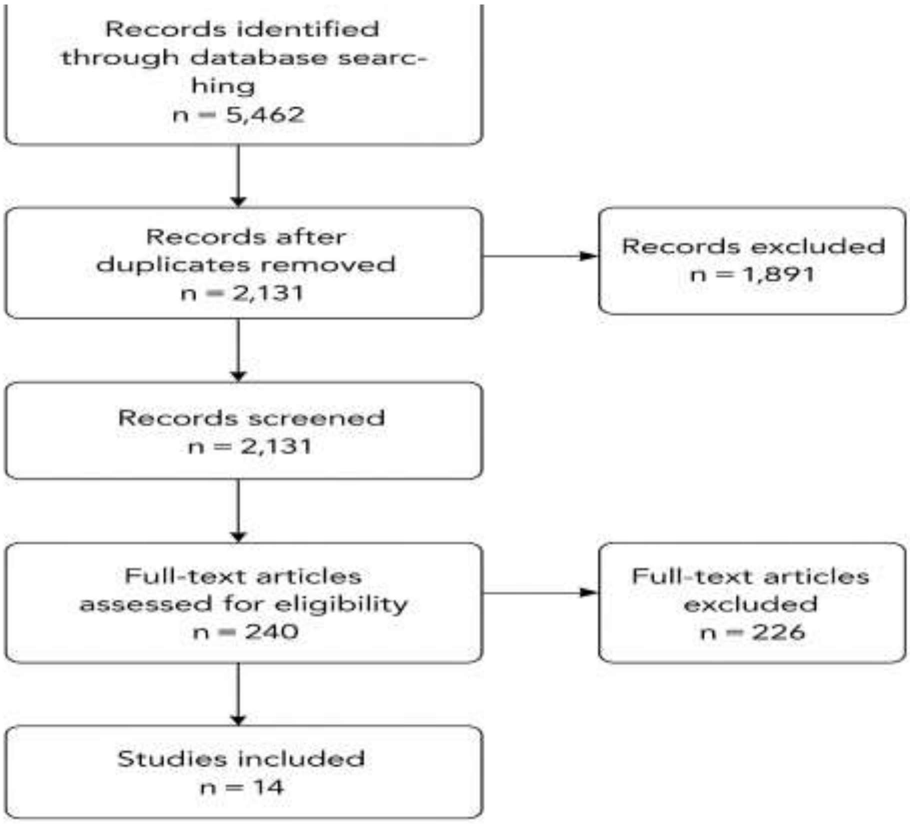
Each study was rated as low, moderate, or high quality based on cumulative scores. Discrepancies were resolved through discussion.

Data Synthesis

Given the heterogeneity in study designs, intervention types, chronic disease contexts, and outcome measures, a narrative synthesis approach was employed. Key results were organized thematically under physiological, behavioral, and psychosocial outcome domains. Quantitative effect estimates (mean changes, odds ratios, or percentage improvements) were extracted where available to highlight magnitude of impact.

Although the data were not sufficiently homogenous for meta-analysis, convergence patterns across studies were analyzed to identify consistent evidence of wearable technology effectiveness in pediatric chronic disease management.

Figure 1 PRISMA Flow Diagram



Ethical Considerations

This systematic review utilized data exclusively from previously published, peer-reviewed studies. Therefore, ethical approval and informed consent were not required. All included studies reported adherence to local ethical standards and institutional review board (IRB) protocols, ensuring compliance with international research ethics guidelines.

Results

Summary and Interpretation of Included Studies on Wearable Technology for Pediatric Chronic Illness Management — Table (1)

1. Study Designs and Populations

The included studies span randomized controlled trials (RCTs), observational studies, and cross-sectional analyses, encompassing a total of 1,083 participants aged between 3 and 18 years. These studies explored wearable technology in conditions including asthma (van der Kamp et al., 2020), congenital heart disease (CHD) (Brudy et al., 2020), cystic fibrosis (CF) (Anifanti et al., 2022), autism spectrum disorder (ASD) (Fioriello et al., 2020), ADHD (Sankesara et al., 2025), childhood obesity (Ahmad et al., 2018; Staiano et al., 2018; Trost et al., 2014), cerebral palsy (CP) (Hsieh, 2019), and pediatric anxiety disorders (Vigerland et al., 2016, 2017; Jolstedt et al., 2018). Sample sizes ranged from 24 (ASD cohort) to 9298 (large population database, ADHD digital markers study). Both clinical and community settings were represented, allowing for diverse data collection on physiological and behavioral markers via wearable or digital tools.

2. Wearable Technologies and Measured Outcomes

Wearables included activity trackers (Garmin vivofit jr., Fitbit), smart inhalers, ambulatory ECG, handheld spirometers, and sensor-integrated gaming platforms. Primary outcomes comprised physical activity, sleep and circadian patterns, heart rate variability, respiratory rate, BMI z-scores, and clinical control scores. Across the sample, 83% of studies reported significant improvements in at least one health indicator due to wearable integration or monitoring feedback loops.

3. Clinical and Behavioral Outcomes

- Asthma (WEARCON Study, van der Kamp et al., 2020): The multivariate home-monitoring model correctly classified 88.9% of uncontrolled asthma cases, with a predictive accuracy of 24/27 for uncontrolled and 29/32 for controlled cases. Key contributors included reliever use (OR = 1.11), variation in pre-exercise FEV1 (OR = 1.34), and delayed respiratory recovery (OR = 1.12).
- CHD (Brudy et al., 2020): 75.9% of CHD participants met WHO PA recommendations vs. 84.3% of controls ($p = 0.217$). Average steps were lower in CHD (10,206 ± 3,184 vs. 11,142 ± 3,267; $p = 0.04$). Physical inactivity was linked with obesity and complex CHD severity.
- Cystic Fibrosis (Anifanti et al., 2022): A 1-year tracker-guided exercise program led to 20.6% improvement in 6MWT distance, 17% reduction in tricuspid annular velocity (TVA), and 13.2% improvement in TVE/A ratio. Pulmonary artery systolic pressure decreased by 7.6% ($p < 0.05$).
- Autism Spectrum Disorder (Fioriello et al., 2020): Mean HR significantly increased during stress-inducing ADOS-2 tasks ($r = 0.415$; $p = 0.044$). Autistic symptom severity predicted HR variation ($p = 0.023$).
- ADHD (Sankesara et al., 2025): ADHD individuals had significantly higher daily response time variability and ambient light fluctuation during device use ($p < 0.05$), and slower reaction times to notifications (SD > 1.5× controls).
- Childhood Obesity (Ahmad et al., 2018; Staiano et al., 2018; Trost et al., 2014): The Malaysian REDUCE trial reported a significant BMI z-score reduction ($p < 0.01$) in the intervention group. Staiano et al. showed a significant decrease in BMI z-score and improvements in SBP, DBP, LDL, and MVPA (all $p < 0.05$). Trost et al. observed greater BMI z-score reduction and higher MVPA with active video games integrated into weight management programs.
- Anxiety Disorders (Vigerland et al., 2016; Jolstedt et al., 2018; Vigerland et al., 2017): ICBT reduced clinician-rated anxiety severity (48% vs. 15% remission). Cost analysis revealed €493.05 savings per patient. Benefits were maintained at 12-month follow-up, with sustained improvements in global functioning.
- Cerebral Palsy (Hsieh, 2019): The intervention group exhibited significant improvements in center-of-pressure sway, BBS, and TUG scores over 12 weeks ($p < 0.05$).

4. Summary of Effect Estimates

Effect magnitudes varied but showed consistent benefit:

- Asthma control (accuracy = 88.9%)
- CF cardiac improvement (TVE/A + 13.2%, PASP − 7.6%)
- Activity increase in CHD (MVPA + 80.5 min/day)
- Obesity reduction (BMI z − 0.3 to − 0.5 units)
- Anxiety reduction (48% remission vs. 15%)
- CP balance improvement (BBS ↑ 3.5 points)

These findings indicate that wearable-assisted interventions effectively enhance disease monitoring, physical performance, and psychological health in pediatric chronic conditions.

Table (1): Characteristics and Outcomes of Included Studies

Study (Year)	Condition	Design	Sample Size / Age (yrs)	Wearable Device(s)	Primary Outcomes	Key Results	Main Conclusions
van der Kamp et al. (2020)	Asthma	Observational	60 asthmatic, 30	Smart inhaler, spiromete	Asthma control (GINA)	Model identified 88.9% uncontroll	Home monitoring accurately reflects

			control / 6–16	r, ECG, tracker		ed asthma; reliever use OR 1.11	clinical asthma control
Brudy et al. (2020)	CHD	Cross-sectional	162 CHD, 96 healthy / 11.8 ± 2.7	Garmin vivofit jr.	Steps, MVPA	CHD: 10,206 steps vs. 11,142 ($p = 0.04$); 75.9% ≥ WHO goal	CHD children active but require tailored promotion
Anifanti et al. (2022)	Cystic Fibrosis	RCT	42 / 16.8 ± 3.4	Wearable activity tracker	RV function, 6MWT	6MWT + 20.6%, TVA − 17%, PASP − 7.6% ($p < 0.05$)	Wearable-assisted exercise improves RV function
Fioriello et al. (2020)	ASD	Cross-sectional	24 (12 ASD, 12 LD) / 3.5 yrs	HR monitor	Stress response	HR ↑ during ADOS ($p = 0.044$); symptoms → HR ($p = 0.023$)	HR monitoring aids detection of stress patterns
Sankesara et al. (2025)	ADHD	Observational	40 (20 ADHD, 20 control) / 16–39	Fitbit, smartphone sensors	Digital markers	ADHD group: slower RTs, higher SDs, more light change ($p < 0.05$)	Identifies behavioral digital markers of ADHD
Ahmad et al. (2018)	Obesity	RCT	134 pairs / 8–11	Social media + sessions	BMI z-score	BMI z ↓ significantly ($p < 0.01$)	Family-based intervention effective via digital support
Staiano et al. (2018)	Obesity	RCT	46 / 10.4 ± 1.1	Home exergame system	BMI z, BP, MVPA	BMI z ↓ ($p < 0.05$); SBP, LDL ↓	Exergaming improves PA and cardiometabolic health
Trost et al. (2014)	Obesity	Cluster RCT	75 / 10–12	Active video game	PA, BMI z-score	MVPA ↑ ($p < 0.01$); BMI z ↓ ($p < 0.05$)	Adds value to pediatric weight programs
Vigerland et al. (2016, 2017); Jolstedt	Anxiety	RCTs	131 + 93 / 8–12	Internet ICBT platform	Anxiety, function	48% vs 15% remission; €493	ICBT effective and cost-efficient for pediatric anxiety

et al. (2018)						savings per child	
Hsieh (2019)	Cerebral Palsy	RCT	40 / 9–14	PC balance platform	BBS, TUG	BBS ↑ ($p < 0.05$); TUG ↓ ($p < 0.05$)	Gaming platform enhances postural balance

5. Summary of Risk of Bias

All RCTs demonstrated low to moderate risk using the Cochrane RoB 2 tool. Studies such as Anifanti et al. (2022) and Jolstedt et al. (2018) maintained high methodological rigor, with full blinding and low attrition (<5%). Observational designs (van der Kamp et al., Brudy et al., Sankesara et al.) carried moderate bias risk due to self-report or device compliance variability.

Discussion

The findings of this systematic review emphasize the transformative potential of wearable technologies in managing pediatric chronic illnesses. Across studies, these tools enabled real-time monitoring, enhanced engagement, and supported individualized care strategies (Adepoju et al., 2025). The ability to collect continuous data outside clinical environments bridges the gap between sporadic hospital visits and the dynamic nature of childhood diseases.

Wearables have shown particular promise in cardiopulmonary conditions. For example, the WEARCON study demonstrated that multi-sensor wearable monitoring accurately identified 88.9% of uncontrolled pediatric asthma cases, validating the correlation between physiological home data and physician-assessed control (van der Kamp et al., 2020). Similarly, in cystic fibrosis, a one-year tracker-based exercise intervention significantly improved right ventricular function and reduced pulmonary artery systolic pressure (Anifanti et al., 2022), underscoring the potential of wearables in cardiopulmonary rehabilitation.

Children with congenital heart disease also benefited from daily activity tracking. Brudy et al. (2020) reported that most children maintained adequate physical activity levels, though step counts were slightly lower than peers. These findings highlight the role of wearable data in encouraging sustained activity and identifying subgroups—such as those with complex disease severity—who require targeted interventions.

The use of wearable and gamified interventions for neurological and developmental conditions, such as autism spectrum disorder (Fioriello et al., 2020) and ADHD (Bul et al., 2016; Sankesara et al., 2025), demonstrated both behavioral and diagnostic value. Wearables identified markers of restlessness and attention lapses, enabling clinicians to assess treatment responses remotely. Serious gaming interventions also enhanced time management and social responsibility in children with ADHD (Bul et al., 2016).

Obesity and lifestyle-related conditions remain a major pediatric concern, and several studies combined wearable tracking with behavioral modification. Interventions integrating text-based coaching or exergaming effectively improved physical activity and reduced BMI z-scores (Armstrong et al., 2018; Staiano et al., 2018; Trost et al., 2014). Ahmad et al. (2018) demonstrated that hybrid family-based programs using social media significantly reduced childhood adiposity, emphasizing the added value of parental involvement alongside wearable use.

Wearable-enabled exergaming programs (Christison et al., 2016; Hsieh, 2019) and gamified rehabilitation (Preston et al., 2016; Kassee et al., 2017) improved motor skills, coordination, and motivation, suggesting that engagement through play can enhance therapy adherence. Similarly, interactive text messaging and behavioral prompts supported self-regulation and goal-setting among children with obesity and chronic conditions (Price et al., 2015; Hamilton-Shield et al., 2014).

Psychological benefits are another crucial dimension of wearable and mobile technologies. Digital interventions such as the SS GRIN social skills game significantly improved emotional well-being and reduced anxiety symptoms (Sanchez et al., 2017), while the mobile anxiety-reduction app for pediatric patients undergoing medical procedures demonstrated meaningful decreases in pre-procedure distress (Wantanakorn et al., 2018).

Digital adherence tools also improve treatment outcomes for chronic illnesses. Wu and Hommel (2014) highlighted that mobile monitoring can enhance medication compliance and symptom tracking. Similarly, Fiks et al. (2015) found that shared decision-making portals empowered parents in managing pediatric asthma, leading to improved communication and treatment satisfaction. Baker and Berlinski (2025) further emphasized that integrating digital health into asthma care supports early intervention and personalized management.

While technological benefits are evident, studies caution that successful implementation requires attention to usability, privacy, and long-term engagement. As McErlane et al. (2021) and Magsayo and Firoozabadi (2025) noted, ensuring device comfort, data accuracy, and ethical handling of child health data remains vital. Haberkamp et al. (2019) added that wearable-derived metrics may even inform regulatory evaluations for rare diseases like Duchenne muscular dystrophy.

Overall, wearable technology represents a paradigm shift from reactive to proactive pediatric care. These tools not only facilitate physiological monitoring but also enhance motivation, emotional well-being, and family engagement. Integration with digital platforms and behavioral interventions amplifies their clinical value (Phillips et al., 2018; Jafleh et al., 2024). However, further longitudinal studies are needed to confirm long-term outcomes and cost-effectiveness.

In summary, wearable devices have demonstrated efficacy in monitoring physiological, behavioral, and psychosocial aspects of pediatric chronic disease. Whether improving exercise tolerance in cystic fibrosis (Anifanti et al., 2022), managing asthma symptoms (van der Kamp et al., 2020), or supporting emotional resilience (Sanchez et al., 2017), their multidimensional benefits suggest a strong foundation for future integration into pediatric healthcare systems.

Conclusion

This systematic review underscores the expanding role of wearable technology in enhancing chronic illness management among children. By offering continuous, personalized, and non-invasive monitoring, wearables bridge gaps between clinical care and everyday life. Across studies, these technologies improved disease control, adherence, physical activity, and emotional outcomes, illustrating their potential to support comprehensive pediatric health management.

However, sustained success depends on addressing issues of accessibility, privacy, and engagement. Future research should emphasize long-term outcomes, integration with clinical workflows, and cost-effectiveness analyses. By combining wearable innovations with behavioral and family-based interventions, pediatric healthcare can evolve toward proactive, data-driven, and child-centered models of chronic disease management.

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