

# Understanding Digital Health Literacy and Attitudes Towards eHealth Technologies Among Cardiovascular Patients: Implications for Secondary Prevention

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# Understanding Digital Health Literacy and Attitudes Towards eHealth Technologies Among Cardiovascular Patients: Implications for Secondary Prevention

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## Abstract

**Background:** Cardiovascular disease is the major cause of death worldwide, leading to a significant socioeconomic burden. Although secondary prevention is a cornerstone in chronic disease management, adherence to guideline recommendations in this regard often falters, leading to suboptimal outcomes. While eHealth technologies are promising for improving treatment adherence, they also represent a new approach to secondary prevention. However, a common critique is that extensive digitalization may not adequately address the needs of older adults with chronic medical conditions.

**Objective:** This study aims to analyze eHealth literacy, digital usage patterns and general attitude towards digital technologies in a collective of cardiovascular patients to identify potential obstacles in implementing mHealth technologies in secondary preventive therapy.

**Methods:** This survey-based study was a part of the baseline examination of the PreventiPlaque trial. It involved 240 participants with known coronary artery disease. The assessment evaluated their current understanding of the general use of digital devices. The questionnaire covered aspects such as the duration of daily usage, personal attitudes, and the perceived burden associated with digital media. eHealth literacy was assessed within the target population and general demographic data were gathered, focusing on cardiovascular comorbidities and risk factors.

**Results:** The analysis revealed an average age of 61.9 years (SD 8.9 years), with 59.9% of the participants being male. Overall, 37.3% of the participants had previous knowledge of digital health interventions, while only 17.8% had utilized them. Despite the generally low practical application within our study population, there was a high level of confidence in handling digital devices, with 61.9% expressing themselves as either rather confident or very confident. Regarding the levels of eHealth literacy in the study collective, 71.2% claimed to be familiar with locating health information on the Internet, and 64% felt capable of critically evaluating its quality. These levels of digital confidence were consistent across all analyzed age groups. Moreover, Internet usage rates remained high even within the elderly collective, with 80% of those over 75 years old using the Internet for one to three hours a day.

**Conclusions:** The study unveiled a notable confidence level among participants regarding the use of digital devices, coupled with a favorable attitude towards digital media evident across all age brackets. Remarkably, Internet usage rates remained high, even among elderly participants. The actual utilization of digital health interventions was relatively low, potentially stemming from challenges in locating reliable sources. These findings emphasize the prospect for future eHealth interventions customized to the distinct needs and preferences of patients in cardiovascular disease management. Recognizing the incongruity between

confidence in device use and the restricted adoption of digital health tools can guide the development of focused interventions to narrow this divide. Clinical Trial: ClinicalTrials.gov NCT05096637

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## Original Manuscript

# Understanding Digital Health Literacy and Attitudes Towards eHealth Technologies Among Cardiovascular Patients: Implications for Secondary Prevention

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### Background

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### Objective

This study aims to analyze eHealth literacy, digital usage patterns and general attitude towards digital technologies in a collective of cardiovascular patients to identify potential obstacles in implementing mHealth technologies in secondary preventive therapy.

### Methods

This survey-based study was a part of the baseline examination of the *PreventiPlaque* trial. It involved 240 participants with known coronary artery disease. The assessment evaluated their current understanding of the general use of digital devices. The questionnaire covered aspects such as the duration of daily usage, personal attitudes, and the perceived burden associated with digital media. eHealth literacy was assessed within the target population and general demographic data were gathered, focusing on cardiovascular comorbidities and risk factors.

### Results

The analysis revealed an average age of 61.9 years (SD 8.9 years), with 59.9% of the participants being male. Overall, 37.3% of the participants had previous knowledge of digital health interventions, while only 17.8% had utilized them. Despite the generally low practical application within our study population, there was a high level of confidence in handling digital devices, with 61.9% expressing themselves as either rather confident or very confident. Regarding the levels of eHealth literacy in the study collective, 71.2% claimed to be familiar with locating health information on the Internet, and 64% felt capable of critically evaluating its quality. These levels of digital confidence were consistent across all analyzed age groups. Moreover, Internet usage rates remained high even within the elderly collective, with 80% of those over 75 years old using the Internet for one to three hours a day.

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The study unveiled a notable confidence level among participants regarding the use of digital devices, coupled with a favorable attitude towards digital media evident across all age brackets. Remarkably, Internet usage rates remained high, even among elderly participants. The actual utilization of digital health interventions was relatively low, potentially stemming from challenges in locating reliable sources. These findings emphasize the prospect for future eHealth interventions customized to the distinct needs and preferences of patients in cardiovascular disease management. Recognizing the incongruity between confidence in device use and the restricted adoption of digital health tools can guide the development of focused interventions to narrow this divide.

**Keywords** cardiovascular diseases; telemedicine; eHealth; patient-centered approach, eHealth literacy

**Trial Registration** ClinicalTrials.gov NCT05096637

# Introduction

## Background

Cardiovascular disease remains the leading cause of global mortality, with coronary artery disease and ischemic heart disease alone contributing to 16% of total annual deaths worldwide [1]. Over the past two decades, ischemic heart disease has demonstrated the most rapid growth in overall death rates globally, resulting in nearly nine million annual deaths [1]. Cardiovascular disease is intricately linked to various comorbidities and a severe mental health burden [2]. While advancements in the understanding and treatment of cardiovascular disease persist, there is an increasing emphasis on secondary prevention. Following guideline recommendations, secondary prevention aims to address modifiable risk factors such as hyperlipidemia, nicotine consumption, arterial hypertension, diabetes mellitus, obesity, chronic stress, and lack of physical activity [3]. Despite the preventive potential of lifestyle modifications supported by guidelines, their implementation remains inadequate. Primary obstacles include the challenge of ensuring adherence to long-term behavioral changes and the scarcity of medical resources and time needed for comprehensive patient education in chronic disease management [4, 5]. Digital health interventions emerge as a promising avenue to educate and empower patients, encouraging an active role in disease management while optimizing the control and monitoring of modifiable risk factors [6]. They offer a potential solution to the current deficiencies in medical infrastructure, addressing the escalating demand associated with the increasing prevalence of cardiovascular disease [7]. However, a frequently cited challenge in the expanding digitization of healthcare is the consideration of special needs among elderly patients concerning the development and structure of digital health interventions [8]. Given that cardiovascular disease predominantly affects older individuals, it is crucial to not disadvantage them to fully utilize the modern treatment options.

The objective of this study was to delve into the digital usage patterns of cardiovascular patients expressing an interest in digital health interventions. The aim was to assess and identify potential obstacles and challenges in the implementation of mHealth/eHealth technologies for secondary prevention of cardiovascular disease. The study sought to evaluate patients' existing knowledge and opinions regarding smartphones, the Internet, and digital health interventions while focusing on uncovering possible age dependent differences. The overarching goal was to gain insights that would inform the design of digital health interventions tailored to meet the specific needs and requirements of individuals managing cardiovascular conditions.

## Methods

### Study design and participants

We conducted a survey-based assessment at the University Hospital Essen, West German Heart and Vascular Center, Department of Cardiology and Vascular Medicine. The questionnaires used were part of the baseline examination of the *PreventiPlaque* trial. PreventiPlaque is a registered (NCT05096637) and randomized clinical trial testing the effects of a smartphone application that included atherosclerotic plaque visualization on adherence to secondary preventive therapy [9]. The recruitment of participants for the *PreventiPlaque* trial occurred in 2022. Patients with atherosclerotic cardiovascular disease were eligible for the participation in this trial. This included patients with documented ischemic heart disease, acute coronary syndrome and patients with proven peripheral artery disease [10]. Another requirement was adult age (18 years and older). Participants had to own a smartphone which was suitable for potential app-usage. Finally, patients had to give written informed consent to comply with the study protocol and had to be willing to participate in the study. Patients with insufficient knowledge of the German language, or unwillingness to use a



smartphone app were excluded from the study.

## Ethics

The conduct of the trial was approved by the ethics committee of the Medical Faculty of the University of Duisburg-Essen (20-9157-BO). Written informed consent was provided by each participant before conducting study inclusion. The study conductance of in accordance to the Declaration of Helsinki. Data was collected and analyzed using a pseudonymous form.

## Measurements

### *Sociodemographic and medical data*

Basic sociodemographic data were assessed, using a questionnaire with 15 items, including the patients' marital status, level of education and current profession. Moreover, patients were asked to self-assess their level of physical activity as well as the quality of their diet. Since the study participants were patients at the University Hospital Essen, electronic data regarding the patients' medical history was included in the analysis after informed consent. We assessed medical information regarding the presence of major cardiovascular risk factors such as diabetes mellitus, arterial hypertension, and hypercholesterolemia in our analysis as well as the prevalence of cardiovascular comorbidities including coronary artery disease, peripheral artery disease, stroke, aortic syndrome, or chronic heart failure.

### *eHealth literacy*

In order to assess the participants skills to find and critically evaluate health information on the Internet, the revised German eHealth Literacy Scale (GR-eHEALS) was used [11]. It is a validated tool to measure eHealth literacy in cardiovascular patients and the modified version contains eight items and two subscales[12]. Responses could be given on a five-point Likert scale (e.g., "I know how to use the Internet to find answers to my health-related questions", 1 = does not apply to me, 5 = does apply to me).

### *eHealth-related data*

The self-generated eHealth data questionnaire started with three items examining the participants general confidence in handling digital media, digital devices and online platforms on the Internet. They could respond on a five-point Likert scale (1= not confident at all, 5= very confident). Patients were asked to self-assess their daily Internet utilization period for private or work-related purposes. Moreover, Internet anxiety was measured by six items with possible responses on a five-point Likert scale (e.g. "I have concerns about using the Internet", 1= does not apply to me, 5= does apply to me). Finally, it was determined whether the participants were already experienced in using digital health interventions, had heard about them or knew where to find them. The self-generated eHealth items had already been used in previous studies [13-16] and have proven good reliability.

## Statistical analysis

We performed descriptive statistical analysis using SPSS (Version 23, IBM). Variables were presented as frequencies and percentages as well as means and standard deviations. Since it is often brought forward, that elderly patients may not be a suitable target group for digital health interventions, we analyzed Internet usage frequency and digital confidence in relation to the participants' age. To serve this purpose we divided the participants into four age groups. To reach comparable sample sizes, we divided the age groups into <55, 55-64, 65-75 and >75-year-olds. Using these age groups, we performed an age-adjusted analysis of the variables "Internet-usage" as well as "confidence in handling Internet platforms/digital media/mobile technologies". This included an age-adjusted means comparison, using the Kruskal-Wallis test. We also conducted bivariate correlations between the participants age and the four items "Internet-usage" and "confidence in handling Internet platforms/digital media/mobile technologies", using Spearman's Rho correlation

for ordinally scaled variables. Finally, we analyzed these items mentioned above, describing the participants' digital confidence adjusted to gender, comparing the two formed subgroups "male" and "female".

## Results

### Sample size and basic socioeconomic characteristics

In total, 240 patients completed the assessment. With a mean age of 61.9 years (SD 8.9 years) and 17.4% being older than 70 years the study showed an elderly collective. A total of 59.9% of all participants identified as male. With 60% in total, most participants were married and 51.5% were retired while 22.5% were working full-time.

### Comorbidities and cardiovascular risk factors

An analysis of the prevalence of major cardiovascular risk factors showed that hypercholesterolemia occurred within 79.6% of the study participants, arterial hypertension even in 80.4%. One fourth of the participants were active smokers (25%), 17% suffered from Type-2 diabetes. Moreover, 36.5% were overweight with a BMI of 25-30 kg/m<sup>2</sup> and another 34.9% were obese with an BMI of >30 kg/m<sup>2</sup> (Table 1). While all patients suffered from coronary artery disease, a total of 36.7% had also been diagnosed with peripheral artery disease. Moreover, 26.3% had known congestive heart failure and 5.8% had once suffered a stroke (Table 1.).

**Table 1.** Cardiovascular risk factors and comorbidities

Cardiovascular risk factors	Prevalence	Total
<i>Body mass index &gt;30</i>	84 (34.85%)	240
<i>Body mass index &gt; 25</i>	88 (36.5%)	240
<i>Type 2 diabetes</i>	41 (17%)	240
<i>Nicotine dependency</i>	60 (25%)	240
<i>Hypercholesterolemia</i>	191 (79.6%)	240
<i>Arterial hypertension</i>	193 (80,4%)	240
<i>Congestive heart failure</i>	63 (26.3%)	240
<i>Peripheral artery disease</i>	88 (36.7%)	240
<i>Stroke</i>	14 (5.8%)	240

### eHealth data

Analyzing the frequency and duration of Internet usage per day, only 5.9% of the study population did not use the Internet daily. With 53.4%, the majority stated an Internet usage of 1-3 hours per day on average (Table 2.). In general, levels of confidence when handling digital media, digital devices and Internet platforms were high in this study population (Table 3.). Regarding Internet-based programs to promote health or provide health information, only 33.4% knew how these programs worked and 47.5% knew where to find them (Table 4.). When asked about having doubts about using the Internet, a total of 75.7% of the study population stated that this did not apply at all or rather did not apply. Furthermore, almost 80% of the study population did not feel negatively affected by carrying a mobile phone with them (Table 5.).

**Table 2.** Daily internet usage

	How long are you using the internet for private purposes per day?	Total

<i>Not at all</i>	14 (5.9%)	236
<i>Less than 1 hour</i>	69 (29.2%)	236
<i>1-3 hours</i>	126 (53.4%)	236
<i>3-5 hours</i>	20 (8.5%)	236
<i>More than 5 hours</i>	7 (3%)	236

**Table 3.** Digital confidence in handling digital media

	<b>Very insecure</b>	<b>Rather insecure</b>	<b>Partly insecure</b>	<b>Rather confident</b>	<b>Very confident</b>	<b>Absolutely confident</b>	<b>Total</b>
<i>How confident are you when handling digital media?</i>	16 (6.8%)	17 (7.2%)	56 (23.7%)	92 (39%)	54 (22.9%)	1 (0.4%)	236
<i>How confident are you when handling internet platforms?</i>	20 (8.5%)	21 (8.9%)	61 (25.8%)	81 (34.3%)	53 (22.5%)	0 (0%)	236
<i>How confident are you when handling digital devices?</i>	20 (8.5%)	16 (6.8%)	54 (22.9%)	92 (39%)	54 (22.9%)	0 (0%)	236

**Table 4.** Knowledge regarding Internet-based programs to promote health.

	<b>I do not agree at all</b>	<b>I rather don't agree</b>	<b>Neither</b>	<b>I rather agree</b>	<b>I fully agree</b>	<b>Total</b>
<i>I can imagine what that might be</i>	27 (11.4%)	45 (19.1%)	35 (14.8%)	97 (41.1%)	32 (13.6%)	236
<i>I know, how those programs work</i>	36 (15.3%)	66 (28.0%)	53 (22.5%)	67 (28.4%)	14 (5.9%)	236
<i>I know where to find these programs</i>	35 (14.8%)	50 (21.2%)	39 (16.5%)	84 (35.6%)	28 (11.9%)	236

**Table 5.** Burden through using the internet.

	<b>Does not apply</b>	<b>Does rather not apply</b>	<b>Partly applies</b>	<b>Rather applies</b>	<b>Fully applies</b>	<b>Total</b>
<i>I do not feel</i>	127	55	28	20	5	235

<i>well when I am constantly carrying a mobile phone</i>	(54%)	(23.4%)	(11.9%)	(8.5%)	(2.1%)	
<i>I have doubts about using the Internet</i>	141 (60%)	37 (15.7%)	37 (15.7%)	11 (4.6%)	9 (3.8%)	235

### *eHealth literacy*

As presented in Table 6, the statistical analysis of the eHealth literacy questionnaire results showed, that more than half of the study population rather or fully agreed to know how to find Internet platforms with helpful information regarding their overall health. Moreover, a total of 71.2% stated to know how to use the Internet as a useful tool to get answers to their questions. When asked, whether the participants thought they were able to critically evaluate the credibility of health information on the Internet, a total of 64% stated that they were able to do so.

**Table 6.** eHealth literacy

	<b>I do not agree at all</b>	<b>I rather not agree</b>	<b>Neither</b>	<b>I rather agree</b>	<b>I fully agree</b>	<b>Total</b>
<i>I know how to find internet platforms with helpful health information</i>	17 (7.2%)	30 (12.7%)	39 (16.5%)	89 (37.7%)	61 (25.8%)	236
<i>I know how to use the internet to get answers to my questions</i>	16 (6.8%)	28 (11.9%)	24 (10.2%)	108 (45.8%)	60 (25.4%)	236
<i>I know which sources for health information are available</i>	18 (7.7%)	45 (19.1%)	45 (19.1%)	90 (38.3%)	37 (1.7%)	235
<i>I know where I can find helpful health information on the internet</i>	18 (7.6%)	32 (19.1%)	39 (16.5%)	103 (43.6%)	44 (18.6%)	236
<i>I know how to use health information from the</i>	24 (10.2%)	48 (20.4%)	50 (21.3%)	88 (37.4%)	25 (10.6%)	235

<i>internet to help me</i>						
<i>I can critically evaluate health information on the internet</i>	17 (7.2%)	23 (9.7%)	45 (19.1%)	101 (42.8%)	50 (21.2%)	236
<i>I can distinguish between questionable and trustworthy internet resources with health information</i>	19 (8.1%)	34 (14.4%)	41 (17.4%)	105 (44.5%)	37 (15.7%)	236
<i>I feel secure to use information from the internet to make decisions regarding my health</i>	27 (11.4%)	48 (20.3%)	48 (20.3%)	78 (33.1%)	35 (14.8%)	236

## Age-related differences in Internet usage and digital confidence

As Figure 1 shows, using the Internet for more than one hour a day, particularly for 1-3 hours per day was the most common answer when asked about the duration of daily Internet usage. This result can be seen throughout all age groups. Putting the focus on the youngest age group of participants younger than 55 years, it is obvious that a longer duration of daily Internet usage of 3-5 hours or more than 5 hours are more common here than in any of the older age groups. When analyzing the confidence in handling digital media, it becomes clear that with an older age, starting from the age group of 65–74-year-olds, the share of “partly confident”, “rather not confident” and “not confident” individuals slightly increases, while still more than 50% of the population remains “rather confident” or “very confident” (Figure 2). The share of at least “partly confident” participants is even higher in terms of confidence in handling digital devices such as smartphones and computers (Figure 4). This is again apparent throughout all age groups, even the oldest group, of more than 75-year-olds, contains less than 20% of participants who are “not confident at all” in handling digital devices (Figure 4). Finally, confidence in handling Internet platforms was generally lower than confidence in handling digital devices and the share of participants who were “very confident” as well as “rather confident” decreased with older age. In the oldest age group of over 75-year-olds, 42% were “very confident” or “rather confident” in using Internet platforms (Figure 3). Using the Kruskal Wallis test to compare Internet usage rates and digital confidence between the four age groups, no statistically significant difference could be found for any of the examined items with an asymptotic significance

of  $>.05$  in each of the age groups. Testing for correlations between the participants age and digital confidence as well as daily Internet usage, the Spearman's-Rho correlation shows the only statistically significant result regarding the confidence in using Internet platforms. A  $\rho$  ( $\rho$ ) of  $-.128$  ( $p = .048$ ) suggests that the confidence in using Internet platforms decreases with older age. Apart from that, no age-related statistically significant difference in the levels of confidence in using mobile technologies ( $\rho$  ( $\rho$ ) of  $-0.70$  ( $p = 0.280$ ) or digital media ( $\rho$  ( $\rho$ ) of  $-0.96$  ( $p = 0.137$ ) or daily Internet usage ( $\rho$  ( $\rho$ ) of  $0.36$  ( $p = 0.577$ ) could be shown.

## Gender specific differences in the level of digital confidence

As shown in Figure 5, we compared the differences in the levels of digital confidence in male and female participant. It is striking, that in all three categories, the levels of digital confidence seem to be at least slightly higher within the male subgroup. This difference becomes the most apparent when comparing the levels of confidence when using Internet platforms, with only about 10% of the male participants feeling “rather not” or “not confident”, while about 25% of the female participants on the other hand feel that way. Moreover, the share of participants who stated to be “very confident” in either of the three subcategories is relevantly higher in the male collective.

## Discussion

### Internet usage and digital knowledge

We conducted an analysis of current Internet usage rates among individuals affected by cardiovascular disease, examining their attitudes toward the Internet and mobile technology, with a specific focus on digital health interventions. Additionally, we assessed participants' confidence in using digital technology and their ability to find credible health information on the Internet.

Recent years have witnessed a notable increase in Internet and smartphone usage, particularly among the elderly population. From 2009 to 2019, the percentage of German citizens over 65 years using the Internet increased significantly, from approximately 30% to over 67% [17]. This trend was reflected in our trial, where less than 6% of the total patient collective reported not using the Internet for private purposes at all. Furthermore, a substantial portion of participants exhibited extended usage durations, with 64.9% spending one to more than five hours a day online. Despite seemingly high Internet usage rates, knowledge about digital health interventions and Internet-based health programs appeared to be limited. Only 34.3% of participants indicated to understand how these programs worked, and merely 47.5% knew where to find them. This knowledge gap might be attributed to the potential lack of accessibility of digital interventions and a scarcity of programs that align with the specific needs of this patient demographic [18, 19].

### Digital confidence

Confidence levels in using digital media, Internet platforms, and digital devices were notably high within this patient collective, with over 60% expressing confidence in these three domains. Participants demonstrated particular assurance in handling digital media and devices. This heightened digital confidence is a crucial factor when contemplating the implementation of digital health interventions in this specific group, as a lack of confidence in digital technology is often cited as a significant barrier to integrating eHealth technologies into patients' chronic disease management [20, 21]. Notably, these results deviate from prior research, which has frequently indicated that elderly patients, in particular, harbored doubts about eHealth technologies and felt insecure about using them [8]. Given the mean age of 61.9 years within the analyzed patient collective, the observed high levels of digital confidence may signify the rapidly increasing rates of smartphone ownership and Internet usage among the elderly population [17]. Supporting this hypothesis, even in age-adjusted analyses, participants displayed sustained high levels of digital confidence, with most

individuals feeling assured in handling digital media and devices. Only a minority expressed a lack of confidence in using these technologies. However, to ensure the inclusion of these individuals and provide them with an opportunity to benefit from digital health interventions, additional education on the matter will be imperative.

## **eHealth literacy**

To derive benefits from digital health solutions and effectively integrate them into daily life, possessing eHealth literacy is another crucial prerequisite [22]. eHealth literacy is defined as "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem" [23]. It also involves the capability to discern between more or less credible sources of information. A common barrier to the adoption of digital health interventions is often the identification of trustworthy sources, leading to concerns about the security and privacy of these interventions [18, 24]. In this trial, it was evident that most participants knew how to use the Internet to find valuable health information and answers to health-related queries. However, it is noteworthy that only 40% of the participants agreed that they knew about the various kinds of sources available for health information on the Internet, with only 1.7% fully agreeing. This lack of awareness could be a contributing factor to the low rates of prior engagement with digital health interventions in this collective. Previous studies have highlighted that the lack of knowledge about eHealth interventions remains a pertinent barrier, especially among elderly patients who may not be adequately informed about the diverse options available to receive health support [25]. The trial's results indicated moderate levels of eHealth literacy. More than half of the participants felt capable of critically evaluating health information on the Internet and distinguishing between questionable and trustworthy online resources. Nevertheless, only 47.9% of the participants felt secure or reasonably secure in incorporating information from the Internet into their health-related decision-making. Previous studies have indicated that even if health information is deemed credible, its implementation often falters due to the digital presentation, which is frequently described as "not user-friendly," "not meaningful," or generally challenging to comprehend [24]. One reason for this may be the sense of depersonalization of health information when presented digitally rather than in a face-to-face interaction, making it harder for individuals to connect with and apply relevant information [20].

## **Outlook – challenges and opportunities of digital health interventions**

To address patients' concerns regarding the security and reliability of health information on the Internet, Germany took a significant step toward the digitalization of the healthcare system in 2019 by introducing digital health applications (DiGA) into standard care and supporting their use with statutory health insurance funding [26]. The approval of an mHealth/eHealth technology as a DiGA is strictly regulated and quality assurance for both prescribing physicians and patients using the intervention has to be ensured on a high level [27]. As highlighted in this study, the challenge of finding credible sources for health information on the Internet remains a major concern. Having clear criteria to assess the quality and validity of health information that can be found on the Internet is crucial to use the full potential of today's digital technology [28]. Confidence in using Internet platforms was generally lower in this patient collective compared to confidence in using digital devices (Figure 3, Figure 4). Therefore, officially approved digital health interventions with proven healthcare benefits that can be prescribed by treating physicians present an opportunity to make them available to more patients and ensure a high quality and credibility of the provided health information. Although this approach appears promising, the level of acceptance by both patients and physicians still needs to be thoroughly evaluated [29].

## Limitations

It should be noted that the eHealth literacy score was self-assessed, and this study did not try to match the perceived eHealth literacy score to the actual abilities in using the Internet for finding health information and implementing it in daily life. It has been shown that self-assessed eHealth literacy scores and actual eHealth literacy can differ when put into practice [30, 31]. Moreover, since the study population was actively interested in participating in a trial revolving around mHealth technologies a possible sampling bias should be considered when transferring the results to the general population.

## Conclusions

This study revealed that individuals with atherosclerotic cardiovascular disease were generally well-acquainted with using the Internet and handling digital devices though all age groups. The Internet was an integral part of their daily lives, leading to a high level of confidence in digital technologies. However, the adoption of digital health interventions remained relatively low, possibly reflecting reservations about incorporating Internet-derived information into daily routines. This hesitancy might stem from uncertainties in identifying credible and trustworthy health sources on the Internet, as well as the perceived lack of personalization in digital health interventions.

Despite their older age, the results suggest that cardiovascular patients can be a suitable target group for digital health interventions, given their high Internet usage rates and digital confidence. The patient collective appears representative in terms of cardiovascular comorbidities and the prevalence of cardiovascular risk factors. To address persistent skepticism toward digital technologies, it becomes crucial to incorporate personalized health information and adopt a patient-centered approach. This approach is essential to enhance the acceptance and effectiveness of digital health interventions within this patient population.

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Alexander Bäuerle: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Amir Mahabadi: Analyzed and interpreted the data, Wrote the paper.

Christos Rammos: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Daniel Messiha: Performed the experiments; Wrote the paper.

Greta Ullrich: Conceived and designed the experiments; Performed the experiments, Wrote the paper.

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Julia Lortz: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Katrin Paldán: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Lisa Jahre: Analyzed and interpreted data; Wrote the paper.

Tienush Rassaf: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

## Conflicts of interest

The authors declare no competing interests.



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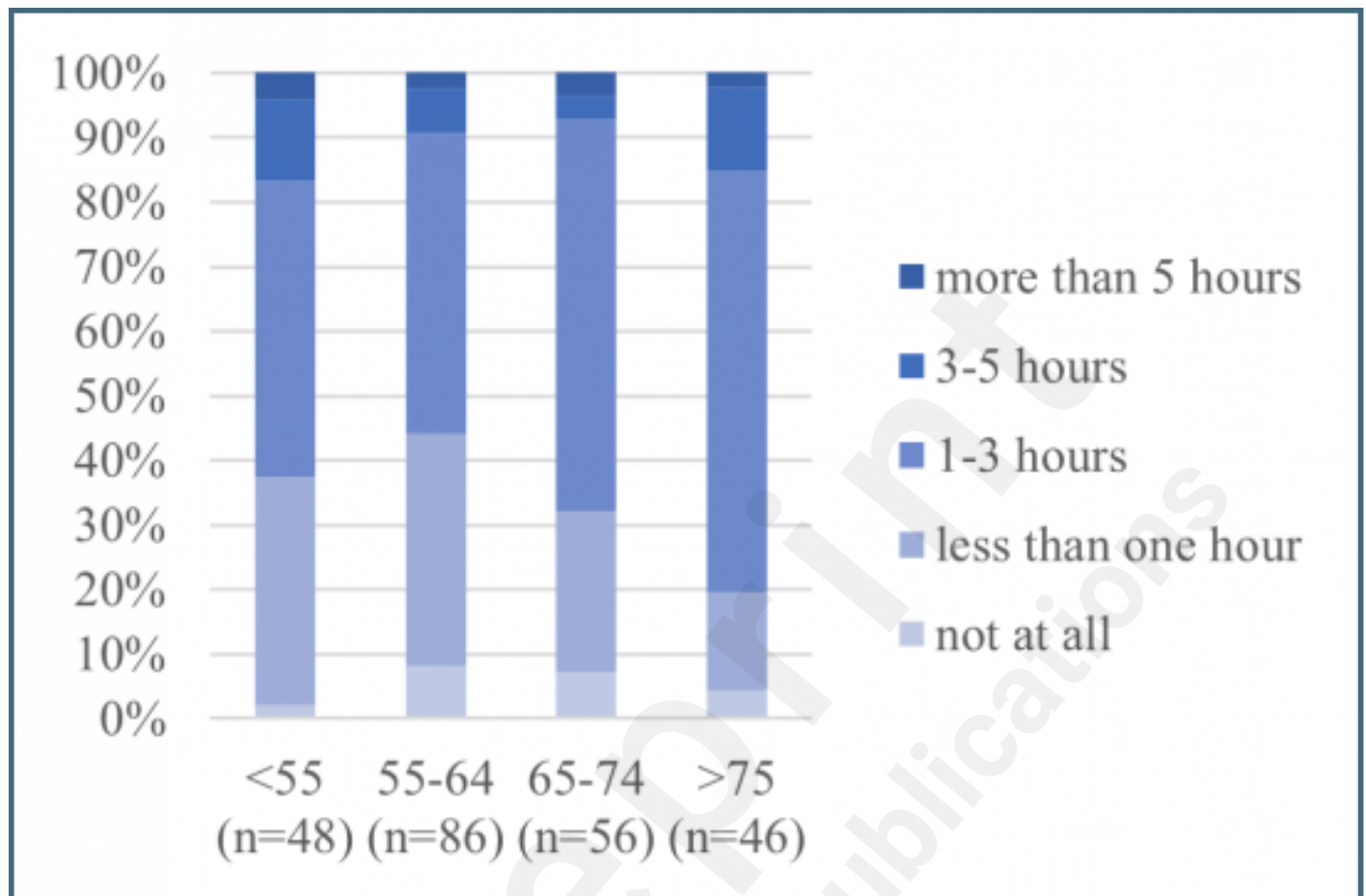
## Abbreviations

eHealth	electronic health
mHealth	mobile health
SD	standard deviation
DiGa	digital health application

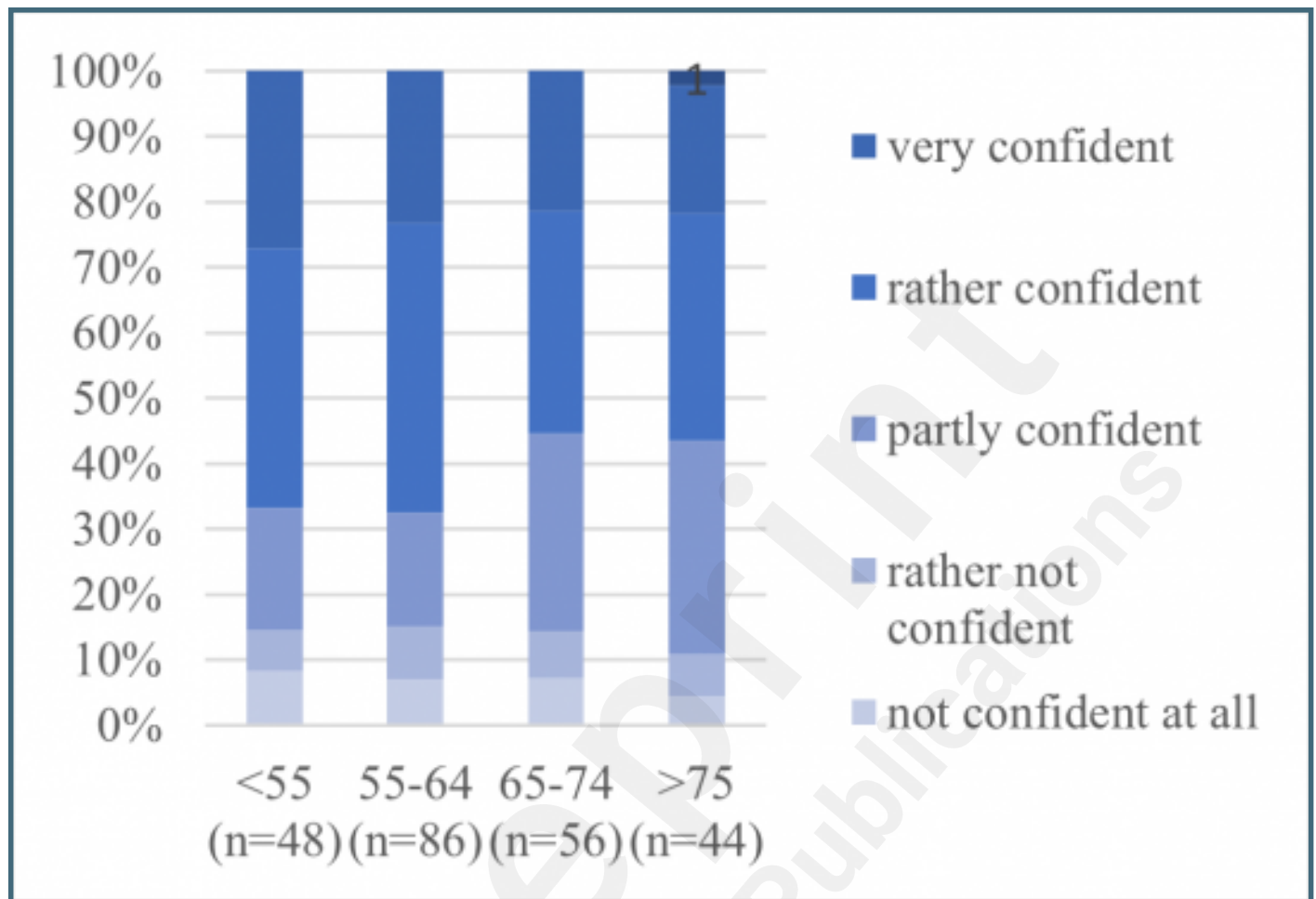
## Supplementary Files

## Figures

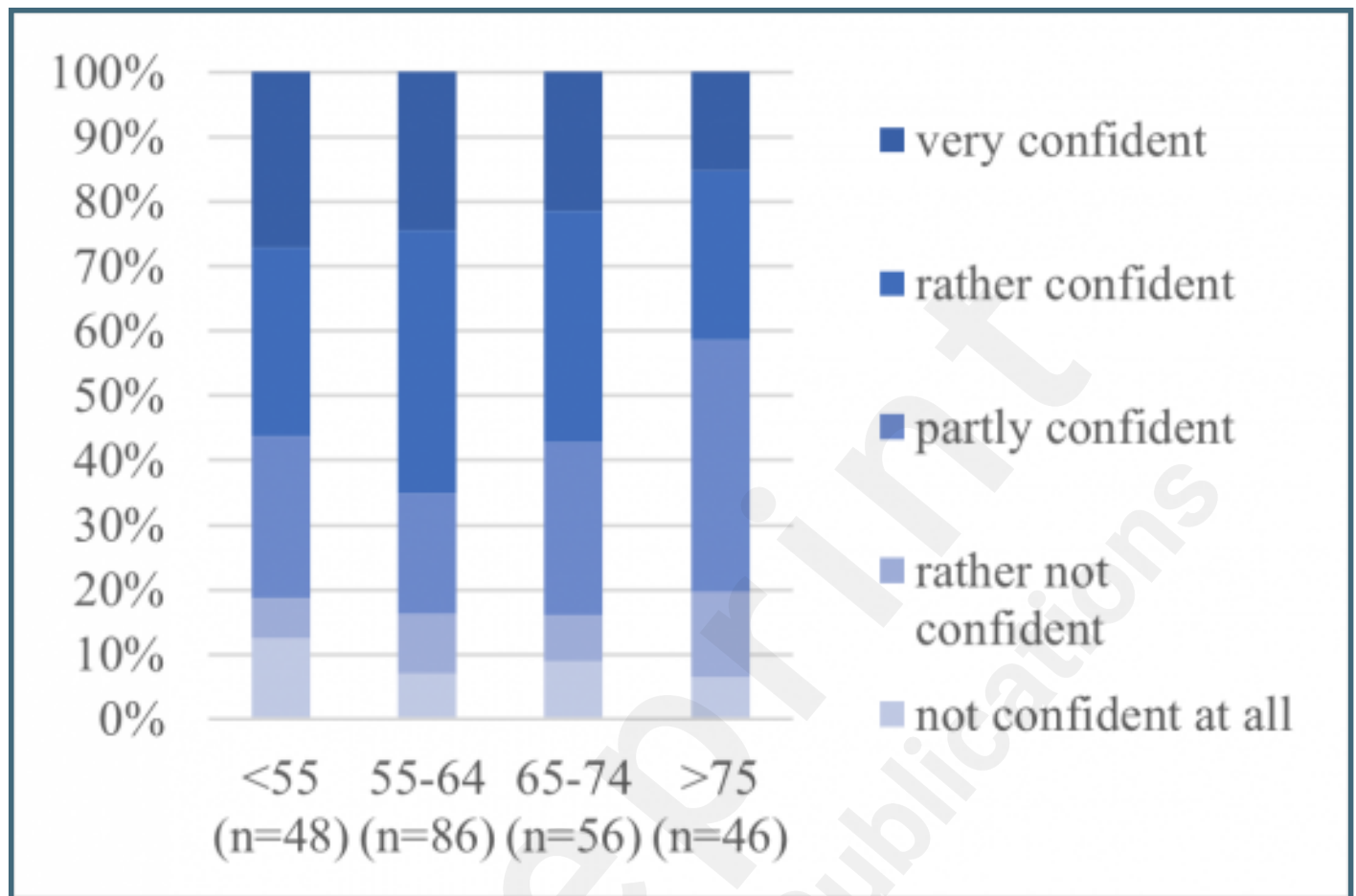
Daily Internet usage in relation to age groups.



Confidence when handling digital media in relation to age groups.

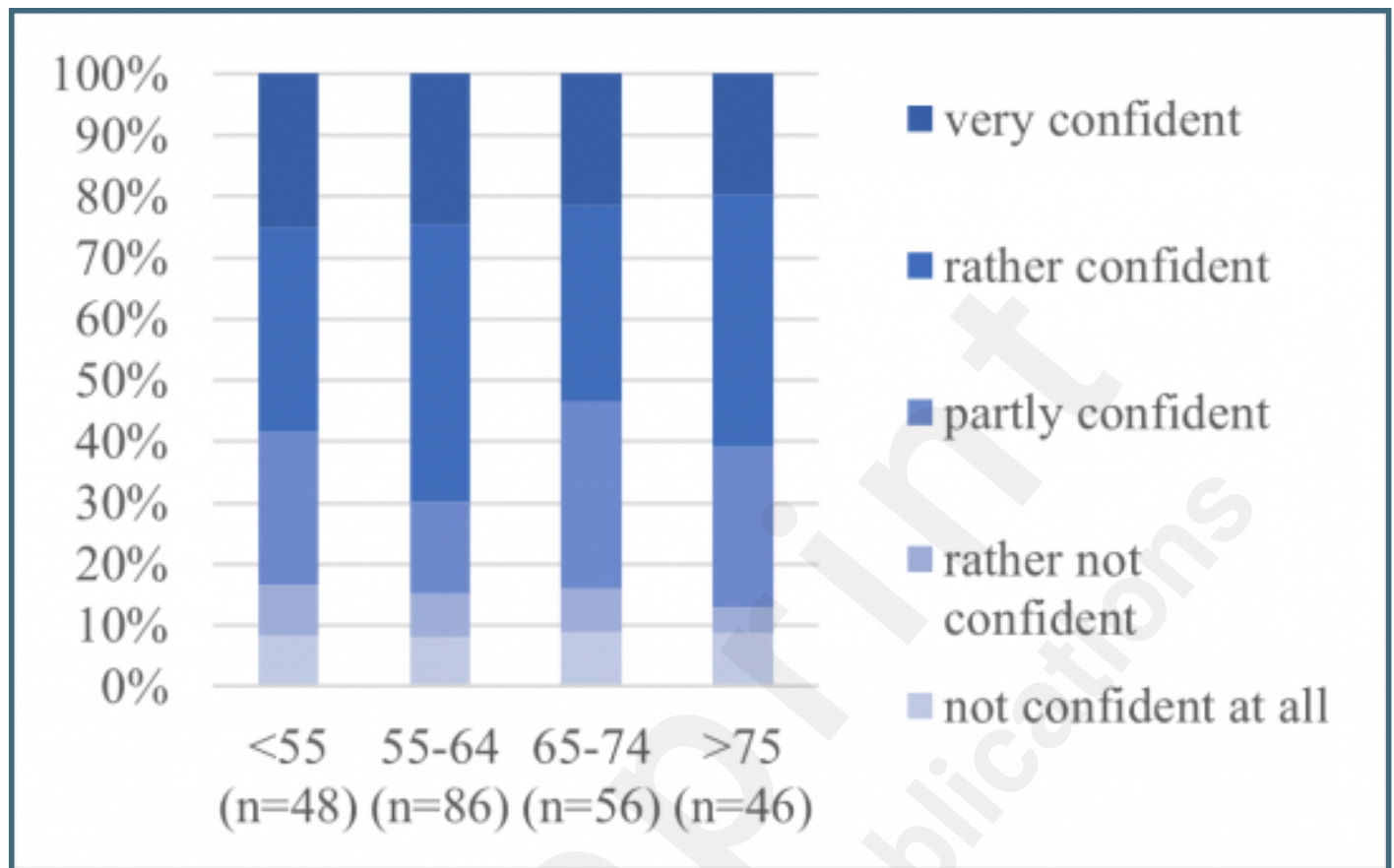


Confidence when handling Internet platforms in relation to age groups.





Confidence when handling digital devices in relation to age groups.



## Gender specific digital confidence.

