Mobile Apps and Wearables for Cardiovascular Health: Review and Analysis

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Abstract

Background: Cardiovascular diseases continue to be the leading cause of global morbidity and mortality. In response, an increasing number of individuals are adopting mobile health apps and wearable devices. These technologies provide critical insights into heart health and fitness, enabling users to actively monitor their well-being and manage their medications.

Objective: This review aimed to investigate the current landscape of mHealth apps and wearables designed for cardiovascular health, with a specific focus on the DACH region (Germany, Austria, and Switzerland). It evaluated their benefits for both patients and clinicians, while also analyzing how well these technologies integrate into the broader healthcare ecosystem.

Methods: To identify heart health apps, a keyword search was performed on both the Swiss Apple App and Google Play Stores, while a separate search on Google targeting heart health wearables. The identified apps and wearables were evaluated using the foundational and contextual criteria of the sociotechnical framework for assessing patient-facing eHealth tools.

Results: After filtering out apps and wearables that did not meet specific criteria, the review analyzed 20 apps and 22 wearables. While all the apps were available in the DACH region, only 30% were specifically designed for these countries. Only 25% of the apps included gender-specific information, and 40% were based on evidence-based research. However, 25% provided no research or general information on cardiovascular health. Four apps had clinical integration, but only 10% effectively enhanced clinician workflows. Privacy policies were present in 95% of the apps, with 75% adhering to GDPR regulations; one app had no data protection policy. Medically certified apps were limited to 20%. For wearables, only 9% were tailored to the DACH region, and 40% addressed women's health. While around 60% offered clinical integration, only 9% improved clinical workflows. Twelve percent of wearables were medically certified, and 77% referenced scientific or peer-reviewed research. All wearables included a privacy policy.

Conclusions: The review highlighted a broad range of mHealth tools available to users, yet only a few provided significant value to both patients and clinicians while effectively integrating into the healthcare system. Many of these tools inadequately addressed the needs of women, who are disproportionately affected by cardiovascular diseases, as their specific needs were often overlooked. Moreover, the benefits for clinicians were sometimes insufficient. These findings emphasize the need for mHealth tools that are evidence-based and tailored to the needs of both patients and healthcare providers, aiming to bridge the gap between them and enhance care management. Clinical Trial: NA

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Introduction

Cardiovascular diseases (CVDs) are the leading global cause of death, responsible for approximately 17.9 million fatalities annually and affecting over 500 million people worldwide [1–3]. These non-communicable conditions impact the heart, arteries, and blood vessels, forming part of the circulatory system. The widespread prevalence of CVD highlights the urgent need for effective diagnosis, treatment, management, and preventive measures [3]. As healthcare shifts from reactive to proactive models, digital health solutions are becoming critical, offering timely diagnosis,

personalized care, and telemedicine services [4].

The advancement of digital technologies presents a significant opportunity to monitor and manage lifestyle factors and health risks, enabling the early detection and prevention of cardiovascular diseases; through innovative tools like telemonitoring, remote patient monitoring, mHealth apps, and wearable health devices, individuals can engage in proactive health management, providing a transformative approach to cardiovascular care [1]. The integration and widespread adoption of these technologies present a promising shift toward more personalized and proactive healthcare solutions, with the potential to enhance patient outcomes while simultaneously reducing healthcare costs [4].

Coorey et al. [5] found that mobile health apps significantly reduce hospital readmission rates, improve blood pressure, support healthy dietary habits, and enhance cardiovascular disease management. Smartphones equipped with photoplethysmography (PPG) technology can detect atrial fibrillation and assess cardiovascular health by measuring blood volume changes using infrared light; this technique provides insights into heart rate and variability, offering a cost-effective and non-invasive method for evaluating cardiovascular fitness [6]. However, PPG is sensitive to hand movements, which can disrupt sensor placement and lead to inaccurate readings during physical activity or movement [6].

Wearable devices, typically worn on the wrist, arms, chest, or hips, can also be effective tools for managing CVD risks [7]. These devices track various health metrics including heart rate, heart rate variability (HRV), blood oxygen levels, sleep patterns, and physical activity utilizing photoplethysmography (PPG) or electrocardiogram (ECG) technology to detect atrial fibrillation (AFib) [7,8]. For example, a study by Guo et al. [9] involving over 187,000 users identified 265,139 potential AFib cases among 424 users using the smart watch; follow-up testing confirmed AFib in 227 out of 262 users, demonstrating that wearables can effectively alert users to potential AFib, prompting timely medical evaluation and early diagnosis. A systematic review of interventions using smartwatches revealed favorable outcomes across various health aspects including improvements in lifestyle changes, medication adherence, reduction in unplanned hospital readmissions, enhanced atrial fibrillation diagnosis, and better adherence to self-monitoring practices [10].

In the DACH region (comprising Germany, Austria, and Switzerland) cardiovascular diseases also rank as the top cause of death [11]. This region accounts for about one third of Europe's medical technology market, presenting a key opportunity for healthcare innovation and research [12]. With its growing focus on health tech, the DACH region is positioned as an emerging leader in advancing medical solutions, making it a compelling market for cardiovascular health interventions [11,12].

Objectives

This review set out to investigate the landscape of mHealth apps and wearables designed for cardiovascular health globally, with special focus on tools available in the DACH region (Germany, Austria, and Switzerland). The objective was to uncover key gaps and untapped opportunities by assessing the value these digital health tools bring to both patients and clinicians. Additionally, the review analyzed how effectively these technologies integrate into the wider healthcare ecosystem, aiming to highlight areas for improvement and future innovation.

Methodology

Search strategy

The search for heart health apps involved a thorough screening of Switzerland's two largest app platforms: Apple's App Store and Google's Play Store. The Apple Store search was conducted using an iPhone, while Google Play Store apps were identified through its web-based platform. Additionally, a supplementary Google search was performed using a combination of English and German keywords to ensure a comprehensive discovery of heart health apps. Keywords were: "heart," "health," "heart health," "cardiac," "pulse monitor," "heart rate," "heart monitor," "best heart apps," "fitness app," "Herz-Apps," "Herzmonitor," and "Herzfrequenz." The search process spanned from April 8 to June 20, 2024, during which time each app was downloaded, thoroughly reviewed, and evaluated.

In contrast to the app search, the screening for wearables took place via Google search aimed at identifying the most relevant heart health wearables available both in the DACH region and globally. The keywords "heart wearables," "heart device tracking," "health wearables," "healthcare wearable devices," "smart wearables," "fitness wearables," "heart health tracking," "medical trackers," "DACH herzmonitor," and "Herzmonitor" were used. The search for wearables occurred between April 8 and July 11, 2024, during which time each vendor's website and accompanying app if available were thoroughly reviewed, and evaluated.

Inclusion and exclusion criteria

The selected apps were required to meet one of two criteria: they either had to measure or log health and well-being, typically categorized as health and fitness apps, or they needed to measure specific metrics such as heart rate and heart rate variability to provide users with a "diagnosis" or result. Apps that did not meet at least one of these criteria were excluded. Consequently, only 20 out of 24 identified apps were included in the analysis. The four excluded apps, Adidas Running, CordiFio, MyCareLink, and Biospectal, were removed for the following reasons: Adidas Running did not measure or track heart rate without requiring exercise and an additional wearable; the remaining three apps were unavailable on both the Apple App Store and Google Play Store, preventing an evaluation of their features and functions.

Similarly, the selection of wearables was based on two criteria: they had to focus on health and wellness features and possess the capability to measure health vitals such as heart rate, heart rate variability, or ECG. Only wearables meeting both criteria were included. One wearable, Leitwert, was excluded due to insufficient information available to assess its functionality and features, despite being intended for patient use.

An app or wearable was deemed DACH-specific based on two key criteria. First, it had to be explicitly designed for the German-speaking region and the DACH countries. While simply providing an app or wearable in German did not automatically qualify it as DACH-specific, those developed by creators from Germany, Austria, or Switzerland, with a focus on their respective healthcare systems, were deemed as such. Second, the app or wearable was considered DACH-specific if the company behind it was based in one of the DACH countries.

Analysis of selected apps and wearables

Each app that met the criteria was downloaded, thoroughly analyzed, and evaluated. Additionally, each website associated with the identified wearables, as well as the accompanying apps where available, were reviewed and downloaded. The features detailed on the wearable companies' websites were then used to assess their core functionalities and offerings. The first author (GC) devoted 2-3 hours to rigorously testing and evaluating each included app and wearable. The assessments were then reviewed by the last author (CJ), and any discrepancies or disagreements were collaboratively discussed and resolved between them.

The analysis was guided by the sociotechnical framework for evaluating patient-facing eHealth tools, which highlights the significance of context in assessing healthcare technologies [13]. This framework considers critical factors affecting the adoption of mHealth solutions by both patients and clinicians and evaluates how these technologies fit within the broader healthcare ecosystem [13–17]. To determine the value for patients, the evaluation focused on the technical features, safety, and functionality of each app and wearable from the patient’s perspective. For clinicians, the analysis extended to include a review of potential impact on clinical workflow, clinical utility, and a cost-benefit analysis to substantiate efficacy claims. Additionally, the evaluation criteria encompassed data protection, safety and regulatory compliance, interoperability and data sharing, revenue models, and certifications, to assess each tool's integration within the healthcare ecosystem.

Results

Mobile apps analysis

Ultimately, 20 apps were selected according to the inclusion criteria. The analysis reveals several key insights into the characteristics and functionalities of the examined apps. Firstly, only 30% of the apps are tailored specifically for the DACH region, with just one, Preventicus Heartbeats GmbH, providing comprehensive heart health monitoring by measuring vital metrics, including heart rate, and integrating clinical research. This app stands out for its CE certification and its focus on delivering valuable insights into heart health, particularly for women, which is not commonly addressed by other apps.

The review highlights that apps can serve either as heart rate measurement tools using PPG technology or as logbooks or tracking systems. Twelve out of twenty apps utilize the phone’s PPG capabilities, offering a convenient way to measure heart rate without additional devices. Conversely, apps like Heart Analyzer and Cardiogram, which do not use PPG, rely on external devices for data collection. Moreover, some apps with PPG functionality, such as CardiMate, require users to watch advertisements before taking a measurement, compromising their usability.

Regarding gender considerations, only 25% of the apps address women’s specific health needs. Preventicus Heartbeats GmbH is notable for explicitly including women in its analysis, particularly menopausal women, and assessing the impact of hormonal changes on heart health. Other apps like Welltory and InPulse Heartrate Monitor Azumio include gender considerations but do not provide as detailed an analysis.

In terms of integration with healthcare providers, 60% of the apps allow users to share heart health reports with clinicians, which enhances their practical value in clinical settings. However, only 20% offer platforms for clinicians to manage patient data or provide telehealth services, and just 10% positively impact clinician workflows by facilitating appointment bookings, prescription management, and patient dossiers.

Most apps (60%) are interoperable with devices like Bluetooth-enabled blood pressure monitors or wearables. However, the ability to export and share data from the app itself is available in 75% of the apps. The predominant revenue model is a free download with in-app purchases, utilized by 70% of the apps. Unique in the market, ProHerz offers insurance coverage in Germany with a doctor's prescription.

Privacy seems to be well-addressed, with 95% of apps including a privacy policy and 75% ensuring GDPR compliance. Only 20% lack explicit GDPR mention but still provide privacy policies. Lastly, only 20% of the apps are medically certified, with three, Preventicus Heartbeats GmbH, CardioSignal, and FibriCheck, being clinically tested and capable of detecting atrial fibrillation.

Table 1 provides a consolidated overview of the characteristics of the analyzed apps. Figures 1 and 2 offer a detailed overview of the analysis conducted on each included app, categorized into two distinct groups: "Heart Health Apps" and "Certified Apps." The Heart Health Apps are distinguished by a red color coding, indicating that these apps either utilize PPG technology to measure heart rate directly through the smartphone or support data logging from other devices such as Bluetooth sensors or blood pressure monitors. These apps mostly function as trackers or logbooks for recording heart health metrics. Conversely, certified Apps are highlighted in green, signifying that these apps possess formal certifications and provide accurate measurements and evidence-based information. This includes various certifications such as CE mark or FDA approval.

Table 1: Aggregated analysis of the included apps

App Characteristics (N=20)	Value, n (%)
DACH specific	6 (30%)
Value for Patients	
Measure heart rate	12 (60%)
Medical diagnosis	3 (15%)
Training and support	12 (60%)
Women-specific measures	5 (25%)
Value for Clinician	
Receives heart report	12 (60%)
Clinician integration	4 (20%)
Positive impact on workflow	2 (10%)
Training and support	3 (15%)
Fit into the Ecosystem	
Interoperable	12 (60%)
Data Sharing	15 (75%)
Revenue-model Type	
Free download and no in-app purchase	5 (25%)
Free download and with in-app purchase	14 (70%)

Insurance covered	1 (5%)
Evidence-based	
Research highlighted	8 (40%)
General knowledge, no references	8 (35%)
No research or scientific evidence	5 (25%)
Privacy Policy	
GDPR or FADP-compliant	15 (75%)
Privacy policy but not GDPR compliant	4 (20%)
No privacy policy	1(5%)
Certification	
Certified as a medical app	4 (20%)
Not Certified	16 (80%)

Figure 1: Analysis of each of the included apps – part I

For the figures, please refer to the end of the manuscript.

Figure 2: Analysis of each of the included apps – part II

For the figures, please refer to the end of the manuscript.

Wearables analysis

The analysis of wearables reveals that only 9% are specific to the DACH region, with Aktiia and SmartCardia representing Swiss companies focused on cardiovascular health. Aktiia emphasizes blood pressure measurement, while SmartCardia specializes in detecting atrial fibrillation (AFib).

Among the wearables, all measure heart rate, but only 55% provide a reliable diagnosis through medically certified devices. PPG technology is used by 9 wearables, whereas 13 employ ECG for detecting heart irregularities. Most wearables (81.8%) offer comprehensive user instructions. However, only 40.9% explicitly include features for women, such as menstrual cycle tracking or gender-specific heart rate analysis.

The Oura Ring and Whoop are particularly notable for their benefits to women. The Oura Ring tracks menstrual cycles and body temperature fluctuations, providing insights into heart health changes throughout the cycle. Whoop offers personalized pregnancy insights and tracks various health metrics through a daily journal.

From a clinical standpoint, wearables can be categorized into three distinct groups: Fitness-First, Certified, and Medically Certified. Fitness-First wearables are primarily designed for general health and fitness purposes, emphasizing exercise and recovery rather than detailed heart health metrics. In contrast, Certified and Medically Certified wearables provide more comprehensive heart health reports, offering valuable data for clinical evaluation. However, a notable gap exists in the cost-benefit analysis provided by these wearables. Most lack robust evidence supporting their efficiency claims, with Philips Mobile Cardia being a notable exception. Philips Mobile Cardia stands out by presenting research that highlights its cost-effectiveness compared to alternative monitoring methods.

Integration with clinical workflows varies: while Fitness-First wearables do not support clinician integration, some Certified wearables offer APIs for data sharing, and Medically Certified wearables often have platforms for real-time remote monitoring. All wearables support data sharing with smartphones and allow export of data, though Medically Certified devices often provide automatic synchronization.

Revenue models vary, with 50% of wearables requiring a one-time purchase and 31.8% using a subscription model. Over 75% are backed by research or clinical trials, while a small fraction provides minimal or no scientific evidence. Privacy policies are universally provided, with most wearables ensuring GDPR or FADP compliance. About two-thirds of the wearables have certifications, with 31.8% being CE or ISO-certified and 54.5% holding medical certifications such as CE marks or FDA approvals. The distinction between certified and medically certified wearables often lies in the explicit proof of certification and medical approval.

Table 2 provides a consolidated overview of the characteristics of the analyzed wearables. Figures 3 and 4 offer a detailed overview of the analysis conducted on each included wearable, categorized into three distinct groups: “Fitness-First Wearables,” “Certified Wearables,” and “Medically Certified Wearables.” Fitness-First Wearables are represented in blue, indicating their primary focus on general fitness and training. Wearables with a quality certification, marked in orange, offer detailed health measurements, including heart rate, blood oxygen levels, stress, and recovery, while also meeting quality certification standards such as FCC, DoC, or ISO. Wearables certified as a medical device are distinguished in purple, denoting their status as medical devices with regulatory clearance such as FDA clearance, or CE mark, ensuring their use in clinical settings and providing a higher level of diagnostic accuracy.

Table 2: Aggregated analysis of the included wearables

Wearables Characteristics (N=22)	Value, n (%)
DACH specific	2 (9.09%)
Value for Patients	
Measure heart rate	22 (100%)
Medical diagnosis	12 (54.54%)
Training and support	18 (81.81%)
Women-specific measures	9 (40.90%)
Value for Clinician	
Receives heart report	18 (81.81%)
Clinician integration	13 (59.09%)
Positive impact on workflow	2 (9.09%)
Training and support	9 (40.90%)
Fit into the Ecosystem	
Interoperable	22 (100%)
Data Sharing	22 (100%)
Revenue-model Type	
One-off purchase of the wearable	11 (50%)
Subscription-based app with wearable	7 (31.81%)
Not stated	4 (18.18%)

Evidence-based	
Research highlighted	17 (77.27%)
General knowledge, no references	4 (18.18%)
No research or scientific evidence	1 (4.54%)
Privacy Policy	
GDPR or FADP-compliant	17 (77.27%)
Privacy policy but not GDPR compliant	5 (22.72%)
No privacy policy	0
Certification	
Holds a quality certificate	7 (31.81%)
Certified as a medical device	12 (54.54%)
Not Certified	3 (13.63%)

Figure 3: Analysis of each of the included wearables – part I

For the figures, please refer to the end of the manuscript.

Figure 4: Analysis of each of the included wearables – part II

For the figures, please refer to the end of the manuscript.

Discussion

The need for evidence-based mHealth solutions

The analysis highlights a significant presence of mHealth apps for managing heart health available in the DACH region. However, only 6 out of 20 apps are specifically tailored for this region, and just 2 are medically certified. This underscores a notable gap in clinical research and evidence supporting these apps. Only 40% of the apps incorporate scientific research to validate their claims, while 8 apps provide general heart health information without specific research backing. Alarmingly, 25% of the apps lack any scientific or general health data.

The absence of clinical trials and scientific validation can undermine both user trust and clinician endorsement. The credibility of mHealth apps relies heavily on accessible, cited scientific research [18]. Without such evidence, users may question the app's reliability, and clinicians may hesitate to recommend these tools, impacting their adoption in healthcare [18].

Clinicians’ reluctance to suggest mHealth apps is partly due to concerns over inadequate evidence and research. A survey found that 62% of physiotherapists would not recommend apps lacking sufficient evidence and quality due to potential risks to patient health [19]. Similarly, 81.1% of general practitioners believe that mHealth apps should undergo clinical testing and receive certification from independent experts to ensure their effectiveness and reliability [20].

Importance of a clear privacy policy

Previous studies demonstrated the crucial role of privacy policies and data protection in building user trust [18]. Their research indicates that apps with privacy policies adhering to GDPR and employing high-security measures are viewed as more trustworthy [18]. According to the analysis, 75% of the

reviewed apps explicitly state their GDPR compliance, while 20% do not mention it at all, and one app, the Hearty app, lacks a privacy policy altogether.

GDPR regulations require that privacy policies be prominently displayed on an app's landing page and remain accessible throughout use [21]. However, some heart health apps analyzed in this review fall short of these transparency standards, making it harder for users to access their privacy policies. Non-compliance with GDPR can erode user trust, as mHealth apps often handle sensitive personal data shared with clinicians, family members, or third parties [18]. Such non-compliance poses risks like data breaches and unauthorized access to personal information, which can adversely affect user perceptions [22]. Apps with unclear or insecure privacy policies may face adoption barriers [23].

Usability and reliability

mHealth heart apps that utilize PPG technology enable users to measure their heart rate directly using their smartphones. However, our review indicates that eight of the analyzed apps do not offer this functionality directly and instead require users to pair the app with an additional device, such as a wearable or a blood pressure monitor, to log and track their heart health. This additional requirement can be cumbersome and may discourage users from engaging with the app, as highlighted by research showing that manual tracking methods often reduce user readiness for self-monitoring [24].

User preferences for measurement methods vary. Most apps in our analysis use the index finger for AFib measurements, others require users to lie down and place the phone on their sternum, which may not be practical in all situations, particularly if a rapid heart rate change occurs. Wearables offer a distinct advantage by allowing heart vitals to be measured directly and automatically synced with a mobile app. Studies reveal that users prefer devices like Fitbit trackers for their seamless integration and automatic data synchronization [24]. This automatic syncing not only benefits users but also provides clinicians with valuable insights into the patient’s activities, such as exercise intensity and duration, which are essential for accurate monitoring and assessment [24].

Accuracy is equally critical for the adoption and effectiveness of mHealth apps and wearables [25]. Users are generally cautious about the accuracy of non-medical devices, with some expecting medical-grade results while others remain skeptical if they encounter data inconsistencies; the perceived reliability of measurements significantly impacts user acceptance and trust in these technologies [25].

Clinical integration

Our analysis highlights that while certified apps and wearables offer valuable platforms for integrating with healthcare providers, several barriers hinder their effectiveness. Successful integration with clinicians’ workflow is essential for fostering two-way communication and enabling efficient remote monitoring. However, challenges such as lack of compensation, increased workload, and insufficient digital literacy are significant obstacles [16,17]. Clinicians often find that while such tools can reduce unnecessary hospital visits, they also require additional time and resources to manage patient communications and symptom analysis [24].

Most of the tools reviewed provide dashboards for remote patient monitoring and data reporting. Yet, many fail to enhance clinicians' workflows significantly, as they often lack features such as appointment scheduling and e-prescription capabilities. This disconnect complicates processes for both patients and healthcare providers. Many clinicians are cautious about these tools due to their poor interoperability with existing healthcare systems and electronic health records, which limits their impact on workflow efficiency [16,17]. Furthermore, research indicates that patients are more likely to trust tools that are recommended by a physician [15,26]; this underscores the necessity of involving clinicians in the app's use to build trust and enhance its effectiveness.

Reimbursement pathways and cost efficiency

The analysis highlights a significant gap in demonstrating cost reimbursement and efficiency for eHealth tools. Despite evidence suggesting that mHealth wearables can reduce stroke frequency and lower costs per stroke for high-risk patients, the lack of a clear reimbursement model remains a major barrier [27]. Previous research indicates that while initial costs for using wearables to detect atrial fibrillation (AFib) may be higher, they ultimately lead to reduced stroke incidence and lower overall costs due to effective anticoagulation therapy [27].

Healthcare providers face challenges integrating eHealth tools primarily due to reimbursement issues and outdated fee-for-service models [28]. Traditional models, where patients are billed per visit, do not support the integration of remote monitoring tools, leading clinics to prefer face-to-face consultations; this lack of reimbursement and incentive for remote care impedes the adoption of such technologies [29].

A shift towards value-based healthcare, which is currently rare and challenging to implement in digital health settings, could address these issues [30]. Some regions, like Germany and Switzerland, offer telemonitoring compensation for specific devices like pacemakers, but this is limited and does not encompass the full potential of wearable technology for cardiovascular disease management [31]. Capitation models, which provide a set amount of funding to cover a patient's care over a period, were suggested as a potential alternative to fee-for-service [29]. Capitation systems could reduce costs, enhance chronic care management, and promote the use of telemedicine; and while not a perfect solution, capitation represents a step towards more value-based, patient-centric care [29,32]. This model could incentivize the effective use of digital health tools and improve patient outcomes by focusing on both remote and face-to-face care options [29,33].

Limitations

This study encountered several limitations. The rapid evolution of technology means that the mobile apps and wearables reviewed may have undergone updates since our analysis, which could have changed their functionalities. Additionally, some apps or wearables were inaccessible to us due to stringent verification requirements or limited access to the physical wearable device; as a result, certain features and functionalities that were not explicitly detailed on the manufacturers' websites or complementary apps could not be thoroughly assessed or included in the evaluation.

Although we reviewed the apps and wearables' claims regarding data security, we could not independently verify their actual data handling practices. Furthermore, despite our efforts to use

comprehensive search terms, there remains a possibility that we missed relevant apps that could have been included in the review.

Conclusion

This review shows that mHealth apps and wearables hold considerable promise for improving the interaction between patients and clinicians in the management of cardiovascular diseases. The review identifies several strengths in these technologies, including accurate measurements, robust privacy policies, and useful clinical features. However, significant gaps remain, particularly in addressing women's cardiovascular health. A notable percentage of apps and wearables do not adequately meet the specific needs of women, who experience cardiovascular diseases differently than men. This underrepresentation in clinical research results in a lack of tailored diagnostic and treatment options, leading to less effective care.

The findings emphasize the need for health apps and wearables that are more inclusive of women's unique cardiovascular needs throughout different life stages, such as pregnancy and menopause. Additionally, there is a critical need for better integration of these technologies into clinical practices to support value-based healthcare. Further research and case studies are required to demonstrate the financial and clinical benefits of these technologies. Moreover, the results indicate that current mHealth tools do not sufficiently improve clinician workflows, limiting their ability to provide seamless and efficient care. These gaps present a vital opportunity for innovation in mHealth, fostering stronger connections between patients and clinicians while ultimately improving heart health outcomes for all.

Acknowledgements

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Figure 1: Analysis of each of the included apps – part I

		Heart Health Apps									
		Cardi Mate: HR Montor	**Cardiio**	**Heart Rate Monitor - Pulse BPM**	**Heartify**	**HeartRate + Coherence**	**InPulse Heart Rate Monitor Azumio**	**Instant Heart Rate Monitor**	**Welltory**	**Hearty**	**Cardiogram**
Patient Value	DACH specific										
	PPG technology in phone	●	●	●	●	●	●	●	●	●	
	Measures heart rate	●	●	●	●	●	●	●	●	●	
	Women's symptoms or gender-specific heart analysis						●		●		●
	Clinical Evidence		●		●				●		
Clinician Value	Heart report	●	●		●			●	●		●
	Integration with clinic										
	Clinical report to patient										
	Medical prescriptions										
Ecosystem Integration	Interoperable			●	●	●	●	●	●	●	●
	Data sharing (PDF, CSV by email or social media)	●	●	●	●			●	●	●	●
	Privacy Policy & compliance GDPR	●*	●*	●	●	●	●	●	●		●*
Ratings & Certification	Google Play	3.6 ★★★½☆ 18.1K reviews	N/A	N/A	N/A	2.9 ★★½☆☆ 439 reviews	N/A	3.4 ★★★½☆ 308K reviews	4.4 ★★★★½ 40.6K reviews	N/A	3.6 ★★★½☆ 9.4K reviews
	Apple App Store	4.4 ★★★★☆ 255	4.5 ★★★★½ 4.4K	4.5 ★★★★½ 411	4.6 ★★★★½ 1.2K	4.2 ★★★★☆ 32	4.5 ★★★★½ 2.9K	4.7 ★★★★★ 3.7K	4.5 ★★★★½ 646	4.4 ★★★★☆ 139	4.3 ★★★★☆ 79
	Certification	-	-	-	-	-	-	-	-		

Legend:
*Does not explicitly mention that GDPR is applied to the privacy policy
N/A = No Data Available
Ratings till 12.06.2024

Figure 2: Analysis of each of the included apps – part II

		Heart Health Apps						Certified as a Medical App			
		Herzinsuffizienz	Tala-Med Cardio	HerzFit	Heart Analyzer	Qaly ECG Reader	Well. Dein Gesundheit Digital.	CardioSignal	Preventicus Heartbeats GmBh	ProHerz	FibriCheck
Patient Value	DACH specific	●	●	●			●		●	●	
	PPG technology in phone							●	●		●
	Measures heart rate							●	●		●
	Women's symptoms or gender-specific heart analysis								●		●
	Clinical Evidence			●				●	●	●	●
Clinician Value	Heart Report	●			●	●			●	●	●
	Integration with clinic						●		●	●	●
	Clinical report to patient					●			●	●	●
	Medical prescriptions			●			●				
Ecosystem Integration	Interoperable				●	●				●	●
	Data sharing (PDF's or family sharing)	●			●	●	●		●	●	●
	Privacy Policy & compliance GDPR	●	●	●	●*	●	●**	●	●	●	●
Ratings & Certification	Google Play	3.1 ★★★½☆ 9 reviews	N/A	N/A	N/A	N/A	3.7 ★★★½☆ 196 reviews	N/A	N/A	N/A	3.2 ★★★½☆ 6.89K reviews
	Apple App Store	4 ★★★★☆ 9	5 ★★★★★ 1	N/A	4.5 ★★★★½ 241	5 ★★★★★ 5	4.1 ★★★★☆ 248	4.8 ★★★★★ 5	3.9 ★★★★☆ 25	N/A	4.3 ★★★★☆ 95
	Certification	-	-	-	-	-	-	FDA, CE	MD CE	Medicinal product Risk class 1, according to MDD, DiGa	FDA, ISO

Legend:
*Does not explicitly mention that GDPR is applied to the privacy policy
**Complies with FADP (Swiss Federal Act on Data Protection)
MDD = Medical Device Directive
N/A = No Data Available
Ratings till 12.06.2024

Figure 3: Analysis of each of the included wearables – part I

		Fitness-First Wearables			Holds a Quality Certificate						
		Amazfit GTR 4	Amazfit Helio Ring	GloryFit	Hexoskin Smart Shirt	Oura Ring	Fourth Frontier	Polar	Samsung Galaxy S6	Garmin Venu 3	Whoop
Patient Value	DACH specific										
	Measurement type	PPG	PPG	N/A	ECG	PPG	ECG	ECG	ECG	PPG	PPG
	Measures Heart Rate	●	●	●	●	●	●	●	●	●	●
	Women's symptoms &/or cycles tracking or gender-specific heart analysis	●	●			●			●	●	●
	Clinical Evidence/trials				●	●		●		●	●
Clinician Value	Heart Report	●	●		●	●	●	●	●	●	●
	Cost-benefit Analysis										
	Integrated Platform							●		●	
Ecosystem Integration	Interoperable	●	●	●	●	●	●	●	●	●	●
	Data sharing (PDF's, email or social media)	●	●	●	●	●	●	●	●	●	●
	Privacy Policy & compliance GDPR	●*	●*	●	●	●*	●	●	●**	●	●
Ratings & Certification	Trustpilot	2.3 Reviews 7 • Poor	2.3 Reviews 7 • Poor	N/A	N/A	1.8 Reviews 1,115 • Poor	4.5 Reviews 255 • Excellent	1.6 Reviews 386 • Bad	N/A	1.7*** Reviews 2,673 • Bad	3.1 Reviews 1,093 • Average
	Certification	-	-	-	FCC	DoC	ISO, DoC	DoC, ISO	FCC	ISO	DoC

Legend:
* Does not explicitly mention that GDPR is applied to the privacy policy
**Policy available and compliance with DPF (Data Privacy Framework -EU, UK, & CH)
***Garmin rating of the Netherlands store and all watches
N/A: data not available
Ratings on 11.07.2024

Figure 4: Analysis of each of the included wearables – part II

		Certified as a Medical Device											
		Fitbit Sense	**CardiacSense**	**Empatica Plus**	**SmartCardia**	**Nuubo ECG**	**Wellysis S-Patch**	**Withings ScanWatch 2**	**Philips Mobile Cardiac Telemetry- MCOT**	**Qardio Heart (QardioArm)**	**Biostrap**	**Apple Watch**	**Aktiia**
Patient Value	DACH specific				●								●
	Measurement Type	ECG	ECG	PPG	ECG	ECG	ECG	ECG	ECG	ECG	PPG	PPG & ECG	PPG
	Measures Heart Rate	●	●	●	●	●	●	●	●	●	●	●	●
	Women's symptoms or gender-specific heart analysis	●						●				●	
	Clinical Evidence/trials	●	●	●	●	●	●	●	●	●	●	●	●
Clinician Value	Heart Report	●	●	●		●	●	●	●	●	●	●	●
	Cost-benefit Analysis								●				
	Integrated Platform		●	●	●	●	●		●	●	●	●**	●
Ecosystem Integration	Interoperable	●	●	●	●	●	●	●	●	●	●	●	●
	Data sharing (PDF's, email or social media)	●	●	●	●	●	●	●	●	●	●	●	●
	Privacy Policy & compliance GDPR	●	●	●	●	●	●*	●	●	●	●	●	●
Ratings & Certification	Trustpilot	1.3 Reviews 6,433 • Bad	N/A	2 Reviews 27 • Poor	N/A	N/A	N/A	3.5*** Reviews 2,748 • Average	N/A	1.4 Reviews 1,138 • Bad	2.4 Reviews 7 • Poor	N/A	2.9 Reviews 2,131 • Average
	Certification	CE, FDA clearance	FDA clearance, CE, ISO	FDA clearance, CE	FDA clearance, CE	ISO, CE, FDA	FDA 510K, CE, ISO	CE, ISO, FDA	HCCA, FDA 510K	CE, FDA	FDA 510K	FDA 510K, CE	Medical Device CE Mark Class IIa

Legend:
* Does not explicitly mention that GDPR is applied to the privacy policy
**Only available in Canada, the UK, and the US
*** Rating for scales and watches
N/A: data not available
Ratings on the 12.06.2024

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