

Research Article

# Pediatric Patient and Parent Attitudes Towards Digital Health Tools: Survey Data from a Pediatric Electrophysiology Practice

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## Abstract

**Background:** Rapid adoption and miniaturization of technology has increased access to connected digital health (DH) technologies, though there are few pediatric cardiac studies assessing these tools. This study assesses the current state of DH access, use and digital literacy in a pediatric electrophysiology (EP) population. **Methods:** Patients presenting to a pediatric EP clinic were prospectively enrolled and completed to complete a 35-question survey focused on access and use of DH tools. **Results:** 206 patient/parent dyads completed the survey. 72% (149/206) of patients who own a smartphone, 94% (141/150) owned a smartphone by age 15 with 64% of smartphone owners (98/154) using health, wellness, or fitness applications on their devices. Only 40% (82/204) of respondents had a wearable device with 72% of patients (59/81) obtaining their device between 12-19 years of age. [Figure 1](#) shows responses to questions regarding type of data from wrist worn wearable devices and DH health literacy. 56% of respondents (115/205) felt their ability to navigate their device/app was average with 38% (77/205) feeling that their ability to navigate was above average. **Conclusion:** Most pediatric patients obtain a smartphone or wearable device in adolescence and utilize the built-in health apps. While a slight majority of adolescents have a basic understanding of their health data and can navigate their devices with ease, there are opportunities to improve DH literacy. Ownership of their health data may empower adolescents to use DH devices to supplement their care.

## Keywords

Digital Health, Pediatric Electrophysiology, Direct to Consumer Wearables, Pediatrics and Digital Health

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## 1. Introduction

As adults, technology shapes nearly every aspect of our lives. Access to broadband internet via computer, smartphone, and/or tablet for both work and social utilization is ubiquitous. According to Consumer Affairs data, 9 out of 10 Americans own a smartphone and spend approximately 4.5 hours per day on their phones [1]. It is also estimated that 20% of adults in the USA are now using a wearable device [2]. In addition to utilizing smartphones and wrist worn wearables as communication devices and timepieces, many of these devices are now equipped with or capable of housing specialized apps developed for health care and wellness. Specific to cardiovascular health, patients can record electrocardiograms (ECGs), heart rates, step counts, pulse oximetry and even blood pressure [3-5]. Clinicians may utilize these biometric data to monitor changes in a patient's clinical course [6, 7].

Children begin interacting with digital media as young as 4 months of age [8]. Recent data shows that ~57% of children aged 9-12 years have a smartphone, 43% have a tablet and 43% have a computer, while 88% of 13 to 18-year-olds have a smartphone, 64% have a tablet and 36% have a computer. In 2018, ~7 % of adolescents had a wearable health device [9]. Currently, there is a lack of data regarding pediatric use of smartphones and wearable devices despite the rapid technology growth in these devices over the last several years. So, while many patients may have access to digital health (DH), few pediatric studies have focused on how patients use DH tools or their overall DH literacy. DH literacy refers to the specific degree of skills and abilities necessary to use and interpret DH technologies and data [10]. Current research suggests that variability in DH literacy may present barriers to use [11]. DH holds significant promise to increase the efficiency of care and improve health outcomes in our pediatric population while offering personalized preventative medicine [12-14]. A proper understanding of our patient population's access to and use of DH, along with their DH literacy, will enable optimal recommendations about the use of DH technologies in clinical settings. In this study, we investigated pediatric patient DH access, the use of these technologies, and literacy in a pediatric electrophysiology clinic population.

## 2. Methods

After receiving IRB approval, we created this prospective survey-based study. We utilized an original 35 question survey which was focused on use and access to DH technology. English speaking pediatric patients presenting to electrophysiology (EP) clinic were invited to participate unless they were a ward of the state. After consent was obtained, the patients and/or family members completed the survey on clinic provided iPads. Adolescent and school age patients were asked to complete the survey on their own or with the help of a family member while non-reading patient's surveys were completed by a family member. Family members that helped

their child fill out the survey were instructed to answer the survey questions from the viewpoint of their child. After completion of the survey, iPads were returned to the study team member and participation in the study was completed. Data was compiled in a Redcap database then analyzed by the study team via descriptive statistics, including mean and ranges.

## 3. Results

### 3.1. Demographics

There were a total of 206 patient/parent dyads who completed the survey (see table 1).

**Table 1.** Demographic data: \*205/206 respondents answered; \*\*204/206 respondents answered.

Patient Demographics	Total number, n (%age)
Age*	
0-5 years	27 (13%)
6-11 years	45 (22%)
12-18 years	97 (47%)
+18 years	36 (18%)
Gender*	
Female	111 (54%)
Male	90 (44%)
Non-binary	2 (1%)
Other	2 (1%)
Ethnicity*	
Caucasian	176 (86%)
Black or African American	17 (8%)
Asian	4 (2%)
Hispanic or Latino	2 (1%)
Other	6 (3%)
Estimated Household Income**	
\$0-30K	20 (10%)
\$31-75K	56 (27%)
\$76-120K	61 (30%)
>\$120K	67 (33%)

The majority had access to internet in the home (205/206, 99.5%) with only 1 (0.5%) of respondents not having internet

access at home. The most common way to access the internet was by smartphone (158/204, 78%), followed by tablet (32/206, 16%) and home computer (14/206, 7%). Access to hardware devices for internet access was also high, with 72% (149/206) owning a smartphone, 75% (153/205) owning a tablet, and 92% (190/206) owning a home computer.

### 3.2. Data from Smartphone Owners

Most patients owned a smartphone by age 15 (141/150, 94%), with 63% of smartphone owners having health, wellness, or fitness applications on their device. See Figure 1.

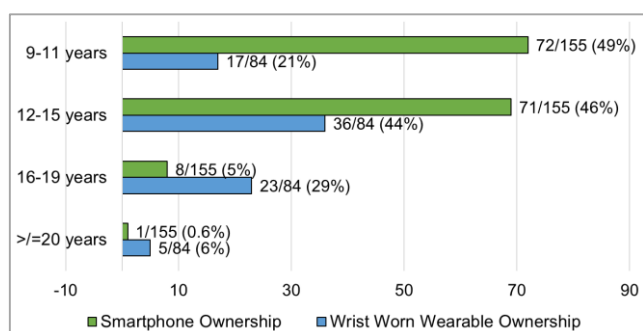


Figure 1. Age at time of Digital Health Ownership.

Figure 1. Results demonstrate the age at which participants acquired their first smartphone or wrist worn wearable. Percentage of patients are shown on the x-axis while patient age in years is shown on the y-axis. The green bar represents Smartphone ownership while the blue bar represents Wrist Worn Wearable ownership.

There were a wide variety of applications that were reported, with the AppleHealth (Apple Inc., Cupertino, CA) application being the most frequently used/downloaded app (See Table 2).

Table 2. This table depicts the wide variety of health and wellness apps that patients report using or having downloaded to their smartphones.

Downloaded Apps for Smartphone Users	Total Count
AppleHealth	63 (69%)
AppleFitness	41 (45%)
MyFitnessPal	10 (11%)
MapMyRun	2 (2%)
ECG Analyzer	4 (4%)
AliveCor Kardia Mobile	2 (2%)
AFibCheck	3 (3%)
SleepCycle	6 (7%)

Downloaded Apps for Smartphone Users	Total Count
Noom	1 (1%)
RunKeeper	1 (1%)
GoogleFit	3 (3%)
Headspace	5 (5%)
Other	29 (32%)

The most cited reasons for using these apps were to monitor exercise (50%), monitor heart rate (47%), monitor fitness level (48%) and monitor heart rhythm (31%). Other reasons for using these apps included sleep monitoring (20%), diet monitoring (10%), pulse oximetry monitoring (7%), to help relax (4%) and for social reasons (5%). A total of 19% reported having the apps but not using them.

### 3.3. Data from Wrist Worn Wearable Users

Less than half (82/204, 40%) of respondents had a wrist worn wearable device, and there was a broader age range at time of ownership. 73% of patients obtained their device between the ages of 12-19 years (See Figure 1). An Apple Inc product (AppleWatch; Apple Inc., Cupertino, CA) was the most owned wrist worn wearable, accounting for 70% (57/81) of respondents, followed by Fitbit (Alphabet Inc., Mountain View, CA) (6/81, 7%), Garmin (Garmin Ltd, Olathe, KS) (5/81, 6%), FitBit Luxe (Alphabet Inc., Mountain View, CA) (3/81, 4%), Samsung (Samsung Electronics Co., Ltd., Suwon, South Korea) (1/81, 1%) and other (8/81, 10%). Many respondents (37/82, 45%) wear their wrist worn wearable device 7 days/week and the majority have owned the device for 3 years or less (35% <1 year, 48% 1-3 years). Respondents reported using their wrist worn wearable device for monitoring heart rhythm (4/82, 5%), monitoring heart rate (12/82, 15%), monitoring fitness level (5/82, 6%), as a fashion accessory (1/82, 1%), to receive phone notifications (4/82, 5%), to tell time (8/82, 10%) or all the above (46/82, 56%).

Most patients (96%, 79/82) had a device that could record their heart rate with only 35% (29/82) having a device that could record an ECG/heart rhythm. Most respondents, 95%, had devices that could record steps/other metric of fitness (78/82). Additionally, the ability to record pulse oximetry was present in 33% of respondents' devices (27/82). See Figure 2.

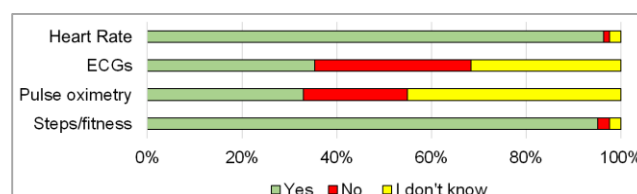


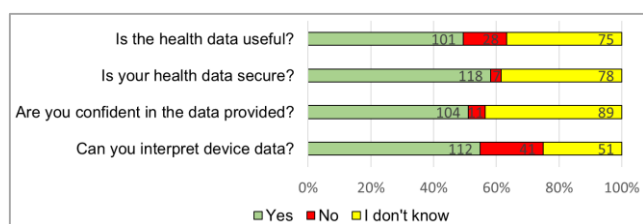
Figure 2. Types of Data Available from Wrist Worn Wearable Devices.

**Figure 2** Results demonstrate the types of data available from wrist worn wearables that participants were aware of. Percentage of patients are shown on the x- axis while types of data are shown on the y-axis. The green bar represents number of participants aware of data, the red bar represents the number of participants not aware of data and the yellow bar represents the number of participants who did not know if their device provided such data.

### 3.4. Digital Health Literacy

Approximately half of patients, 50% (101/204) found that the health data provided by their device(s) was useful, with 37% (75/204) reporting that they did not know if the data was useful. A minority of respondents, 14% (28/204) felt that the data provided by their device(s) was not useful. 84% (173/205) respondents did not think that the device(s) gave too many alerts, with only 4% (8/205) thinking that the device did give too many alerts and 12% (24/205) reporting that sometimes the device gave too many alerts.

Most patients, 59% (120/203), felt that the data from their device(s) never impacted their behaviors with 55% (112/204) understanding how to interpret the health data from their device(s). 56% of respondents (115/205) felt their ability to navigate their device(s) and app(s) was average with an additional 38% (77/205) feeling that their ability to navigate was above average. Most frequently, respondents ask either a parent (56%, 115/204), Google (25%, 50/204) or sibling (7%, 14/204) for help when there is trouble with the device/app. Confidence in the data provided by the device(s) was varied, with 51% (104/204) having confidence and 44% (89/204) responding that they did not know. Only 5% (11/204) did not have confidence in the data provided by their device(s). Most patients, 58% (118/203), felt that their private health data were secure with 39% (78/203) not being certain and only 3% (7/203) believing their health data was not secure. See [Figure 3](#).



**Figure 3.** Data Interpretation and Literacy.

**Figure 3** Results demonstrate the participants perception of data usefulness, security as well as their confidence in the data provided by their device and ability to interpret such data. Percentage of patients are shown on the x- axis while questions regarding data are shown on the y-axis. The green bar represents number of participants who responded yes, the red bar represents the number of participants who responded no,

and the yellow bar represents the number of participants who did not know.

## 4. Discussion

The purpose of this study was to investigate what digital technologies our patients had access to and how they were using these technologies. We found that most patients in our clinic had access to internet in their homes and that most of those patients utilize a smartphone to go online, though many patients had multiple devices at home that could access the internet. These data are consistent with previous research [15]. They also show that many of our patients are utilizing their digital technology for health-related activities such as using smartphone applications to monitor exercise and heart rate. This suggests that even among the pediatric population, there is an opportunity to leverage DH technology to improve patient care, particularly as DH interventions were found to be cost-saving when compared to nondigital standards of care [16]. These implementations could include using a smartphone application for logging symptoms, recording symptomatic ECGs or consuming digital education videos to help patients learn about their health and treatments. As new content and technologies continue to evolve more research would need to be conducted to find the most effective ways to leverage DH technologies in this population, but previous studies have shown similar receptiveness of adolescents to adopting DH technologies [9, 17].

Additionally, a significant percentage (40%) of patients reported using a wrist worn wearable device, much higher than the previously reported 7% [9]. This data comes from a 2018 report, and the increase in ownership likely reflects market changes and technology adoption changes over time. Patients with wrist-worn wearables were on average older than the average smartphone user. The most common device owned by our patients is the AppleWatch (Apple Inc, Cupertino, CA), and the patients used their devices for a variety of reasons, including monitoring heart rate/heart rhythm, to receive phone notifications, and as a fashion accessory. A similar opportunity for integration of DH technologies to improve patient care exists with these patients as well.

Our data reveals that one of the barriers to widespread adoption of DH technologies is digital literacy. Specifically, only 29 patients reported the ability to record an ECG/heart rhythm with their device despite 57 patients reporting that they own a device that likely has this capability. Education of technology features is one of many obstacles to overcome to properly utilize DH technologies [18].

When asked about their comfort and confidence in their DH data, patient responses were mixed, with many patients reporting that they didn't find that the health data that was provided was useful or didn't know how to interpret the data. We did expect that this population may not have great insight into how this health data might have implications on their health conditions, and this is reflected in the survey. Educational



models should be implemented to improve DH literacy, allowing patients to confidently appraise their health data and discuss their concerns with clinicians [19]. Only 50% of patients perceived that the health data they received from their devices was useful. Additionally, only a slight majority of the patients found that their behaviors changed because of their health data. This is in line with a previous review by Au et al (2024) which found that adolescents using wearable devices did not increase their physical activity, though they may benefit from increased at-home biometric data collection and analysis [7, 20]. This review did note some limitations to their study, however, more rigorous studies are likely needed to evaluate the effectiveness of any new digital health technologies that might be introduced into this population. Many patients did not have full confidence that their data was secure, highlighting data security as another important consideration [18].

**Study Limitations.** These data do not represent the general population. Patients enrolled in this study were seen in a subspecialty pediatric EP clinic at an academic university, many have chronic health conditions or implanted devices and therefore may be more conscientious about their health compared to the average child and a large majority of patients (86%) included in this survey self-identified as White. Without adequate representation from other demographic groups, our data likely lacks nuances that may be important for developing solutions that can work in a variety of different communities. Indeed, there have been many studies which show that study populations are very important when developing new digital health technologies [2, 13, 14]. Care to recruit a diverse study population should be taken in any studies evaluating the efficacy of novel digital health technologies.

## 5. Conclusion

Adolescence has become the prime age when children obtain a smartphone or wrist worn wearable, with many patients utilizing the built-in health data apps on these devices. Fewer patients seek out these devices for their health data alone. Adolescents in our patient population are mixed in their understanding of the health data they receive but can navigate their devices with ease. This may lead to a greater sense of ownership over their health and empower them to use digital devices to supplement their care. As this is the first study to assess pediatric and parental attitudes towards digital health in a pediatric electrophysiology practice, further research on this topic is recommended.

## Abbreviations

ECG	Electrocardiogram
DH	Digital Health
EP	Electrophysiology

## Author Contributions

**Lisa Roelle:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing

**Nathan Miller:** Conceptualization, Data curation, Investigation, Project administration, Writing – review & editing

**David Catherall:** Data curation, Formal Analysis, Resources, Writing – original draft

**Animesh Tandon:** Resources, Writing – review & editing

**Anthony Pompa:** Conceptualization, Writing – review & editing

**William Orr:** Conceptualization, Methodology, Resources, Writing – review & editing

**Jennifer Avari Silva:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

## Ethics Approval and Consent to Participate

This study was approved by the Washington University in St. Louis IRB on June 27, 2023. The IRB ID# is 202306039. All research was conducted in accordance with the Declaration of Helsinki. Eligible participants were invited to participate, received and reviewed the Informed Consent, expressed understanding of the study and signed Informed Consent. Adolescents provided assent when applicable.

## Conflicts of Interest

Jennifer Silva is a co-founder of Sentiar, Inc and Excera, Inc.

Animesh Tandon reports consulting relationships with Synergen Health Technologies; Gabi Smartcare; Medtronic; Siemens Healthineers. AT reports equity in Realize Medical. AT reports stock in AMD; AMZN; GOOGL; LLY; MRNA; NVDA; NVO; VKTX; and VRTX.

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