
A Survey of Pediatric Chronic Disease Management: Self-Management Support and Patient Empowerment

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Abstract

This survey paper explores the multifaceted approach necessary for managing pediatric chronic diseases, emphasizing self-management support and patient empowerment. Chronic conditions such as asthma, diabetes, and neuromuscular diseases significantly impact children and their families, necessitating comprehensive care strategies. The integration of digital health interventions and remote patient monitoring, enhanced by artificial intelligence, offers promising avenues for personalized care. The roles of healthcare providers and caregivers are critical, requiring dynamic treatment plans and innovative technologies like Socially Assistive Robots and smart garments to enhance patient engagement. Educational and behavioral strategies, including serious games and advanced analytical models, promote self-management and tailored interventions. Integrated care models, exemplified by platforms like Diabetes Link and methods like RECONNECT, consolidate healthcare data to optimize care coordination. Despite advancements, challenges remain, including data noise, health information fragmentation, and the complexity of disease trajectories, necessitating adaptive treatment plans. Privacy, security, and ethical concerns are paramount, requiring robust data protection, especially with the rise of the Internet of Medical Things. Health education plays a crucial role in improving literacy and empowerment, with mobile applications and adaptive interfaces enhancing outcomes. The survey concludes by highlighting the need for continued research to refine these approaches, address ethical concerns, and explore new technologies to improve the quality of life for children with chronic diseases.

1 Introduction

1.1 Structure of the Survey

This survey is systematically structured into several key sections, each addressing vital aspects of pediatric chronic disease management. The **Introduction** establishes the importance of self-management support and patient empowerment within pediatric chronic care. The subsequent section, **Background and Definitions**, provides a comprehensive overview of chronic diseases in children, offering critical definitions and exploring the interrelations among these conditions.

The third section, **Current Approaches to Pediatric Chronic Care**, evaluates existing strategies and models, emphasizing the roles of healthcare providers, caregivers, educational and behavioral strategies, and integrated care models. Following this, the section on **Self-Management Support in Pediatric Care** examines methodologies, challenges, and barriers to fostering self-management in pediatric contexts.

In the fifth section, **Role of Health Education**, the survey underscores the significance of health literacy and education, detailing how effective communication in health education promotes patient empowerment. This discussion transitions to **Patient Empowerment and Engagement**, which

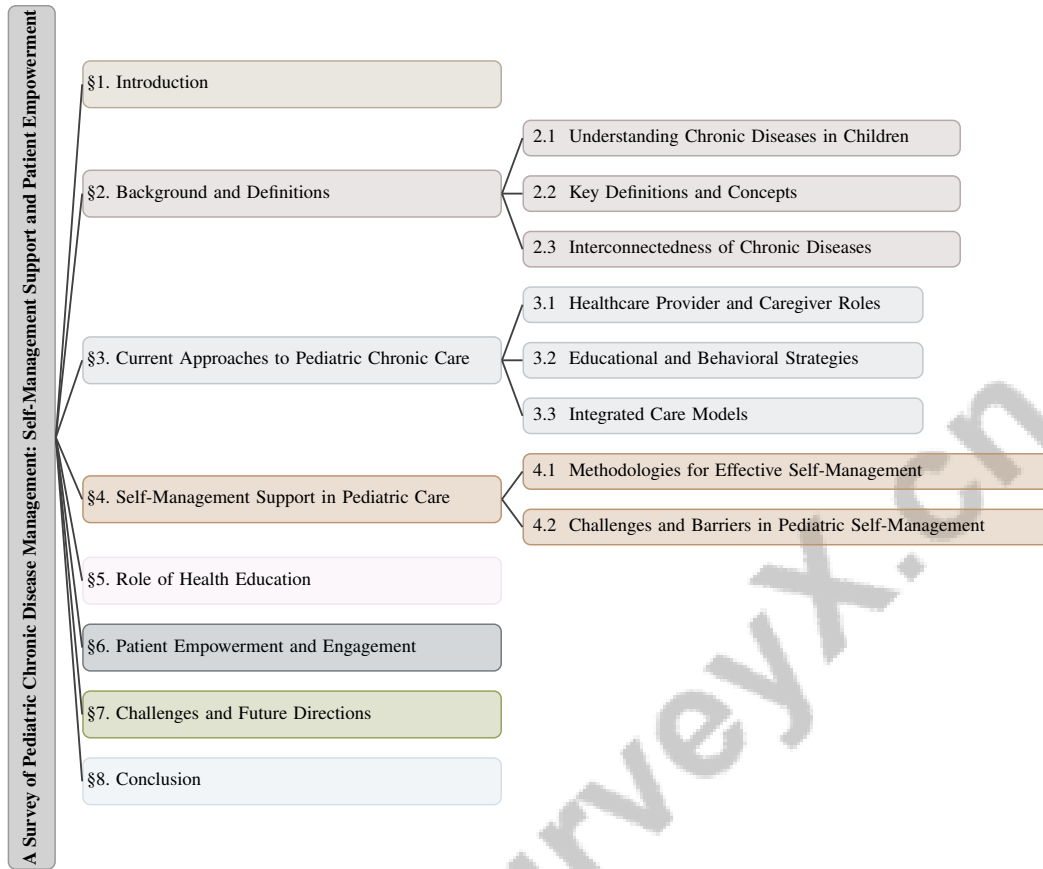


Figure 1: chapter structure

analyzes strategies to enhance engagement through innovative methods, including gamification and interactive tools.

The survey concludes with a focus on **Challenges and Future Directions** in implementing pediatric chronic disease management programs, addressing issues such as privacy, security, ethical concerns, and the potential of innovative technological interventions. The findings from the systematic review of chronic disease management interventions indicate that self-management support is the most effective strategy for improving patient outcomes, highlighting the essential role of patient empowerment in enhancing healthcare delivery, particularly in primary and community care settings, where these interventions have demonstrated statistically significant health improvements [1, 2, 3, 4, 5]. The following sections are organized as shown in Figure 1.

2 Background and Definitions

2.1 Understanding Chronic Diseases in Children

Pediatric chronic diseases, such as asthma, diabetes, and neuromuscular disorders like Duchenne Muscular Dystrophy (DMD) and Spinal Muscular Atrophy (SMA), present significant challenges due to their prevalence and impact on children and families. Asthma affects over 8

Chronic conditions like diabetes and heart disease contribute to high pediatric mortality rates. Diabetes Mellitus (DM) affects approximately 10

Broader societal burdens are imposed by chronic diseases such as depression, arthritis, cancer, and non-specific low back pain [6]. Chronic kidney disease (CKD) exemplifies the complexity requiring innovative management strategies [7]. Digital health interventions (DHIs) and remote patient monitoring (RPM) offer personalized care opportunities tailored to individual contexts [8].

Evaluating health indicators in a cohort of 1,172 children highlights resilience’s role in managing chronic diseases [9].

A holistic approach is essential for addressing pediatric chronic diseases, focusing on early diagnosis, effective management, and technological integration to improve health outcomes and quality of life. This approach recognizes the interconnectedness of chronic diseases, often sharing physiological responses like inflammation, affecting multiple conditions concurrently [10]. Optimizing time allocation among sleep, sedentary behavior, and physical activity is crucial for children’s health, well-being, and cognitive development, emphasizing comprehensive management strategies [11].

2.2 Key Definitions and Concepts

‘Chronic disease’ encompasses long-term health conditions requiring ongoing management, including diabetes, asthma, and neuromuscular disorders like DMD and SMA. These conditions impact children’s health, necessitating sustained therapeutic interventions to manage symptoms and prevent exacerbations. AI integration in Remote Patient Monitoring (RPM) systems enhances chronic and acute illness management [12].

‘Self-management support’ empowers patients and families to manage health effectively, providing education, resources, and tools for informed decision-making and active care participation [13]. Digital health interventions, such as mobile apps and eHealth applications, facilitate self-management by offering personalized patient management solutions.

‘Pediatric chronic care’ involves a comprehensive approach integrating medical, educational, and psychosocial support tailored to children’s unique needs, aiming to optimize health outcomes and improve quality of life [14]. Effective chronic disease management interventions are structured strategies designed to enhance health outcomes for chronic condition patients [15].

‘Health education’ improves health literacy by equipping patients and families with necessary knowledge to understand conditions and treatment options. Effective health education requires clear communication and adaptive user interfaces and mHealth applications to facilitate learning and engagement. Despite its importance, many children and adolescents exhibit inadequate health literacy [16].

‘Patient empowerment’ involves enabling active healthcare participation, fostering agency, responsibility, and self-management efforts. This is achieved through education to enhance health literacy, effective communication facilitated by advanced technologies like large language models, and Internet of Medical Things (IoMT) integration, enabling personalized care and active health monitoring [1, 16, 17, 18, 19].

2.3 Interconnectedness of Chronic Diseases

Chronic diseases are interlinked through shared physiological mechanisms and risk factors, influencing progression and management strategies. Inflammation is a common factor exacerbating conditions such as cardiovascular diseases, diabetes, depression, and autoimmune disorders [10]. A holistic pediatric care approach, understanding shared pathways, can lead to more effective management for children with multiple chronic conditions.

The complexity of chronic disease management is compounded by Electronic Health Record (EHR) data heterogeneity, challenging disease trajectory modeling and predictive model accuracy [20]. This affects model interpretability and tailoring interventions to individual needs.

Fragmented health data across disconnected systems complicates continuity of care, hindering comprehensive health information access for clinicians, patients, and policymakers [21]. Integrated data systems are needed for seamless information exchange, improving pediatric chronic care quality.

Chronic diseases exhibit distinct trajectory phases—acute, unstable, and stable—necessitating different treatment regimens [6]. Understanding these phases is essential for developing dynamic treatment plans adapting to pediatric patients’ evolving needs.

The Internet of Medical Things (IoMT) integration enhances healthcare delivery and patient outcomes through real-time monitoring and data collection [18]. IoMT bridges gaps between disparate data systems, providing insights into disease patterns, enabling proactive and personalized care for children

with chronic diseases. Leveraging these technological advancements allows healthcare providers to address the interconnected nature of chronic conditions and optimize pediatric treatment strategies.

In recent years, the management of pediatric chronic diseases has evolved significantly, necessitating a comprehensive understanding of the various approaches employed in this field. This evolution is encapsulated in Figure 2, which illustrates the hierarchical structure of current approaches to pediatric chronic care. The figure details the roles of healthcare providers and caregivers, alongside educational and behavioral strategies, as well as integrated care models. Each primary category is further divided into subcategories that highlight innovative tools, challenges, and technological integrations. This visual representation emphasizes the collaborative and holistic efforts essential for effective management of pediatric chronic diseases, thereby enhancing our understanding of the multifaceted nature of care in this domain.

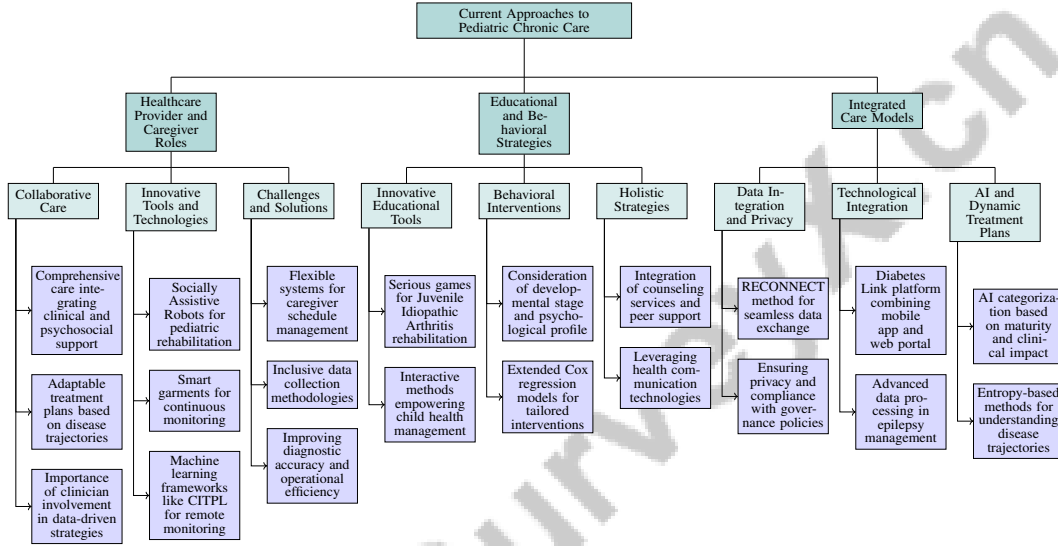


Figure 2: This figure illustrates the hierarchical structure of current approaches to pediatric chronic care, detailing the roles of healthcare providers and caregivers, educational and behavioral strategies, and integrated care models. Each primary category is further divided into subcategories that highlight innovative tools, challenges, and technological integrations, emphasizing the collaborative and holistic efforts in managing pediatric chronic diseases.

3 Current Approaches to Pediatric Chronic Care

3.1 Healthcare Provider and Caregiver Roles

Healthcare providers and caregivers are crucial in managing pediatric chronic diseases through a collaborative approach aimed at optimizing patient outcomes. Providers deliver comprehensive care by integrating clinical interventions with psychosocial support, tailored to the child's evolving health needs. This requires understanding disease trajectories and applying adaptable treatment plans, as care often risks being symptom-driven rather than trajectory-informed, potentially undermining management effectiveness [6]. Caregivers, often family members, ensure adherence to treatment regimens and manage healthcare appointments, although challenges such as parental work schedules can complicate these efforts, highlighting the need for flexible systems [22]. Engaging children in pediatric rehabilitation is essential, with innovative tools like Socially Assistive Robots (SARs) emerging to maintain interest in therapeutic activities [23]. Conditions like Juvenile Idiopathic Arthritis (JIA) benefit from holistic care solutions, where technological advancements, including smart garments, provide continuous monitoring and support [24]. Similarly, diabetes management necessitates rigorous monitoring strategies to prevent severe complications [5]. Integrating clinician expertise into machine learning frameworks, such as Clinician-Informed Treatment Policy Learning (CITPL), can enhance treatment policy performance, particularly in remote monitoring contexts like type 1 diabetes management [8]. This underscores the importance of clinician involvement in

developing data-driven strategies to ensure clinical relevance. However, limitations in administrative health data often lead to biased samples, posing challenges for healthcare providers [25]. Addressing these issues requires inclusive data collection methodologies to ensure equitable care strategies. Research highlights improvements in diagnostic accuracy and operational efficiency, crucial for advancing intelligent healthcare systems [26].

3.2 Educational and Behavioral Strategies

Educational and behavioral strategies are pivotal in managing pediatric chronic diseases, facilitating behavior modification and enhancing adherence to treatment protocols. The incorporation of serious games into rehabilitation for Juvenile Idiopathic Arthritis (JIA) exemplifies an innovative approach, serving as both educational tools and motivational aids, promoting sustained engagement in therapeutic exercises [27]. This interactive method empowers children to take an active role in their health management.

As depicted in Figure 3, the hierarchical structure of educational and behavioral strategies emphasizes the importance of innovative approaches, behavioral interventions, and holistic strategies in managing pediatric chronic diseases. Behavioral interventions must consider the patient's developmental stage and psychological profile. Utilizing extended Cox regression models with age-varying coefficients allows for sophisticated analysis of healthcare utilization patterns, such as Mental Health Emergency Department (MHED) visits, enabling tailored interventions that enhance educational and behavioral strategy effectiveness [25]. Addressing the psychological and emotional aspects of chronic disease management is critical. A holistic strategy integrating counseling services, peer support networks, and active family participation fosters a nurturing environment tackling the multifaceted challenges of health and wellness, particularly regarding chronic diseases and mental health issues. This approach enhances the support system for individuals and leverages advancements in health communication technologies to improve health literacy and engagement among diverse populations [3, 1, 16]. By employing educational tools and behavioral interventions, healthcare providers can improve adherence to treatment regimens, reduce healthcare visit frequency, and enhance the quality of life for children with chronic conditions.

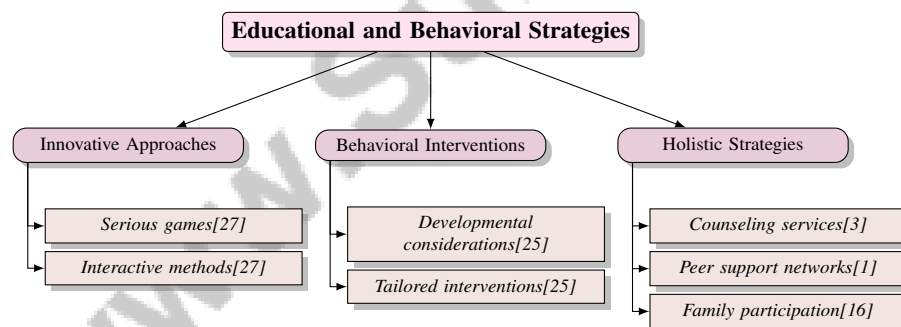


Figure 3: This figure illustrates the hierarchical structure of educational and behavioral strategies in managing pediatric chronic diseases, emphasizing innovative approaches, behavioral interventions, and holistic strategies.

3.3 Integrated Care Models

Integrated care models are crucial for managing pediatric chronic diseases by consolidating various care aspects into a cohesive framework. These models enhance coordination among healthcare providers, optimize resource utilization, and improve patient outcomes. The RECONNECT method employs a four-layer architecture to integrate healthcare data while ensuring privacy and compliance with governance policies [21], facilitating seamless data exchange across healthcare systems and improving continuity of care for pediatric patients. In diabetes management, the Diabetes Link platform exemplifies an integrated care model that combines a mobile application with a web portal, streamlining monitoring and management processes [5]. This integration enables effective collaboration between patients and healthcare providers. Pediatric epilepsy management also benefits from integrated care models utilizing advanced data processing techniques. Preprocessing steps

like bandpass filtering and independent component analysis reduce noise and improve prediction accuracy, enhancing epilepsy management [28]. This underscores the importance of integrating technological advancements into clinical workflows to optimize treatment outcomes. Novel entropy-based methods for fitting survival densities and simulating patient life courses through discrete event simulation provide a robust framework for understanding chronic disease trajectories [15]. This allows for dynamic treatment plan adaptation, ensuring interventions align with pediatric patients' evolving health status. Integrating artificial intelligence (AI) into healthcare systems further enhances integrated care models. By categorizing AI applications based on maturity and impact on clinical workflows, healthcare providers can systematically incorporate AI-driven insights into practice, improving the precision and efficiency of chronic disease management [26]. These integrated care models, bolstered by cutting-edge technology and comprehensive data frameworks, represent a promising direction for advancing pediatric chronic care and improving the quality of life for affected children.

4 Self-Management Support in Pediatric Care

4.1 Methodologies for Effective Self-Management

Method Name	Technological Tools	Interactive Learning	Data Integration
DMCS[29]	Mobile Application	Using Exergames	Adaptive Difficulty System
PVA[30]	3D Camera	Gaming Elements	-
SGF-LR[27]	Kinect Sensor	Serious Games	Session Data
JL[19]	Smartphone Application	Interactive Learning Experiences	Video Modeling, 360-degree Views
MB[31]	Mobile Apps	Gaming Elements	Structured Data
DEHR[32]	-	-	Both Data Types
MPEF[4]	-	-	-
EDESM[15]	-	-	Structured And Unstructured

Table 1: Overview of methodologies for effective self-management in pediatric care, highlighting the technological tools, interactive learning approaches, and data integration methods employed by various methods. This table provides a comparative analysis of eight methodologies, demonstrating their unique contributions to enhancing self-management among children with chronic diseases.

Methodologies for effective self-management in pediatric care are pivotal in empowering children with chronic diseases to take an active role in their health management. These methodologies employ innovative tools and approaches to boost patient engagement and optimize health outcomes. Mobile applications, such as those designed for wrist movement classification during rehabilitation, provide real-time adaptive feedback, facilitating self-management [29]. Similarly, active video game prototypes with 3D cameras encourage physical activity through interactive gameplay, making self-management enjoyable for children [30].

The integration of advanced input devices and serious games frameworks, particularly for lower limb rehabilitation, exemplifies technological support for self-management. These tools enable precise tracking and interaction, motivating adherence to rehabilitation protocols and fostering autonomy [27]. Despite limitations, mobile health applications offer significant potential for chronic illness management, providing platforms for health data tracking and facilitating communication between patients, families, and healthcare providers [33].

Interactive learning experiences like the Joy Learning application aid children with chronic conditions, such as Parkinson's disease, in skill development through engaging educational content [19]. The MedBike method combines physical exercise with gaming, supporting cardiac rehabilitation and reinforcing the role of interactive gaming in self-management [31].

Methodologies like Deep EHR utilize both structured and unstructured data to inform self-management strategies, highlighting the importance of data integration in personalizing care plans [32]. The use of large language models and few-shot learning techniques for chronic disease detection showcases artificial intelligence's potential in refining self-management methodologies [4].

Entropy-based discrete event simulation models provide a robust framework for simulating patient life courses and developing dynamic treatment plans that align with pediatric patients' evolving health statuses [15]. These methodologies emphasize personalized and adaptive approaches in facilitating effective self-management, ultimately enhancing health outcomes and quality of life for children with chronic diseases.

As shown in Figure 4 and further detailed in Table 1, self-management support in pediatric care is crucial for empowering young patients and their families to manage health conditions effectively. This figure illustrates the hierarchical categorization of methodologies for effective self-management in pediatric care, highlighting technological tools, interactive learning approaches, and data integration methods. Table 1 presents a comprehensive comparison of methodologies for effective self-management in pediatric care, illustrating the diverse technological tools, interactive learning strategies, and data integration techniques utilized across different approaches. The methodologies for effective self-management include examples such as optimizing appointment schedules to reduce missed consultations and ensuring high-quality evidence for self-management strategies through systematic reviews. These structured methodologies are vital in fostering effective self-management support in pediatric care [22, 2].

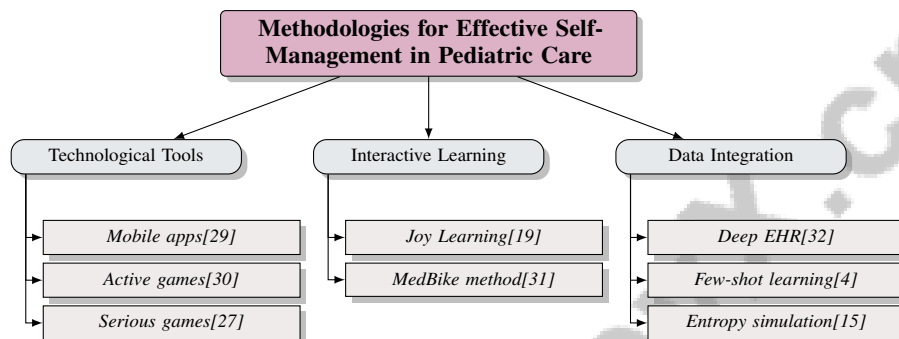


Figure 4: This figure illustrates the hierarchical categorization of methodologies for effective self-management in pediatric care, highlighting technological tools, interactive learning approaches, and data integration methods.

4.2 Challenges and Barriers in Pediatric Self-Management

Implementing self-management support in pediatric care faces several challenges and barriers that can hinder its effectiveness. A significant challenge is maintaining patient motivation during repetitive rehabilitation exercises. Socially Assistive Robots (SARs) address this by keeping engagement through interactive methods [23]. However, existing methods often fail to adapt to individual needs, leading to frustration and disengagement, particularly in conditions like cerebral palsy [29].

Pediatric self-management complexity is further complicated by high noise and artifacts in EEG data, affecting accurate seizure prediction for epilepsy [28]. Additionally, ineffective methods to motivate physical activity limit the success of interventions aimed at promoting healthier lifestyles [30]. Traditional rehabilitation methods often appear uninspiring to young patients [31].

Heterogeneity in trial outcomes, as revealed by complex meta-regression models, indicates that additional covariates may be necessary to fully capture variation, suggesting that current models may not adequately address all influential factors in self-management interventions [34]. The integration of adaptive user interfaces into self-management tools faces challenges, as many studies focus narrowly on specific aspects without comprehensively evaluating user needs and contexts [35].

Technological barriers, such as internet access issues and user training, hinder mobile health application deployment, resulting in lower engagement rates among caregivers and patients [14]. Additionally, limited benchmarks for diabetes care, often lacking comprehensive evaluation metrics, complicate effective management [36].

Addressing these challenges requires a comprehensive strategy that integrates adaptive technologies, robust evaluation frameworks, and tailored interventions. This approach aims to enhance self-management support systems by leveraging advancements in eHealth and AI-driven methodologies. By utilizing adaptive user interfaces that respond to individual needs and contexts, along with innovative frameworks incorporating personalized prompts and medical knowledge, healthcare providers can significantly improve patient engagement and outcomes in managing chronic conditions [4, 1, 35].

5 Role of Health Education

5.1 Health Literacy and Education

Health literacy and education are critical components in managing pediatric chronic diseases, providing children and their families with essential knowledge and skills. Integrating large language models (LLMs) into educational strategies significantly enhances health literacy by improving communication and comprehension of health-related information, empowering children to make informed healthcare decisions [16]. The effectiveness of health videos varies depending on content type, platform, and viewer interaction, suggesting that tailoring video content to pediatric preferences can enhance engagement and understanding [3].

As illustrated in Figure 5, the integration of LLMs, health videos, and adaptive learning technologies plays a pivotal role in enhancing health literacy and education for pediatric chronic disease management. Addressing diverse learning needs through adaptive learning technologies allows educational content to be personalized according to individual learning styles and cognitive abilities. Utilizing advanced technologies, such as LLMs and mobile health (mHealth) applications, healthcare providers can improve health literacy and outcomes among pediatric populations by facilitating communication across different reading levels and leveraging remote monitoring capabilities. These strategies enhance healthcare access, reduce costs, and address disparities, ultimately empowering a more informed generation of patients to navigate complex health challenges [37, 1, 16].

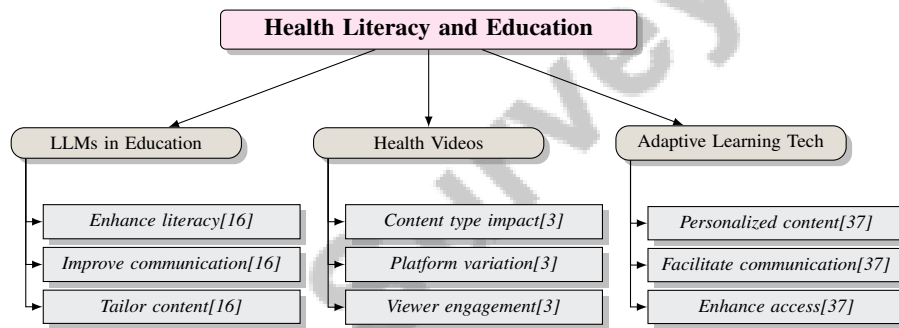


Figure 5: This figure illustrates the integration of large language models, health videos, and adaptive learning technologies in enhancing health literacy and education for pediatric chronic disease management.

5.2 Role of Health Education and Communication

Health education and communication play a crucial role in enabling pediatric patients and their families to manage chronic diseases effectively. Systems like RECONNECT, which integrate chronic disease datasets, enhance healthcare delivery by improving decision-making for clinicians and policymakers and ensuring comprehensive patient care [21]. Effective communication strategies bridge the gap between complex medical information and patient understanding, thereby enhancing health literacy.

The application of LLMs in health communication represents a significant advancement, making health information more accessible and empowering young patients to make informed decisions [16]. Health education fosters open dialogue between healthcare providers and patients, crucial for addressing concerns, clarifying doubts, and tailoring educational content to individual needs. By implementing advanced communication strategies and educational tools, such as LLMs and integrated health systems like SaludConectaMX, healthcare providers can enhance health literacy among pediatric patients. This approach empowers children with chronic conditions by delivering tailored health information and facilitating cooperative health monitoring, leading to improved outcomes and quality of life [14, 16].

6 Patient Empowerment and Engagement

6.1 Innovative Approaches to Patient Engagement

Enhancing patient engagement in pediatric chronic care is crucial for fostering active participation and improving health outcomes. Integrating clinical knowledge into machine learning models enhances treatment policy efficacy and interpretability, empowering patients with clearer care insights and enabling informed decision-making [8]. The Diabetes Link platform exemplifies this by offering comprehensive features and connectivity with healthcare supervisors, empowering diabetes patients to manage their health autonomously [5]. Active video games and frameworks for lower limb rehabilitation further illustrate innovative engagement by transforming routine exercises into enjoyable activities, thus promoting adherence to rehabilitation protocols [30, 27].

As shown in Figure 6, innovative approaches to enhancing patient engagement in pediatric chronic care focus on clinical knowledge integration, engagement technologies, and health communication. Advanced strategies, including LLMs for personalized health communication, mobile health applications for children’s health, and IoT technology for continuous monitoring, significantly enhance patient engagement. This proactive approach fosters better health literacy among children with chronic diseases and enables families to effectively manage care by tracking health metrics [1, 16, 17, 33, 14].

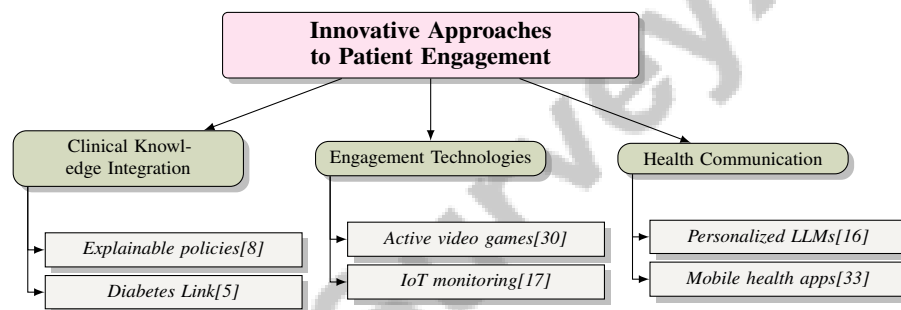


Figure 6: This figure illustrates innovative approaches to enhancing patient engagement in pediatric chronic care, focusing on clinical knowledge integration, engagement technologies, and health communication.

6.2 Gamification and Interactive Tools for Engagement

Gamification and interactive tools are effective strategies for enhancing patient engagement in pediatric chronic care. By transforming traditional rehabilitation exercises into enjoyable activities, these approaches increase motivation and adherence to treatment protocols. Exergames, exemplified by wrist movement classification methodologies, demonstrate how gamification can boost patient engagement [29]. The ‘Joy Learning’ smartphone application utilizes video modeling and interactive problem-solving to enhance social skills and engage children in a dynamic learning environment, fostering empowerment and self-efficacy [19].

In cardiac rehabilitation, the MedBike project creates an immersive environment that encourages exercise and engagement by integrating gamification into routine physical activity, promoting better health outcomes and a positive attitude towards condition management [31]. The integration of gamification and interactive strategies in pediatric chronic care highlights the importance of innovative methods for engaging young patients. Initiatives like the MedBike cardiac rehabilitation game provide environments tailored to children’s rehabilitation needs, enhancing motivation and treatment adherence. Leveraging LLMs for health information communication further bolsters health literacy by tailoring responses to various reading levels and making complex medical concepts more accessible [31, 16]. By harnessing play and interactive technology, healthcare providers can create more engaging and effective care plans for children with chronic diseases.

7 Challenges and Future Directions

7.1 Privacy, Security, and Ethical Concerns

In pediatric chronic care management, safeguarding privacy, security, and ethics is crucial for responsible healthcare delivery. The integration of the Internet of Medical Things (IoMT) poses significant ethical, legal, and social challenges, particularly concerning data protection, a topic insufficiently addressed in current literature [18]. The reliance on extensive datasets for neuromuscular disease classification highlights the necessity for robust data protection measures to prevent unauthorized access to sensitive patient information [38].

Privacy concerns are further underscored in adaptive user interface (AUI) studies, revealing a critical need for improved evaluation methodologies across various chronic disease contexts [35]. Ensuring data accuracy and patient privacy is essential, especially in using aggregate medication data, as shown in asthma management scenarios [39]. Additionally, the limited sample size in studies like the Joy Learning app raises questions about the generalizability of findings, emphasizing ethical considerations in research design [19].

Ethical considerations are particularly vital in pediatric chronic care, especially regarding participant preferences in clinical trials. The SMART-EXAM approach demonstrates how ethically considering participant welfare can enhance recruitment and retention rates, crucial for managing pediatric chronic conditions [40]. Moreover, the quality of longitudinal data in dynamic treatment planning methods, such as VDC-HMMX, raises privacy and ethical issues that require attention to validate treatment strategies [6].

The entrenched biomedical model, which isolates diseases, limits the ability to address the interconnected nature of chronic conditions, necessitating a shift towards holistic approaches that incorporate ethical implications [10]. Future research should refine methodologies for diverse patient populations, explore factors influencing no-show rates, and develop strategies for collecting and safeguarding patient preference data to uphold privacy and ethical standards in pediatric chronic care management. The initial lack of updates in systems like MedBike highlights the need for ongoing improvements to foster long-term engagement, emphasizing the importance of ethical considerations in healthcare technology development and implementation [31].

7.2 Innovative Technological Interventions

Innovative technological interventions are pivotal in transforming pediatric chronic care by addressing limitations and enhancing patient outcomes. Advanced deep learning algorithms applied in hospitals with EEG machines mark a significant advancement in overcoming seizure prediction challenges, improving care for epilepsy [28]. Additionally, the development of serious games as novel interventions demonstrates their potential to enhance patient engagement and adherence in managing pediatric chronic diseases, converting therapeutic exercises into interactive experiences that motivate children to adhere to rehabilitation protocols [27].

The MedBike project exemplifies gamification integration in cardiac rehabilitation, creating an engaging environment that encourages physical activity. Future enhancements for MedBike should include customization options, additional levels, and a quest system to further engage users and cater to diverse rehabilitation needs [31]. Similarly, active video game prototypes promoting physical activity in children suggest transitioning to more current, cost-effective devices to broaden access and acceptance of these interventions [30].

Socially Assistive Robots (SARs) have shown promise in maintaining engagement during pediatric rehabilitation, with future research focusing on enhancing their interactive capabilities and exploring long-term therapeutic benefits. The use of smartphone sensors for real-time classification of wrist movements during rehabilitation exercises further exemplifies the impact of innovative technological interventions in pediatric care [29].

Recent advancements in technology, particularly in wearable devices and data analytics, underscore the vital role of innovation in addressing challenges faced by children with chronic diseases. These technologies facilitate continuous monitoring and management of conditions such as diabetes and heart disease, empowering patients and caregivers through personalized healthcare solutions. As the healthcare landscape confronts rising costs and the complexities of chronic disease management,

these innovations pave the way for more effective, tailored interventions that enhance care quality and improve health outcomes for vulnerable populations [41, 1].

8 Conclusion

Effective management of pediatric chronic diseases necessitates a comprehensive approach emphasizing self-management and patient empowerment. This survey highlights the pervasive impact of conditions such as asthma, diabetes, and neuromuscular disorders on children and their families. The integration of digital health solutions and remote monitoring, enhanced by artificial intelligence, offers promising avenues for personalized care and improved disease management.

Healthcare providers and caregivers are pivotal in this domain, requiring adaptable treatment plans responsive to children's evolving health needs. The significance of flexible scheduling, demonstrated by stratified patient appointment systems, is crucial for efficient care delivery. Innovations like Socially Assistive Robots and smart garments have shown potential in enhancing patient engagement and adherence to treatment.

Educational and behavioral strategies are crucial for empowering pediatric patients, with serious games and advanced analytical models enhancing engagement and tailoring interventions. Technologies like the 'Joy Learning' app exemplify the role of digital tools in supporting skill development and education for children with chronic conditions.

Integrated care models, such as the Diabetes Link platform and the RECONNECT method, underscore the importance of consolidating healthcare data to optimize care coordination and improve outcomes. These models leverage digital health interventions and real-time monitoring to deliver personalized care strategies.

Despite these advancements, challenges remain in implementing effective self-management support. Data noise, health information fragmentation, and the complexity of disease trajectories pose significant barriers to seamless care coordination. Privacy, security, and ethical considerations are paramount, necessitating robust data protection in digital health interventions.

Health education is vital in enhancing health literacy and empowering patients in pediatric chronic care. The efficacy of educational strategies, including mobile health applications, in improving health literacy and outcomes is well-established. By promoting open communication among healthcare providers, patients, and families, health education enables patients to actively participate in their care, leading to improved health outcomes.

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