

Article

Digital Health Literacy Profiles: A Cluster Analysis of Digital Health Application Users

Nejc Bernik ¹ , Polona Šprajc ¹, Miha Rupar ² and Eva Jereb ^{1,*} 

¹ Faculty of Organizational Sciences, University of Maribor, 4000 Kranj, Slovenia; nejc.bernik1@um.si (N.B.); polona.sprajc@um.si (P.Š.)

² Faculty of Mathematics, Natural Sciences and Information Technologies, University of Primorska, 6000 Koper, Slovenia; miha.rupar33@gmail.com

* Correspondence: eva.jereb@um.si

Highlights

Please indicate how your work links to systems science via your contributions to systems practice, theory, and/or methodology.

- The study adopts a systems-oriented perspective by examining how Digital Health Literacy, Digital Health Engagement, and Autonomous Use and Technical Access interact within digital healthcare systems to shape user behaviour.
- Hierarchical cluster analysis provides a systems-based methodology for identifying heterogeneous user profiles and supporting evidence-based interventions in digital health ecosystems.

What are the main findings and/or the implications of the main findings?

- Four distinct user profiles were identified, demonstrating that digital health application users represent a heterogeneous group with varying levels of access, literacy, and engagement.
- Effective digital health transformation requires more than digital literacy alone; tailored interventions addressing specific user profiles are needed to promote inclusive and sustainable adoption of digital health technologies.

Abstract

The digital transformation of healthcare systems increasingly depends on the successful adoption and use of digital health technologies (DHTs) by healthcare users. In this context, digital health literacy (DHL) has emerged as a key factor influencing the effective use of digital health applications. Despite growing interest in DHL, limited research has focused on identifying distinct user profiles in the context of digital health applications. This study aims to identify DHL profiles among users of digital health applications in the Slovenian healthcare system. Data were collected from 247 respondents using the eHealth Literacy and Use Scale (eHLUS), which captures three dimensions: Autonomous Use and Technical Access, Digital Health Engagement, and DHL. Hierarchical cluster analysis (Ward's method, Euclidean distance) was applied to identify user groups. The analysis revealed four distinct DHL profiles: Digitally Empowered Users, Digitally Vulnerable Users, Passive Digital Users, and Motivated Developing Users. The findings indicate substantial heterogeneity among users in their use of digital health applications across the dimensions of DHL. This study represents one of the first applications of the eHLUS instrument outside its original context and contributes to a better understanding of user diversity within digital healthcare systems. The findings offer a foundation for the development of targeted educational



Academic Editor: Ikpe Justice Akpan

Received: 7 July 2026

Revised: 11 August 2026

Accepted: 14 August 2026

Published: 17 August 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and

conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

interventions, the reduction in digital inequalities, and the design of user-centered digital health applications that support the ongoing digital transformation of healthcare systems.

Keywords: digital health literacy; digital health applications; eHLUS; user profiles; cluster analysis; digital health users

1. Introduction

The digital transformation of healthcare systems represents one of the key development priorities of contemporary society. An important component of this transformation is the growing adoption of digital health technologies (DHTs), such as electronic health records, telemedicine, digital health applications, and wearable devices, which are significantly reshaping healthcare delivery and interactions between users and healthcare organizations [1]. The successful implementation of DHTs depends not only on the technological maturity of healthcare systems and their adoption by healthcare professionals, but also on the ability of patients and other users to utilize these technologies effectively [2]. In this context, digital health literacy (DHL) has emerged as a critical factor for the successful digital transformation of healthcare [3].

DHL enables individuals to search for, access, understand, critically evaluate, and apply digital health information and services, which is essential for making informed health decisions [4].

It facilitates the effective use of digital health services and DHTs, supports the monitoring of personal health status, and promotes active participation in healthcare processes [5]. As the adoption of DHTs continues to increase, so does the need for digital health applications, particularly in healthcare environments where traditional paper-based processes are increasingly being replaced by digital health data exchange, electronic health services, and digital communication between healthcare professionals and healthcare users. Consequently, DHL is becoming a key determinant of the successful use of digital health applications and the effective engagement of users within modern healthcare systems [6].

In recent years, European Union (EU) member states have implemented numerous national digital health applications that provide users with access to medical records, electronic prescriptions, referrals, and other digital health services while simultaneously reducing administrative burdens on healthcare professionals and improving the efficiency of healthcare delivery. At the EU level, the digital transformation of healthcare is further supported by the Improving Digital Empowerment for Active Healthy Living (IDEAHL) initiative and the European Health Data Space (EHDS) regulation, both of which aim to strengthen citizens' digital empowerment and promote the safe and effective use of digital health services [7,8].

Although the digital transformation of healthcare is promoted at the EU level, member states differ considerably in the governance, financing, and organization of their healthcare systems, including tax-funded national health services, social health insurance systems, and mixed public–private arrangements [9,10]. These institutional differences can influence the implementation and adoption of DHTs. Countries' capacity to adopt DHTs also varies according to their economic and technological development, digital infrastructure, institutional capacity, and public investment, resulting in differences in how these technologies are accepted and integrated into healthcare [11,12]. Adapting healthcare systems to these differences involves interoperable, secure, and accessible digital services, supported by appropriate regulation and targeted investment [13].

Healthcare expenditure does not directly measure investment in digital health, but it indicates the share of economic resources devoted to healthcare. According to the latest available data, healthcare expenditure accounts for the highest share of GDP in Germany (11.7%) and the lowest shares in Luxembourg and Romania (both 5.7%), while the EU average is 10.0% [14]. In Slovenia, current healthcare expenditure represents 9.3% of GDP, placing the country close to the EU average [15]. Slovenia therefore provides a relevant setting for examining differences in DHL among healthcare users.

The successful digital transformation of healthcare also depends on healthcare professionals' acceptance and effective use of DHTs [16]. Integrating these technologies into everyday practice involves motivation, continuous education, practical training, and technical and organizational support adapted to professionals with different levels of experience, digital competence, and technological readiness [17,18]. Such support can strengthen professionals' digital competencies across age groups and facilitate the use of DHTs in clinical practice [19]. Their readiness may also influence users' engagement, as professionals who can confidently explain, recommend, and support DHT use may help users develop the skills required to engage effectively with digital health services and strengthen patient–professional relationships [20].

Against this background, understanding differences in users' DHL is essential for providing appropriate support. However, despite growing interest in DHL, existing research has largely focused on overall literacy levels rather than distinct user profiles, particularly in the context of digital health application use [21–23]. To address this gap, German researchers developed the eHealth Literacy and Use Scale (eHLUS), an instrument designed to assess DHL in the context of digital health application use [24]. Although the scale conceptualizes eHealth literacy, we used the term DHL because it is more consistent with current terminology in the field. The scale conceptualizes DHL as a multidimensional construct comprising three dimensions: Autonomous Use and Technical Access, Digital Health Engagement, and DHL. The authors specifically highlighted the need for further research aimed at identifying and analyzing user profiles based on eHLUS results.

The present study follows these recommendations and makes three main contributions:

- (1) It applies the eHLUS instrument in a new national context;
- (2) It identifies distinct DHL user profiles using cluster analysis;
- (3) It provides actionable insights for targeted interventions aimed at reducing digital inequalities and improving user-centered digital health solutions.

2. Materials and Methods

This study employed a quantitative cross-sectional design to identify distinct user profiles of DHL users of digital health applications within the Slovenian healthcare system.

2.1. Ethics Statement

Ethical approval for the study was granted by the Ethical Committee for Research in Organizational Sciences at the Faculty of Organizational Sciences, University of Maribor, which operates in accordance with the principles of the Declaration of Helsinki (Approval No. 514-21/2026/1/250-DJ). Ethical approval was issued on 19 May 2026 based on the submitted research documentation.

Prior to participation, all respondents were informed of the study's purpose, the data collection procedure, the expected benefits of the research, and their right to withdraw from the study at any time without consequences. Data collection and processing were conducted in accordance with the General Data Protection Regulation (GDPR) and the Slovenian Personal Data Protection Act (ZVOP-2). As all data were collected and processed

in anonymized form, the privacy and confidentiality of participants were fully protected throughout the study.

2.2. Survey Instrument

The study employed the eHLUS, which was originally developed and validated on a German population [24]. The eHLUS instrument was developed by building upon established measures of DHL, particularly the eHealth Literacy Scale (eHEALS) [25]. For the purposes of this study, the term “digital health application users” is used broadly to include individuals with varying levels of experience and engagement with digital health applications, including those who use them infrequently or demonstrate limited engagement.

For the purposes of this study, the questionnaire was translated from English into Slovenian by the research team. The translated version was subsequently reviewed by faculty colleagues to assess its linguistic and conceptual adequacy. To ensure semantic equivalence between the original and translated versions, a back-translation procedure was conducted, whereby the Slovenian version was translated back into English. Comparison of the original and back-translated versions revealed no substantial conceptual discrepancies, confirming the adequacy of the Slovenian translation. The final Slovenian version of the questionnaire was then used to collect data from users of the Slovenian public healthcare system.

The translated version retained the structure and all 14 items of the original eHLUS instrument, organized into three dimensions: Autonomous Use and Technical Access, Digital Health Engagement, and Digital Health Literacy (Table 1). Respondents evaluated each item using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Table 1. Items and dimensional structure of the eHLUS instrument.

Item No.	Item	Dimension
1	Digital health applications can generally help improve my health.	Digital Health Engagement
2	I find it appealing that I can use digital health applications independently.	Digital Health Engagement
3	I am motivated to use digital health applications in everyday life.	Digital Health Engagement
4	Using digital health applications is easy to integrate into my daily life.	Digital Health Engagement
5	I always have access to the necessary hardware (e.g., smartphone, PC) to use digital health applications.	Autonomous Use and Technical Access
6	I always have access to stable and reliable internet.	Autonomous Use and Technical Access
11	I feel confident using digital devices (smartphone, PC, etc.).	Autonomous Use and Technical Access
12	I am able to use digital health applications without help from others.	Autonomous Use and Technical Access
13	If I need help using apps or digital technology, I can always get support from my social environment.	Autonomous Use and Technical Access
14	I think my data is sufficiently protected when using digital health applications.	Autonomous Use and Technical Access

Table 1. *Cont.*

Item No.	Item	Dimension
7	I know how to use the internet to get answers to my health-related questions.	Digital Health Literacy
8	I know where to find useful health information on the internet (e.g., Federal Center for Health Education, Federal Ministry of Health).	Digital Health Literacy
9	I am able to critically evaluate information related to my health.	Digital Health Literacy
10	I can distinguish reliable from questionable information and sources regarding my health on the internet.	Digital Health Literacy
Total		

2.3. Sample

Participants were eligible for inclusion if they were aged 18 years or older, were users of the Slovenian healthcare system, agreed to participate after reading the participant information, and completed the questionnaire in full. Responses were excluded if participants did not meet the eligibility criteria or submitted an incomplete questionnaire.

A convenience sampling approach was employed, with participants recruited through the researchers' social media networks. The final sample comprised 247 respondents who completed the questionnaire in full and were included in the subsequent analyses. Of these, 138 (55.9%) were female, and 109 (44.1%) were male. Most respondents were aged 18–29 years ($N = 177$; 71.7%), followed by those aged 40–49 years ($N = 27$; 10.9%), 50–59 years ($N = 21$; 8.5%), 30–39 years ($N = 18$; 7.3%), and 60 years or older ($N = 4$; 1.6%). Regarding years of service, most participants had 0–9 years of service ($N = 180$; 72.9%), followed by 20–29 years ($N = 33$; 13.4%), 10–19 years ($N = 16$; 6.5%), 30–39 years ($N = 13$; 5.3%), and 40 or more years of service ($N = 5$; 2%). The demographic characteristics of the sample are presented in Table 2.

Table 2. Demographic characteristics of the study sample.

Variable	Category	N	%
Sex	Female	138	55.9
	Male	109	44.1
Age	18–29	177	71.7
	30–39	18	7.3
	40–49	27	10.9
	50–59	21	8.5
	60+	4	1.6
Years of service	0–9	180	72.9
	10–19	16	6.5
	20–29	33	13.4
	30–39	13	5.3
	40+	5	2

Given the use of convenience sampling and online distribution, the sample may not be fully representative of the general population. Nevertheless, it included respondents with varying demographic characteristics, enabling the exploration of DHL profiles among users of digital health applications.

2.4. Data Collection

The survey link was distributed through the researchers' social media networks, and participation was voluntary and anonymous.

The demographic variables included gender, age, and years of service. The questionnaire was administered using the online survey platform 1KA (). Data collection took place between 20 and 25 May 2026. During this period, the survey link was accessed by 394 individuals. Of these, 247 respondents completed the questionnaire in full and were included in the subsequent quantitative analysis, yielding a completion rate of 62.7%.

2.5. Data Analysis

Data analysis was conducted using RStudio 4.5.2. Hierarchical cluster analysis was performed using respondents' mean scores across the three eHLUS dimensions: Digital Health Engagement, Autonomous Use and Technical Access, and Digital Health Literacy. Ward's method (Ward.D2) and Euclidean distance were applied to identify groups of users with similar DHL profiles. The optimal number of clusters was determined by examining the dendrogram and the within-cluster sum of squares (WCSS). Frequency distributions were calculated for the demographic variables, while the internal consistency of the overall instrument and its three dimensions was assessed using Cronbach's alpha in IBM SPSS Statistics 31.

3. Results

The translated eHLUS instrument demonstrated good overall internal consistency (Cronbach's $\alpha = 0.887$). The reliability coefficients for its three dimensions were also acceptable to good: Digital Health Engagement ($\alpha = 0.789$), Autonomous Use and Technical Access ($\alpha = 0.817$), and Digital Health Literacy ($\alpha = 0.863$). The results are presented in Table 3.

Table 3. Internal consistency reliability of the eHLUS instrument and its dimensions.

Dimension	Number of Items	Cronbach's Alpha
Digital Health Engagement	4	0.789
Autonomous Use and Technical Access	6	0.817
Digital Health Literacy	4	0.863
Overall eHLUS instrument	14	0.887

3.1. Hierarchical Cluster Analysis

To identify distinct DHL profiles among users of the Slovenian healthcare system, hierarchical cluster analysis was performed using Ward's method (Ward.D2) and Euclidean distance. Euclidean distance was used to calculate the similarity between respondents based on their scores across the dimensions of DHL in the use of digital health applications, while Ward's method was employed to form clusters that maximized within-group homogeneity and between-group differences. To determine the optimal number of clusters, the within-cluster sum of squares (WCSS) and the dendrogram presented in Figure 1 were analyzed. The results showed that the decrease in WCSS values was less pronounced in the four-cluster solution, which, along with the dendrogram analysis, indicated that it was the most appropriate for segmenting users based on DHL's use of digital health applications.

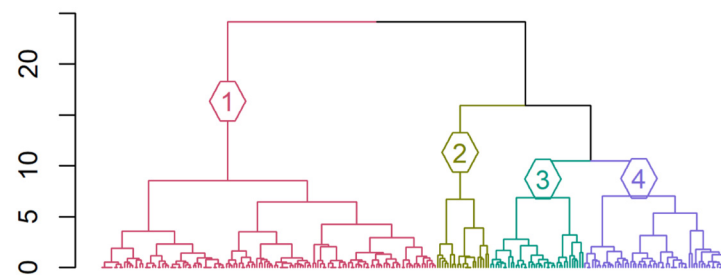


Figure 1. Dendrogram for identification of the optimal number of clusters.

The dendrogram showed that the third (C3; 23.1%) and fourth clusters (C4; 15%) were the most similar, as they merged at the lowest distance. The second cluster (C2; 8.5%) joined this group at a higher distance, whereas the first cluster (C1; 53.4%) was the most distinct from all remaining groups and merged with them only in the final stage of the hierarchical clustering procedure. This structure confirms the existence of four conceptually distinct user profiles across the dimensions of Autonomous Use and Technical Access, Digital Health Engagement, and DHL. Based on the results of the hierarchical cluster analysis, four distinct user profiles were identified according to their level of DHL in the use of digital health applications.

The mean values for the individual user profiles are presented in Table 4, supporting the findings shown in Figure 1 and indicating that the identified profiles differ in their levels of Autonomous Use, Technical Access, Digital Health Engagement, and DHL.

Table 4. Mean scores of the DHL dimensions across identified clusters/profiles.

Cluster	N	Access	Engagement	Literacy	Profiles of Users
C1	132	4.55	4.01	4.48	Digitally Empowered Users
C2	21	2.33	2.15	2.32	Digitally Vulnerable Users
C3	57	4.04	2	4.18	Passive Digital Users
C4	37	3.71	3.24	3.36	Motivated Developing Users

Digital Health Engagement emerges as the key differentiating dimension between clusters, particularly among profiles with otherwise similar levels of access and literacy.

Table 4 shows that Cluster C1 (N = 132; 53.4%) achieved the highest mean scores across all three dimensions of DHL in the use of digital health applications (Autonomous Use and Technical Access = 4.55; Digital Health Engagement = 4.01; DHL = 4.48), representing a group of users with a high level of DHL in the use of digital health applications. Given their high levels of access, engagement, and DHL, this profile was labelled Digitally Empowered Users.

The cluster C2 (N = 21; 8.5%) exhibited the lowest mean scores across all three dimensions (Autonomous Use and Technical Access = 2.33; Digital Health Engagement = 2.15; DHL = 2.32), indicating limited access and use, low engagement, and a low level of DHL. Due to their increased risk of digital exclusion, this profile was labelled Digitally Vulnerable Users.

The cluster C3 (N = 57; 23.1%) was characterized by high levels of Autonomous Use and Technical Access (4.04) and DHL (4.18), whereas Digital Health Engagement was considerably lower (2.00). This profile was therefore labelled Passive Digital Users.

The cluster C4 (N = 37; 15%) achieved moderately high scores across all three dimensions (Autonomous Use and Technical Access = 3.71; Digital Health Engagement = 3.24;

DHL = 3.36), indicating a moderately developed level of DHL in the use of digital health applications. Although their levels of access, engagement, and DHL do not reach those observed in the first cluster, they demonstrate considerable potential for further development of the competencies required for DHL in the use of digital health applications. Owing to their developmental potential and relatively favorable level of engagement, this profile was labelled Motivated Developing Users.

3.2. Demographic Characteristics of the Identified User Profiles Based on DHL in the Use of Digital Health Applications

Figure 2 presents the distribution of DHL profiles in the use of digital health applications by sex. The results indicate that the most prevalent profile among both genders was Digitally Empowered Users (C1), accounting for 138 (56%) of female respondents and 109 (50%) of male respondents. The Passive Digital Users profile (C3) was slightly more common among males (N = 29; 27%) than females (N = 28; 20%), whereas the Motivated Developing Users profile (C4) was somewhat more prevalent among females (N = 24; 17%) than males (N = 13; 12%). The Digitally Vulnerable Users profile (C2) was the least represented in both groups, comprising 9 (7%) females and 12 (11%) males.

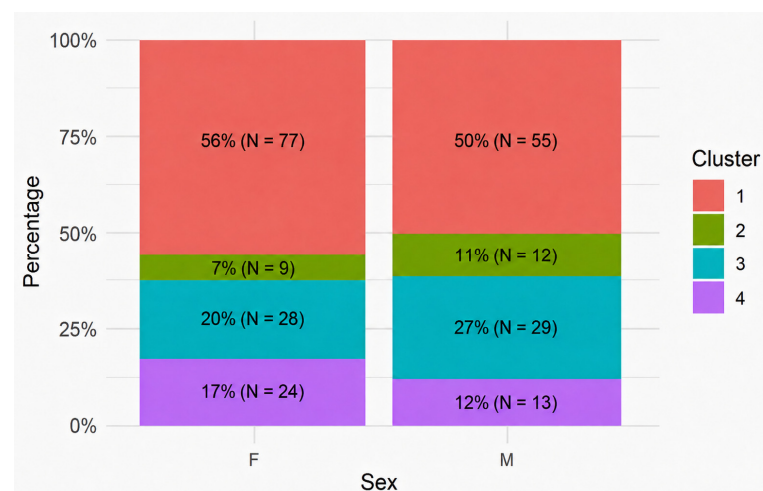


Figure 2. Distribution of DHL profiles in the use of digital health applications by sex.

The results in Figure 2 indicate a relatively balanced distribution of DHL profiles in the use of digital health applications between male and female respondents, with no substantial gender differences.

Furthermore, Figure 3 presents the distribution of DHL profiles in the use of digital health applications across age groups. Among respondents aged 18 to 59 years, Digitally Empowered Users (C1) represented the most prevalent profile in every age group, ranging from 48% (85 of 177) among those aged 18–29 years to 83% (15 of 18) among those aged 30–39 years. The highest proportion of this profile was therefore observed in the 30–39 age group.

Among older users, the profile structure changed considerably. In the 60–69 age group, all three respondents were classified as Digitally Vulnerable Users (C2), and the same pattern was observed for the single respondent aged 70 years or older. These findings suggest that the prevalence of profiles characterized by higher levels of DHL in the use of digital health applications decreases with age, whereas the proportion of users with limited DHL in the use of digital health applications increases.

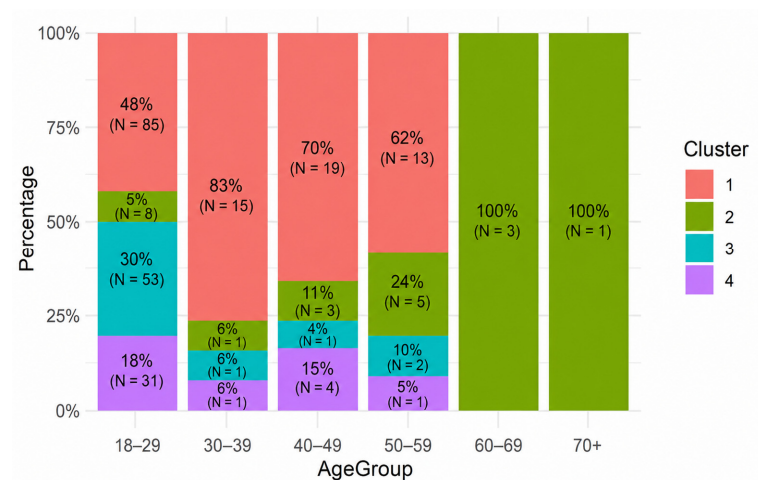


Figure 3. Distribution of DHL profiles in the use of digital health applications across age groups.

Particularly noteworthy is the youngest age group (18–29 years), in which, alongside the dominant Digitally Empowered Users profile, there was also a relatively high representation of Passive Digital Users (N = 53; 30%) and Motivated Developing Users (N = 31; 18%). This finding indicates greater heterogeneity in DHL's use of digital health applications among younger users.

Figure 4 shows differences in DHL profiles according to years of service. Digitally Empowered Users (C1) represented the largest proportion among respondents with 0–9 years of service (N = 88; 49%), 10–19 years (N = 13; 81%), 20–29 years (N = 22; 67%), and 30–39 years (N = 8; 62%). Among respondents with 40 or more years of service, Digitally Vulnerable Users (C2) predominated (N = 4; 80%), while one respondent was classified as a Digitally Empowered User (N = 1; 20%). The proportion of Digitally Vulnerable Users increased from 4% (8 of 180) among respondents with 0–9 years of service to 23% (3 of 13) among those with 30–39 years of service. However, these patterns should be interpreted cautiously because the older service groups contained relatively few respondents.

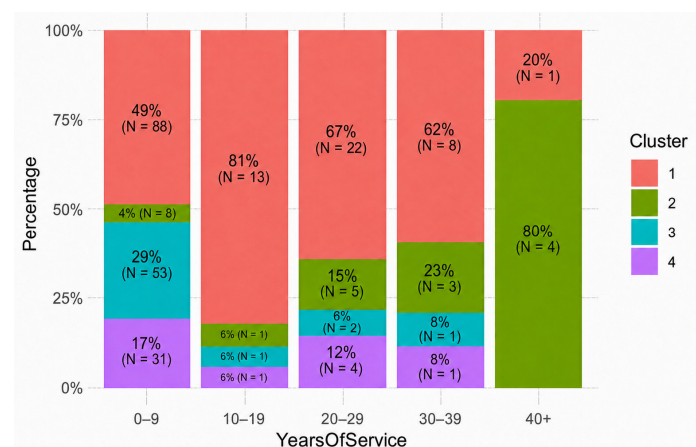


Figure 4. Distribution of DHL profiles in the use of digital health applications by years of service.

The results presented in Figure 4 suggest that longer years of service are associated with a higher likelihood of belonging to profiles characterized by lower levels of DHL in the use of digital health applications, whereas profiles with higher levels of DHL in the use of digital health applications are more prevalent among respondents with fewer years of service. This pattern is consistent with the distribution of profiles across age groups,

where older respondents were more frequently represented in the Digitally Vulnerable Users profile.

4. Discussion

This study contributes to the DHL literature by presenting one of the first applications of the eHLUS instrument to identify user profiles in the context of digital health applications. By responding to calls for research on DHL profiling [24], the study extends the instrument's application beyond its original validation context.

Although originally developed in Germany, the use of eHLUS in Slovenia is justified by the shared EU digital health ecosystem, which supports the comparability and broader relevance of the findings. The good internal consistency of the Slovenian version further strengthens confidence in the results.

The main findings revealed four DHL profiles in the use of digital health applications: Digitally Empowered Users, Digitally Vulnerable Users, Passive Digital Users, and Motivated Developing Users. These findings complement existing research on user segmentation by DHL level. Three DHL profiles were identified among Chinese students using the DHL Instrument (DHLI) [26,27], whereas six profiles were identified among Norwegian patients [2]. The differences in the number of identified profiles suggest that digital DHL is a complex and context-dependent construct influenced by the measurement instrument used, population characteristics, and the broader socio-technological environment. An important finding of this study is that high levels of DHL do not necessarily translate into active engagement with digital health applications. The identification of the Passive Digital Users profile demonstrates that individuals may possess adequate access to DHTs and strong DHL skills while remaining relatively disengaged from digital health services.

The analysis of the demographic characteristics of the identified DHL profiles revealed that the working-age population generally demonstrates at least a basic level of DHL [23]. Nevertheless, important differences were observed across age groups. Respondents aged 30–39 years, who typically had 10–19 years of service, exhibited the highest levels of DHL in the use of digital health applications, regardless of gender. In contrast, younger respondents, particularly those with up to 9 years of service, reported lower engagement with digital health applications. This is reflected in the relatively high proportion of respondents classified as Passive Digital Users, a profile characterized by adequate access and literacy but low engagement. This finding further supports the notion that sufficient access and literacy do not necessarily lead to active engagement with digital health applications.

One possible explanation for this finding is that younger individuals generally have fewer healthcare needs due to their better overall health status [28]. On the other hand, older respondents and those with more than 20 years of service also demonstrated lower levels of use of digital health applications, which may be associated with lower digital competence and greater barriers to adopting new digital technologies. Older individuals may continue to rely more heavily on traditional forms of healthcare interaction, such as telephone consultations and in-person visits. Overall, the findings suggest that DHL reaches its highest level during the middle stage of working life, when sufficient digital competencies coincide with a greater need to utilize healthcare services [28].

Furthermore, the findings provide additional evidence that DHL should not be viewed as a homogeneous construct, as it consists of multiple interrelated dimensions. At the same time, DHL builds on digital health competencies that enable individuals to effectively use DHTs and applications. In this regard, the study complements and extends previous research that primarily focused on the development of digital health competency profiles [29–31]. Whereas these studies classified individuals according to levels of digital health competencies, the present study extends this approach by identifying DHL profiles.

Such an extension is meaningful because digital competencies constitute a fundamental prerequisite for the development of digital literacy [32].

4.1. Theoretical Implications

The study contributes to the development of DHL theory in several ways. First, it represents one of the first applications of the eHLUS instrument for segmenting users of digital health applications, thereby extending its use beyond its original validation context [24]. Second, the findings highlight that engagement should be considered a distinct and critical dimension of DHL, rather than a direct consequence of digital competencies.

Third, by identifying four distinct user profiles, the study proposes a novel typology of DHL that enables a more nuanced understanding of differences among users of digital health applications and provides a foundation for further theoretical development and comparative research across different contexts.

4.2. Practical Implications

The findings have important practical implications for the Slovenian healthcare system, the broader EU context, and the advancement of digital healthcare within the framework of Society 5.0. As initiatives such as the European Health Data Space (EHDS) and Improving Digital Empowerment for Active Healthy Living (IDEAHL) are being implemented, DHL is becoming a key prerequisite for the effective use of digital health services and an important factor in improving the quality of healthcare delivery [24,33].

The identified profiles facilitate a better understanding of differences among user groups and provide a foundation for developing tailored educational programmes, communication strategies and user-centred digital health solutions. These findings highlight the need for profile-specific interventions that address differences in access, literacy, and engagement. Healthcare professionals can contribute to such interventions by adapting their guidance and support to the needs of users with different DHL profiles. Providing healthcare professionals with appropriate training and practical support may enhance their ability to help users adopt and use DHTs effectively.

The findings may also support developers of digital health applications in designing and adapting applications to the needs of diverse user groups with the aim of improving the user experience. In this regard, digital health applications should be easy to use, accessible to a broad range of users, and supported by clear instructions and user assistance mechanisms. Such approaches may help reduce digital inequalities among users of digital healthcare and promote more effective, inclusive adoption of DHTs.

4.3. Limitations and Future Research

Despite its important contributions, the study has several limitations. The sample was obtained through convenience online sampling, which limits the generalizability of the findings to the broader population of users of the Slovenian healthcare system. In addition, younger individuals were overrepresented in the sample, which may have influenced the identified structure of DHL profiles. Furthermore, the study relied on self-reported data and employed a cross-sectional research design, limiting the interpretation of the findings as causal. Additionally, the relatively small size of certain clusters should be considered when interpreting subgroup differences.

Future research should examine the stability of the identified profiles using more representative samples and across different national and cultural contexts. Further studies should also investigate how the identified profiles differ in terms of actual use of digital health applications, trust in digital healthcare, and willingness to adopt emerging technologies, including artificial intelligence. Another particularly important area for future research is the relationship between digital health competencies and DHL. Such investiga-

tions could provide a deeper understanding of the extent to which digital competencies serve as a prerequisite for DHL's development in the use of digital health applications.

Overall, the findings confirm that DHL is a complex and multidimensional construct that requires a differentiated approach in both research and practice. The identified profiles provide valuable insight into user heterogeneity and highlight that successful digital health transformation depends not only on technological advancements but also on a nuanced understanding of users' capabilities and engagement patterns.

The findings demonstrate that user engagement with digital health applications arises from the interplay among multiple interrelated system elements, including access to technology, digital literacy, healthcare services, and user characteristics.

Without sufficient levels of DHL and active engagement, digital health applications cannot fully realize their potential to improve healthcare delivery and accessibility.

5. Conclusions

This study identified four distinct DHL profiles among users of digital health applications: Digitally Empowered Users, Digitally Vulnerable Users, Passive Digital Users, and Motivated Developing Users. The findings demonstrate that access and DHL do not necessarily lead to active engagement with digital health services. Recognizing differences in users' access, literacy, and engagement provides a valuable foundation for targeted educational interventions and user-centred digital health solutions. By addressing the specific needs of different user profiles, healthcare professionals and systems can promote more inclusive and effective use of digital health applications and support the continued digital transformation of healthcare.

Author Contributions: Conceptualization, N.B. and M.R.; methodology, N.B. and M.R.; software, N.B.; validation, N.B., M.R., P.Š. and E.J.; formal analysis, N.B. and M.R.; investigation, N.B. and M.R.; resources, N.B., M.R., P.Š. and E.J.; data curation, N.B.; writing—original draft preparation, N.B. and M.R.; writing—review and editing, P.Š. and E.J.; visualization, N.B.; supervision, P.Š. and E.J.; project administration, P.Š. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee for Research in the Field of Organizational Sciences (514-21/2026/1/250-DJ) on 19 May 2026.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data used in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

DHTs	Digital Health technologies
DHL	Digital Health Literacy
eHLUS	eHealth Literacy and Use Scale
EU	European Union
WCSS	Within-Cluster Sum of Squares

References

- Roy, S.; Lartey, S.T.; Durneva, P.; Jha, N.; Ofori, M.A.; Zeba, Z.; Dockery, S.; Scarboro, N.S.; Taylor, M.; Joshi, A. Digital Health Technology Infrastructure Challenges to Support Health Equity in the United States: Scoping Review. *J. Med. Internet Res.* **2025**, *27*, e70856. [CrossRef] [PubMed] [PubMed Central]
- Andersen, M.H.; Hermansen, Å.; Dahl, K.G.; Lønning, K.; Meyer, K.B.; Vidnes, T.K.; Wahl, A.K. Profiles of health literacy and digital health literacy in clusters of hospitalised patients: A single-centre, cross-sectional study. *BMJ Open* **2024**, *14*, e077440. [CrossRef] [PubMed] [PubMed Central]
- Özatkan, Y.; Tekin, P.S. Determinants of digital health literacy of healthcare professionals: A systematic review. *J. Telemed. Telecare* **2026**, 1357633X261426228. [CrossRef] [PubMed]
- Arias López Mdel, P.; Ong, B.A.; Borrat Frigola, X.; Fernández, A.L.; Hicklent, R.S.; Obeles, A.J.T.; Rocimo, A.M.; Celi, L.A. Digital literacy as a new determinant of health: A scoping review. *PLoS Digit. Health* **2023**, *2*, e0000279. [CrossRef] [PubMed] [PubMed Central]
- Fitzpatrick, P.J. Improving health literacy using the power of digital communications to achieve better health outcomes for patients and practitioners. *Front. Digit. Health* **2023**, *5*, 1264780. [CrossRef] [PubMed] [PubMed Central]
- Xie, G.; Liao, J.; Tang, X.; Yang, Y.; Han, F.; Liu, D.; Li, D.; Jin, Y.; Wang, T. Digital health literacy in medical education: A scoping review of current challenges and development strategies. *BMC Med. Educ.* **2026**, *26*, 567. [CrossRef] [PubMed]
- About IDEAHL—IDEAHL. 2022 October 22. Available online: <https://ideahl.eu/about-ideahl/> (accessed on 31 May 2026).
- European Health Data Space (EHDS) | Updates. Available online: <https://www.european-health-data-space.com/> (accessed on 6 June 2026).
- Molander, P. Public versus private healthcare systems in the OECD area—A broad evaluation of performance. *Eur. J. Health Econ.* **2025**, *26*, 1163–1173. [CrossRef] [PubMed] [PubMed Central]
- Reibling, N.; Ariaans, M.; Wendt, C. Worlds of Healthcare: A Healthcare System Typology of OECD Countries. *Health Policy* **2019**, *123*, 611–620. [CrossRef] [PubMed]
- Hamasaki, T.; Briand, C.; Mahroug, A.; Sauvageau, A. Digital health technology adoption factors: A rapid review of systematic reviews and checklist development. *Disabil. Rehabil. Assist. Technol.* **2026**, *21*, 95–112. [CrossRef] [PubMed]
- Wittich, L.; Rödiger, H.; Rombey, T.; Brecher, A.L.; Kraft, L.; Sgraja, S.; Stein, V.; Henschke, C. Navigating the complexities of digital health technology implementation: A scoping review of barriers and facilitators. *Implement. Sci. Commun.* **2026**, *7*, 69. [CrossRef] [PubMed]
- Fellner, R.; Sutherland, E.; Vujovic, K. *Digitalisation of Public Health: Leading Practices in Immunisation Reporting and Respiratory Disease Surveillance*, 185th ed.; OECD Health Working Papers; OECD: Paris, France, 2025. Available online: https://www.oecd.org/en/publications/digitalisation-of-public-health_97204768-en.html (accessed on 5 August 2026).
- 10% of the EU's GDP Went to Healthcare in 2023. 2025. Available online: <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20251117-2> (accessed on 4 August 2026).
- Health Expenditure and Sources of Funding 2024. 2026. Available online: <https://www.stat.si/StatWeb/en/news/Index/14355> (accessed on 4 August 2026).
- Ebo, T.O.; Clement David-Olawade, A.; Ebo, D.M.; Egbon, E.; Olawade, D.B. Transforming healthcare delivery: A comprehensive review of digital integration, challenges, and best practices in integrated care systems. *Digit. Eng.* **2025**, *6*, 100056. [CrossRef]
- Alotaibi, N.; Wilson, C.B.; Traynor, M. Enhancing digital readiness and capability in healthcare: A systematic review of interventions, barriers, and facilitators. *BMC Health Serv. Res.* **2025**, *25*, 500. [CrossRef] [PubMed]
- Esperança, M.; Ferreira, J.C.; Martins, A.L. The imperative of digital competence in healthcare professionals: Comparison between the North and South of Europe. *BMC Health Serv. Res.* **2026**, *26*, 191. [CrossRef] [PubMed]
- Sahan, F.; Gutermuth, A.; Müller, J.A.; Muth, T.; Panitz, K.; Apolinário-Hagen, J. Acceptance and use of digital health technologies among physiotherapists in Germany: A web-based cross-sectional survey. *BMC Health Serv. Res.* **2026**, *26*, 147. [CrossRef] [PubMed]
- Boz, M.K.; Çimen, M. The Effect of E-Health Literacy and Patient–Physician Relationship on Treatment Adherence. *Healthcare* **2025**, *13*, 632. [CrossRef] [PubMed] [PubMed Central]
- Duan, Y.; Dong, X. Does Digital Literacy Matter for E-Government Usage Behavior? An Empirical Analysis Based on Data from Rural Women in China. *Sage Open* **2025**, *15*, 21582440251376118. [CrossRef]
- Li, X.; Song, W.; Ye, C. The impact of digital literacy on life satisfaction among rural residents. *Curr. Psychol.* **2026**, *45*, 416. [CrossRef]
- Yoon, J.; Yang, S.; Kang, S.J.; Lee, M.; Kim, D.; Park, J.; Kim, S.J.; Han, J.; Joo, J.; Cho, J. Digital Health Literacy in the General Population: National Cross-Sectional Survey Study. *J. Med. Internet Res.* **2025**, *27*, e67780. [CrossRef] [PubMed] [PubMed Central]
- Stephan, J.; Gehrmann, J.; Dehner, J.C.; Stullich, A.; Richter, M. Development and validation of the eHealth Literacy and Use Scale (eHLUS) to measure medical app literacy. *Public Health* **2025**, *240*, 27–32. [CrossRef] [PubMed]

25. Norman, C.D.; Skinner, H.A. eHealth Literacy: Essential Skills for Consumer Health in a Networked World. *J. Med. Internet Res.* **2006**, *8*, e9. [CrossRef] [PubMed] [PubMed Central]
26. Ning, L.; Zheng, Z.; Liu, M.; Gao, S.; Yang, X.; Bi, J.; Yu, X.; Yi, D. Profiles of digital health literacy among university students and its association with mental health during the COVID-19 pandemic: A latent profile analysis. *Digit Health* **2024**, *10*, 20552076231224596. [CrossRef] [PubMed] [PubMed Central]
27. Vaart Rvan der Drossaert, C. Development of the Digital Health Literacy Instrument: Measuring a Broad Spectrum of Health 1.0 and Health 2.0 Skills. *J. Med. Internet Res.* **2017**, *19*, e6709. [CrossRef] [PubMed]
28. Jeong, S.H.; Nam, Y.G. The Paradox of Digital Health: Why Middle-Aged Adults Outperform Young Adults in Health Management Utilization via Technology. *Healthcare* **2024**, *12*, 2261. [CrossRef] [PubMed] [PubMed Central]
29. Comparcini, D.; Simonetti, V.; Totaro, M.; Tomietto, M.; Forastefano, B.; Jarva, E.; Pastore, F.; Minoia, F.; Gullo, B.; Rea, T.; et al. Profiling Healthcare Professionals' Digital Health Competence and Associated Factors: A Cross-Sectional Study. *J. Adv. Nurs.* **2025**, *82*, 7917–7927. [CrossRef] [PubMed]
30. Jarva, E.; Oikarinen, A.; Andersson, J.; Pramila-Savukoski, S.; Hammarén, M.; Mikkonen, K. Healthcare professionals' digital health competence profiles and associated factors: A cross-sectional study. *J. Adv. Nurs.* **2024**, *80*, 3236–3252. [CrossRef] [PubMed]
31. Mikkonen, K.; Tomietto, M.; Lee, J.J.; Ye, F.; Mandysova, P.; Pekara, J.; Kommusaar, J.; Kangasniemi, M.; Liao, X.; Cicolini, G.; et al. Digital health competence among healthcare professionals: A cross-sectional cluster analysis across 19 countries and regions. *Int. J. Nurs. Stud.* **2026**, *176*, 105348. [CrossRef] [PubMed]
32. Cosgrove, J.; Cachia, R. *DigComp 3.0: European Digital Competence Framework*; JRC Publications Repository; Publications Office of the European Union: Luxembourg, 2025. Available online: <https://publications.jrc.ec.europa.eu/repository/handle/JRC144121> (accessed on 15 December 2025).
33. Awad, A.; Trenfield, S.J.; Pollard, T.D.; Ong, J.J.; Elbadawi, M.; McCoubrey, L.E.; Goyanes, A.; Gaisford, S.; Basit, A.W. Connected healthcare: Improving patient care using digital health technologies. *Adv. Drug Deliv. Rev.* **2021**, *178*, 113958. [CrossRef] [PubMed]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.