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The Effect of European Health Literacy-Based e-Pulse Education and e-Pulse Instructional Materials on Health Literacy Levels in Adults Aged 45–64: A Randomized Controlled Trial

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ABSTRACT

e-Pulse is an electronic personal health record system known as e-Nabız in Turkey. This study compares the effect of European Health Literacy-based e-Pulse education and e-Pulse instructional materials on the health literacy levels of adults aged 45–64 with inadequate and problematic-limited health literacy levels. This single-blind, randomized controlled trial was conducted from June 2023 to September 2023. It included 140 participants, assigned to either the intervention group ($n = 70$) or the active control group ($n = 70$). The intervention group received HLS-EU-based e-Pulse education, which consisted of two 45-min sessions over 6 weeks, along with the e-Pulse user guide and introduction video. The active control group only received the e-Pulse user guide and introduction video, and each participant was individually briefed on the e-Pulse system content for 5–10 min. Results were measured using the European Health Literacy Survey Questionnaire (HLS-EU-Q47) and the eHealth Literacy Scale (eHEALS) at baseline and the sixth week. Both the intervention and active control groups showed an increase in health literacy and eHealth literacy scores, but the mean change was greater in the intervention group. A statistically significant difference was found in the effects of HLS-EU-based e-Pulse education and e-Pulse instructional materials on both health literacy ($F(1, 137) = 25.215$; $p < 0.001$) and eHealth literacy ($F(1, 137) = 36.134$; $p < 0.001$). HLS-EU-based e-Pulse education significantly improved health literacy ($d = 0.8492$; $p < 0.001$) and eHealth literacy ($d = 1.0175$; $p < 0.001$) compared to e-Pulse instructional materials. The intervention group demonstrated significantly higher rates of sufficient (32.9%) and excellent (12.9%) health literacy. Notably, a medium correlation ($r = 0.602$; $p < 0.001$) was observed between health literacy and eHealth literacy.

Trial Registration: ClinicalTrials.gov (ID: NCT05831254) https://clinicaltrials.gov/study/NCT05831254.

1 | Introduction

Health literacy is defined as the ability of individuals to obtain, process, and understand basic health information and services necessary for making informed health decisions (Chesser et al. 2016). Health literacy enhances individuals' participation in healthcare, whereas those with lower levels of health literacy have more limited access to and engagement with healthcare services, potentially leading to negative health outcomes (Sørensen et al. 2012). Enhancing health literacy is crucial for

promoting health equity, as individuals with an improved understanding of health information can make informed decisions, navigate healthcare systems more effectively, and adopt healthier behaviors (Rowlands et al. 2017).

Electronic health (eHealth) literacy, as defined by Norman and Skinner (2006), refers to the ability to search, locate, comprehend, critically assess, and apply health information from electronic sources to manage and resolve health-related issues (Norman and Skinner 2006). With the rapid digitization of healthcare, digital tools such as online platforms and mobile applications have become increasingly significant for healthcare consumers (Van Der Vaart and Drossaert 2017), making digital health—a broad field encompassing eHealth, mobile health, telehealth, and health data—a crucial component in enhancing healthcare systems (World Organization Health 2022). In this context, eHealth literacy is integral for accessing and applying reliable health information, and enhancing health management. However, the digital divide remains a challenge, limiting access to these resources for certain populations and hindering equitable benefits from digital healthcare (Neter and Brainin 2012). Effective eHealth literacy involves not only accessing but also reliably applying health information to improve outcomes (Kim and Xie 2017).

A study comparing European health literacy surveys (HLS-EU) across eight countries—Austria, Bulgaria, Germany, Greece, Ireland, the Netherlands, Poland, and Spain—found that 12% of participants had insufficient health literacy. Additionally, 47% had limited health literacy, with higher rates observed in older age groups (Sørensen et al. 2015). Additionally, two meta-analytic studies have shown that older individuals have lower levels of health literacy (Chesser et al. 2016; Kobayashi et al. 2016). A Turkish study similarly showed that inadequate and limited health literacy increased with age, with 70% of individuals aged 45–54 and 80% of those aged 55–64 experiencing inadequate or limited literacy (Özkan et al. 2018). Another Turkish study found that 27% of participants had inadequate literacy, 31% had limited literacy, and 42% had adequate literacy, with young adults demonstrating higher health literacy than older adults, especially among those seeking information from healthcare providers and reliable online sources (Said Bodur et al. 2017). Improving health literacy among adults in Turkey is essential for enhancing public health, accessing healthcare, and increasing system efficiency. This enhancement helps individuals manage their health and make informed decisions. However, those with low health and eHealth literacy often struggle to effectively use electronic personal health record systems (PHRs) for health monitoring.

Language plays a vital role in accessing and understanding health information. When individuals access health information in their native language, they experience increased understanding and confidence, facilitating easier navigation and utilization of healthcare services. Those who can comprehend health information in their native languages are more likely to follow medical advice. In a study examining the effects of language preference and health literacy on health information-seeking experiences among a low-income, multilingual community, participants reported that searching for health information in their preferred languages felt more comfortable and meaningful (Chu et al. 2022). Another study indicates that language barriers lead to difficulties in accessing healthcare services, resulting in misdiagnoses and improper treatments, lower patient satisfaction, and increased risk of health issues (Lawrence, Martinez, and Ahmed 2023). In this study, participants were selected from Turkish-speaking individuals because it is important to evaluate the user experience accurately without any language barriers.

eHealth education can help alleviate negative emotions, such as stress and anxiety, that hinder the use of eHealth technologies, while also improving individuals' skills to research and use health information, thereby positively impacting their self-management and well-being (Czaja et al. 2013). In Turkey, the electronic personal health record system (PHRs), known as e-Nabız (e-Pulse), allows individuals to access healthcare services online through mobile devices. This includes appointment bookings, consultations, test results, and health risk assessments (Birinci 2023). Czaja et al. (2015) aimed to identify the challenges of using electronic PHRs and assess the ability of adults with low health literacy to use them for health management, with the study finding that most participants struggled to complete tasks, required assistance, and still recognized the value of PHRs (Czaja et al. 2015). Additionally, qualitative reviews highlight that PHRs can often be difficult for patients to understand (Lester et al. 2016). A study in Turkey found that 60% of participants were unaware of the application, though users considered it useful and essential for accessing health services (Yeşiltaş 2018). Another study revealed that 49.7% had heard of e-Pulse, while 50.3% had not, with only 17% registered and 14.9% having used the system (Yorulmaz, Odacı, and Akkan 2018). Furthermore, only 38.6% of e-Pulse users were aged 45 or older, indicating that health literacy and e-Pulse usage are positively correlated, with younger individuals more likely to engage with the system (Özaydın and Nokay 2024). The significantly lower usage rates among those over 45 highlight a lack of widespread adoption of electronic health services in this demographic, underscoring the need for improved electronic health literacy and technology access, particularly for the elderly. To address this, enhancing electronic access and education is essential.

Healthcare organizations are implementing PHRs to improve patient engagement, aiming to achieve three primary goals: enhancing access to healthcare, reducing costs, and improving care quality (Zhao et al. 2017). A systematic review found that utilizing PHRS aids in managing chronic diseases (Paydar et al. 2021). Improved health decision-making, effective communication, adherence to treatment guidelines, and overall health status can positively influence cost-effectiveness and patient-caregiver satisfaction in the healthcare system (Chesser et al. 2016). Interventions targeting health literacy have been shown to positively impact behaviors that reduce disease burden (Miller 2016). For instance, active learning-based health education has been demonstrated to increase health literacy in adults (Uemura, Yamada, and Okamoto 2018) and promote healthier lifestyles (Uemura, Yamada, and Okamoto 2021).

The correlation between health literacy and eHealth literacy plays a crucial role in improving individuals' access to health information and services, which can significantly enhance health outcomes. Norman and Skinner (2006) emphasize that

eHealth literacy equips people with the skills to make more informed health decisions, as they can better navigate and utilize digital health resources. Similarly, Bodie and Dutta (2008) highlight the importance of eHealth literacy in reducing health disparities, noting that strengthening this connection can help bridge gaps in health equity. According to the World Health Organization (2013), eHealth literacy is essential for public health, especially in addressing health inequalities for those with limited access to reliable health information. Furthermore, Paasche-Orlow and Wolf (2007) point out that limited health literacy can restrict access to health services, thereby negatively impacting health outcomes. Thus, the strong correlation between health literacy and eHealth literacy not only facilitates access to health information but also enables individuals to use this information effectively, thereby improving public health outcomes overall (Van Der Vaart and Drossaert 2017). Investing in both types of literacy is, therefore, not just beneficial but essential to empower individuals, reduce health disparities, and create a healthier society for all.

In the context of chronic illness management, a study found that cancer patients with higher health literacy reported a better quality of life (Avci and Ayik 2022). Additionally, educational comic books have shown a stronger impact on adult health literacy compared to brochures (Yu et al. 2017), and group participation interventions can effectively promote health among adults (Blancafort Alias et al. 2021). As individuals aged 45-64 are projected to be part of the elderly population by 2050, enhancing both health and eHealth literacy is crucial. Improved literacy can lead to better health behaviors, fewer hospitalizations, regular medication adherence, and more effective use of preventive health services. Future studies should utilize conceptual models like the European Health Literacy Survey (HLS-EU CONSORTIUM 2012), which covers treatment, disease prevention, and health promotion.

Inadequate health literacy can significantly affect older adults' ability to access healthcare, make informed decisions, and manage their health effectively. This issue not only undermines individual health outcomes but also impacts the overall efficiency of the healthcare system, increasing the burden of illness. While many studies have explored ways to improve health literacy, research comparing European Health Literacy (HLS-EU)-based education programs with digital approaches remains limited. HLS-EU-based electronic PHRs education offers a comprehensive approach to enhancing skills in accessing, understanding, evaluating, and applying health information. In contrast, electronic PHR instructional materials allow individuals to learn independently, enabling them to access their medical data and manage their health.

This study aims to compare the impact of European Health Literacy-based e-Pulse education and e-Pulse instructional materials on the health literacy levels of adults aged 45–64 with inadequate or limited health literacy. Comparing these two interventions could be important for identifying the most effective method to improve health literacy, particularly for adults who may face challenges in accessing or understanding health information due to limited digital skills or knowledge. Additionally, understanding the effectiveness of these approaches will help shape future health education policies and resource allocation, promoting the development of personalized, accessible, and sustainable health literacy strategies. The findings could help make digital health tools more user-friendly and effective. This may support adults in making informed decisions, improving health outcomes, and engaging more actively with their healthcare. Ultimately, this study may help in developing more accessible and effective strategies to improve health literacy in underserved adult populations.

1.1 | Aim, Hypotheses, and Questions

This study aims to compare the effects of European Health Literacy-based e-Pulse education and e-Pulse instructional materials on the health literacy levels of adults aged 45–64 with inadequate and problematic-limited health literacy. This study is designed based on the following three hypotheses: Hypothesis 1 (H_1): Health literacy levels are higher in the group receiving European Health Literacy-based e-Pulse education compared to the group receiving only e-Pulse instructional materials. Hypothesis 2 (H_1): eHealth literacy levels are higher in the group receiving European Health Literacy-based e-Pulse education compared to the group receiving only e-Pulse instructional materials. Hypothesis 3 (H_1): The proportion of participants with sufficient and excellent health literacy levels is higher in the group receiving European Health Literacy-based e-Pulse education compared to the group receiving only e-Pulse instructional materials. Additionally, the question "Is there a correlation between health literacy and eHealth literacy?" was explored.

2 | Materials and Methods

2.1 | Study Design

This study, conducted from June to September 2023, was designed as a single-blind (participant), randomized controlled trial with an active control group.

2.2 | Study Population and Sample

The study population consists of adults aged 45–64 with inadequate or limited health literacy residing in the Konyaaltı region of Antalya, Turkey, who have enrolled at the Healthy Life Center. Healthy Life Centers in Turkey are multipurpose structures established to protect individuals and society from health risks, promote a healthy lifestyle, strengthen primary health services, and facilitate access to these services. A prior study indicated that an active learning program demonstrated a medium effect size on health literacy levels in adults with low health literacy (Uemura, Yamada, and Okamoto 2021). Therefore, when calculating the sample size in our study, the effect size was taken as 0.5 (medium effect size). The sample size was calculated using Gpower 3.1.9.7 software, assuming an effect size of 0.5, an α value of 0.05, and 80% power. Each group required 64 participants. Considering a 10% dropout rate, as observed in similar studies (Uemura, Yamada, and Okamoto 2021; Yu et al. 2017), 70 participants per group (total

140) were included. Participants with a European Health Literacy Scale (HLS-EU-Q47) score of 0–25 (inadequate health literacy) and > 25–33 (problematic-limited health literacy) (HLS-EU CONSORTIUM 2012), who could use electronic devices such as smartphones, tablets, or computers, and who volunteered to participate were included. Participants who did not speak Turkish were excluded from the study due to the materials used being in Turkish.

2.3 | Randomization and Blinding

Simple randomization (1:1) based on HLS-EU-Q47 scores of 0–25 and > 25–33 was performed by an independent researcher using the "Statistics and Sample" program and placed in sealed envelopes given to the researcher. Although the researcher could not be blinded due to the nature of the interventions, participants were blinded. Data were entered into a database labeled Group A and Group B and analyzed by a statistician unaware of group assignments, ensuring statistician blinding.

2.4 | Outcome Measurement

Data on participants (age, gender, education level, perceived income status) were collected using a Google Form. Additionally, data were gathered before the intervention and at the sixth week using the European Health Literacy Survey Questionnaire 47 (HLS-EU-Q47) and the eHealth Literacy Scale (eHEALS).

2.4.1 | European Health Literacy Survey Questionnaire (HLS-EU-Q47)

The HLS-EU-Q47 was developed by the European health literacy research consortium (HLS-EU CONSORTIUM 2012) and adapted into Turkish in 2014 (Durusu-Tanrıöver et al. 2014) and 2016 (Abacıgil, Harlak, and Oktay 2016). This self-report scale assesses health literacy levels in individuals aged 15 and above. The scale covers three health-related dimensions (treatment, disease prevention, and health promotion) and processes related to health decision-making and practice (accessing, understanding, evaluating, and applying information). The scale includes 47 items across 12 dimensions, with each item rated on a 4-point scale: 1 = *Very difficult*, 2 = *Difficult*, 3 = *Easy*, 4 = *Very easy*. *Don't know* is coded as 5.

The total score obtainable from the scale ranges from 47 to 188. To facilitate calculation, the total score has been standardized to fall within the range of 0–50 using the following formula: Formula: Index = (Arithmetic mean-1) × [50/3]; Index = The calculated individual-specific index; Arithmetic mean = The average of the responses to each item; 1 = The lowest possible value of the mean (ensures the index's lowest value is 0); 3 = The range of the mean; 50 = The highest value selected for the new scale. On the scale, 0 indicates the lowest level of health literacy, and 50 indicates the highest level of health literacy. Based on the formula, cut-off points have been determined for four dimensions (general, treatment, disease prevention, and health promotion). Health literacy levels are categorized based on the scores: 0–25 indicates inadequate health literacy; > 25–33 indicates problematic-limited health literacy; > 33–42 indicates sufficient health literacy; > 42–50 indicates excellent health literacy (Abacıgil, Harlak, and Oktay 2016). The Cronbach's alpha values for the Turkish forms of the HLS-EU-Q47 were found to be 0.97 (Durusu-Tanrıöver et al. 2014), 0.95 (Abacıgil, Harlak, and Oktay 2016), and 0.97 in this study.

2.4.2 | eHealth Literacy Scale (eHEALS)

Developed by (Norman and Skinner 2006) to assess traditional literacy, health literacy, information seeking, scientific research, media literacy, and computer literacy, eHEALS was adapted into Turkish by Coşkun and Bebiş (2015). The scale includes 10 items: 2 items related to internet usage. The remaining 8 items assess an individual's eHealth literacy, specifically their confidence and self-efficacy when navigating and utilizing online health resources. These items evaluate aspects such as confidence in finding health resources online, the ability to use this information for health decisions, perceptions of the usefulness of internet health information, and the ability to determine which information is of high quality. These 8 items are rated on a 5-point Likert scale: 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5 = *Strongly agree*. The 2 items related to internet usage are not included in the scoring, resulting in a score range of 8–40. Higher scores indicate higher levels of eHealth literacy. The scale has been shown to have high reliability in adults over 45 years of age, and the Cronbach α value was found to be 0.97 (Uskun et al. 2022), and the Cronbach α value was found to be 0.96 in this study.

2.5 | Interventions

The planning of interventions in this study utilized the TIDieR checklist (Hoffmann et al. 2014). Details of the interventions are summarized in Table 1.

2.5.1 | Intervention Group: Interventions for the e-Pulse Education Group Based on HLS-EU

The interventions for this group are explained under three main headings below.

2.5.1.1 | HLS-EU-Based Education Package. The education package consists of six modules. The education was conducted over 6 weeks, with each week comprising two 45-min sessions held face-to-face in an interactive group setting. The education modules were based on the HLS-EU, considering content available on the e-Pulse system such as my visits, my prescriptions, my reports, my illnesses, my tests, my radiological images, my allergies, my emergency notes, my documents, my vaccination schedule, my medications, and my appointments. Each module had distinct content. In each module related to using e-Pulse, participants practiced on their e-Pulse platform. The aim was to enhance participants' skills in accessing, understanding, evaluating, and using/applying health-related information.

TABLE 1 | Characteristics of the interventions.

Features	Education package based on HLS-EU	e-pulse user guide e-pulse introduction video
Time	After randomization	After randomization
Content and practice	Module 1: The definition of Health and eHealth was provided. Tools for accessing accurate information were discussed. A focus group discussion was conducted to reflect and share perspectives on the approaches and perceived images of technology. Module 2: The aim was to introduce the e-Pulse system. Topics such as accessing the e-Pulse system, appointments, my medications, and my prescriptions were covered. Module 3: The focus was on the usability concept of accessing the e-Pulse system and its subdimensions. Training was provided in the areas of treatment services, disease prevention, and health promotion within the e-Pulse system. Module 4: Education was provided on topics such as visited healthcare institutions, prescribed medications, medical report documents, physician diagnoses, tests, radiological images, emergency notes, doctor appointments, and cardiovascular disease risk calculation within the e-Pulse system. Module 5: Education was provided on topics such as disease prevention, early diagnosis, treatment services, physical activity, balanced nutrition, chronic disease control, health warnings, vaccinations by age group, health screenings, general health check-ups, assessing the reliability of health-related information in the media, medication use, and socialization. Module 6: Education was provided on topics such as participation in activities, healthy living spaces (homes, parks, walking areas, etc.), chronic disease management, smart medication use, balanced nutrition, and understanding information on food packaging.	1. An e-Pulse user guide have been sent to their phones. The guide explains the system's purpose and function, account creation, password management, doctor appointments, and medication management with step-by-step instructions. 2. An e-Pulse introduction video has been sent to their phones. The video covers topics such as account creation, login, password setup, doctor appointments, medication management, and emergency notes.
Aim	Achieving a sufficient and above level of health and e-health literacy	
Teaching method	Group-interactive/active	Individual—Passive
Intervention group: e-Pulse education group based on HLS-EU	✓	✓
Active control group: e-Pulse instructional materials group	✗	✓
Practitioner	Researcher	Researcher
Practice	Face-to-face + Phone via WhatsApp	Face-to-face + Phone via WhatsApp
Method of practice	Group- Individual	Individual
Practice time	Each education module consisted of two 45-min sessions, lasting a total of 6 weeks. 90 min × 6 modules: 540 min.	Individual interviews: Average 5–10 min. e-Pulse introduction video: 45 s.

2.5.1.2 | e-Pulse User Guide. This guide, prepared by the Ministry of Health of the Republic of Turkey, was sent to participants in PDF format via WhatsApp. The guide explains account creation, system login, and usage of sections such as "my illnesses" with instructions and visuals.

2.5.1.3 | e-Pulse Introduction Video. This video, prepared by the Ministry of Health of the Republic of Turkey, introduces the e-Pulse system. It can be accessed at https://enabiz.gov.tr. The video includes information on areas within the e-Pulse system such as "my appointments," "my radiological images," "my prescriptions," and "my tests." This video was downloaded and sent to participants via WhatsApp.

2.5.2 | Active Control Group: Interventions for the e-Pulse Instructional Materials Group

This group was provided with e-Pulse instructional materials, consisting of the e-Pulse user guide and an e-Pulse introduction video. The content of the e-Pulse system was also briefly explained to each participant in an individual session lasting approximately 5–10 min. The e-Pulse user guide provides sufficient detail and practical information to support individuals in learning the system. During these individual sessions, participants received necessary explanations to ensure they did not struggle to understand or apply the provided materials. Participants' questions were answered, and additional information about the basic functioning of the system was given. Afterwards, the participants were expected to learn the e-Pulse system on their own through the e-Pulse user guide and the e-Pulse introduction video.

2.6 | Data Analysis

Data were analyzed using the licensed SPSS Statistics Base v23 software. Statistical significance was evaluated at $p < 0.05$. χ^2 tests were used for categorical variables. ANCOVA analysis is used to analyze differences between groups' means in the posttest. The pretest was used as the covariate. Posttests were taken as the Dependent Variable. Pairwise comparisons were based on estimated marginal means. Bonferroni adjustment was made for multiple comparisons. Cohen's d analysis was conducted to measure the size of the difference between groups with a d value of 0.20 indicating a small effect, 0.50 representing a medium effect, and 0.80 corresponding to a large effect (Cohen 1988). Pearson's r measures the strength of the relationship between two variables. Pearson's r correlation analysis was performed to identify the strength of the relationship between health and eHealth literacy with a r value of 0.10 indicating a small effect, 0.30 representing a medium effect, and 0.50 corresponding to a large effect (Cohen 1988).

3 | Results

The CONSORT flowchart and workflow of the study are shown in Figure 1. All participants completed their post-tests with no dropouts. Baseline characteristics of the intervention and control groups were similar (Table 2). Changes in pre-test and posttest mean scores within the groups for (a) health literacy and (b) eHealth literacy are shown in Figure 2. ANCOVA analysis results on the effects of HLS-EU-based e-Pulse education and e-Pulse instructional materials on health literacy and eHealth literacy are presented in Table 3. The proportion of sufficient and excellent health literacy and the correlation between health literacy and eHealth literacy is represented in Table 4.

3.1 | Health Literacy (HLS-EU-Q47)

In the intervention group, pretest health literacy scores were 28.65 ± 4.502, increasing to 34.41 ± 6.563 in the posttest. For the active control group, these scores were 28.14 ± 4.629 at the pretest and increased to 29.38 ± 6.647 at the posttest (Figure 2a). A significant difference emerged in the effects of HLS-EU-based e-Pulse education and e-Pulse instructional materials on health literacy ($F(1, 137) = 25.215$; $p < 0.001$). There was a significant difference between HLS-EU-based e-Pulse education and e-Pulse instructional materials ($p < 0.001$). The HLS-EU-based e-Pulse education demonstrated a large effect size on health literacy ($d = 0.8492$; 95% CI: 0.5033–1.1951) (Table 3). Thus, Hypothesis 1 was supported.

3.2 | eHealth Literacy (eHEALS)

In the intervention group, the pretest eHealth literacy score was 24.90 ± 8.326, increasing to 30.21 ± 6.968 in the posttest. In the active control group, pretest and posttest eHealth literacy scores were 24.07 ± 7.839 and 24.76 ± 7.158, respectively (Figure 2b). A significant difference was observed in the effects of HLS-EU-based e-Pulse education and e-Pulse instructional materials on eHealth literacy ($F(1, 137) = 36.134$; $p < 0.001$). There was a significant difference between HLS-EU-based e-Pulse education and e-Pulse instructional materials ($p < 0.001$). The HLS-EU-based e-Pulse education demonstrated a large effect size on eHealth literacy ($d = 1.0175$; 95% CI: 0.6654–1.3696) (Table 3). Thus, hypothesis 2 was accepted.

3.3 | Proportion of Sufficient and Excellent Health Literacy

There was a significant difference in the proportions of health literacy levels between the two groups ($p < 0.001$). The proportion of individuals with sufficient and excellent health literacy levels was notably higher in the intervention group, with rates of 32.9% and 12.9%, respectively. By comparison, the active control group exhibited lower rates of sufficient and excellent health literacy, at 10% and 2.9%, respectively (Table 4). Consequently, Hypothesis 3 was supported.

3.4 | Correlation Between Health and eHealth Literacy

A medium correlation was observed between health literacy and eHealth literacy in the posttest results ($r = 0.602$; $p < 0.001$) (Table 4).

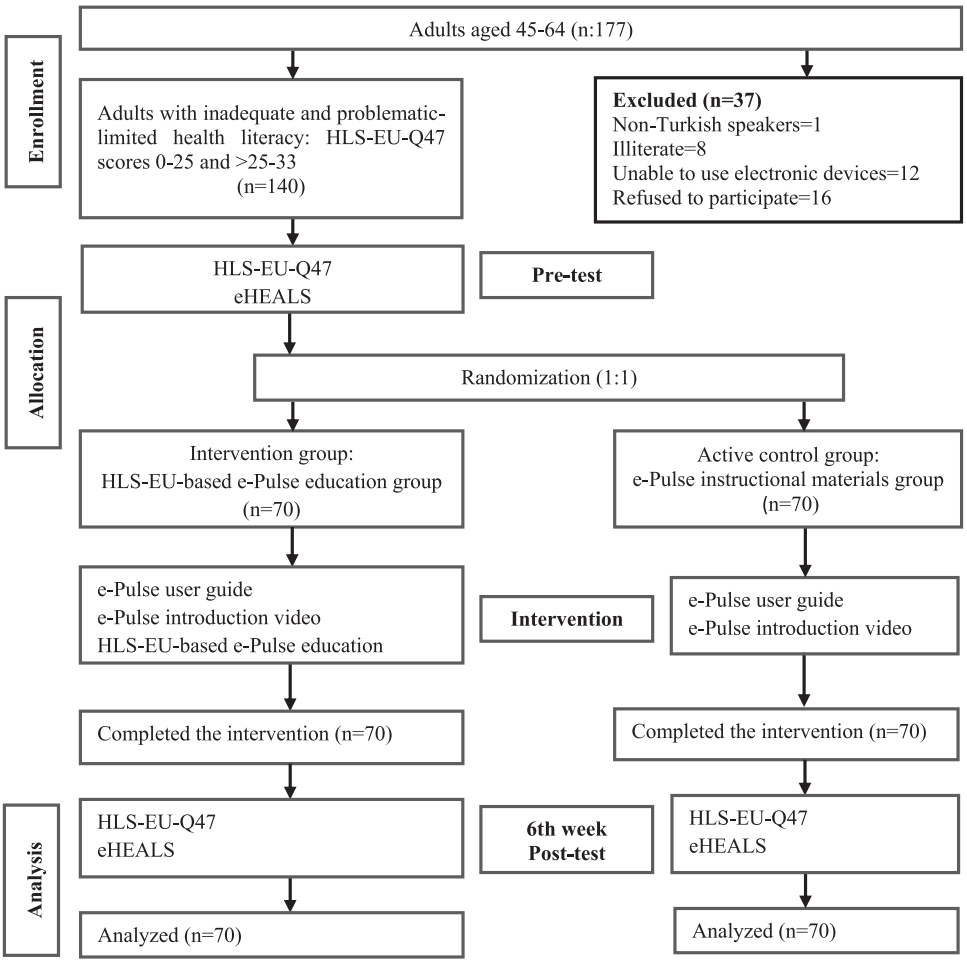

FIGURE 1 | CONSORT flow and workflow chart. HLS-EU-Q47: European Health Literacy Survey Questionnaire 47. eHEALS, eHealth Literacy Scale.

4 | Discussion

Both groups exhibited an increase in health and eHealth literacy scores, though the increase was more pronounced in the intervention group. The HLS-EU-based e-Pulse education was more effective in increasing health and eHealth literacy in the intervention group, showing a large effect. The number of participants with sufficient and excellent health literacy was higher in the intervention group. There is a positive medium relationship between health literacy and eHealth literacy.

The findings of our study indicate that active learning-based education can improve health and eHealth literacy. In a study conducted in a hospital in Turkey with the participation of 906 staff members, 26.2% of participants stated that they did not use the e-Pulse application due to a lack of training, while 36.9% reported that they were unsure whether the application contained up-to-date information (Ketenci et al. 2021). Another study conducted in Turkey concluded that individuals who actively use the e-Pulse application have higher health literacy levels than those who do not (İlgar and Bilgili 2023). Additionally, a study conducted in Turkey found that an increase in e-health literacy levels enhanced the perception of using the e-Pulse system (Uslu and İpek 2022), while another study found that as e-health literacy levels increased among older adults, the awareness and usage rates of digital health systems like e-Pulse also increased (İlgar and Bilgili 2023). Studies have shown that active learning enhances health literacy among adults with low health literacy (Uemura, Yamada, and Okamoto 2021) and effectively promotes a healthy lifestyle (Uemura, Yamada, and Okamoto 2018). Additionally, an educational program for adults with uncontrolled hypertension significantly improved health literacy in the intervention group (Ongkulna et al. 2022). Group-based interventions have been shown to enhance health literacy in terms of a better understanding of medical information (Blancafort Alias et al. 2021). In our study, the face-to-face group format of the e-Pulse education and the interaction among participants may have positively influenced health behavior through social bonding, information exchange, and collaborative learning.

A comprehensive study across 17 countries found individuals with lower health literacy rated their health negatively and faced significant challenges accessing healthcare services, hindering their ability to effectively manage their health (Pelikan et al. 2022). A systematic review examining a variety of interventions designed to improve health literacy, most of which were theory-based and group-focused, found that the vast majority of interventions produced positive results, particularly in improving individuals' ability to better understand health-

TABLE 2 | Characteristic of participants.

Characteristic	Intervention ($n = 70$) n (%)	Active control ($n = 70$) n (%)	Total ($N = 140$) n (%)
Age (mean ± SD)	55.14 ± 6.22	55.89 ± 5.92	55.51 ± 6.06
Gender n (%)			
Woman	28 (40)	27 (38.6)	55 (39.3)
Male	42 (60)	43 (61.4)	85 (60.7)
Education			
Secondary school and below	29 (41.4)	36 (51.4)	65 (46.4)
High school and above	41 (58.6)	34 (48.6)	75 (53.6)
Income status			
Income is less than expenses	31 (44.3)	30 (42.9)	61 (43.6)
Income equals expenses	29 (41.4)	32 (45.7)	61 (43.6)
Income exceeds expenses	10 (14.3)	8 (11.4)	18 (12.8)
Using internet			
How helpful do you think the internet helps you in making decisions about your health?			
Not helpful at all	2 (2.9)	1 (1.4)	3 (2.1)
Not helpful	3 (4.3)	6 (8.6)	9 (6.4)
I'm undecided	7 (10)	11 (15.7)	18 (12.9)
Beneficial	40 (57.1)	34 (48.6)	74 (52.9)
Very helpful	18 (25.7)	18 (25.7)	36 (25.7)
How important is it for you to have access to health resources on the internet?			
Does not matter	0 (0)	1 (1.4)	1 (0.7)
It's not important	8 (11.4)	9 (12.9)	17 (12.1)
I'm undecided	5 (7.2)	5 (7.1)	10 (7.2)
Important	36 (51.4)	31 (44.3)	67 (47.9)
Very important	21 (30)	24 (34.3)	45 (32.1)
Health literacy pretest score (mean ± SD)	28.65 ± 4.502	28.14 ± 4.629	28.39 ± 4.557
eHealth literacy pretest score (mean ± SD)	24.90 ± 8.326	24.07 ± 7.839	24.49 ± 8.068

related information, make decisions, and access health services (Berkman et al. 2011). In a study where the interventions were grounded in theory, they significantly improved eHealth literacy among adults, especially in understanding and using online health resources (Chang et al. 2022). A systematic review of evidence on the effectiveness of health literacy interventions in the EU, based on a variety of theoretical bases, found that group-based health literacy interventions were generally effective and resulted in significant increases in health literacy levels (Visscher et al. 2018). These findings support our study by showing that group-based and theoretically based interventions to increase health literacy are a critical strategy to improve individuals' health status and facilitate their access to health care.

Although technological devices have gained widespread acceptance among adults, a significant gap persists between ownership and utilization, with many individuals failing to fully leverage their benefits and utilizing only a fraction of their available features (Lai 2020). Various findings suggest that eHealth literacy can be improved through education in structured learning environments. Theory-based education programs effectively increase eHealth literacy (Chang et al. 2021), and a systematic review found that such interventions outperform nontheoretical approaches in enhancing eHealth literacy and promoting eHealth behaviors by raising health awareness (Pourrazavi et al. 2020). Another study reported that training programs help adults facilitate their learning of technologies (Tsai et al. 2019). In another study, individuals with high health literacy benefited more from telehomecare services, demonstrating better improvement in health outcomes and greater success in adhering to treatment recommendations and actively interacting with telehomecare tools. In contrast, individuals with low health literacy utilized these services less effectively (Korsbakke Emtekaer Haesum, Ehlers, and Hejlesen 2016). A study on electronic patient decision support tools for hypertension treatment found that the intervention group significantly improved their perceived health literacy regarding hypertension (Wehkamp et al. 2021). These findings emphasize that improving health literacy can significantly enhance health outcomes and quality of life across various adult populations. In our study, standardized interventions, such as hands-on practice and repetition with the e-Pulse system over six sessions,

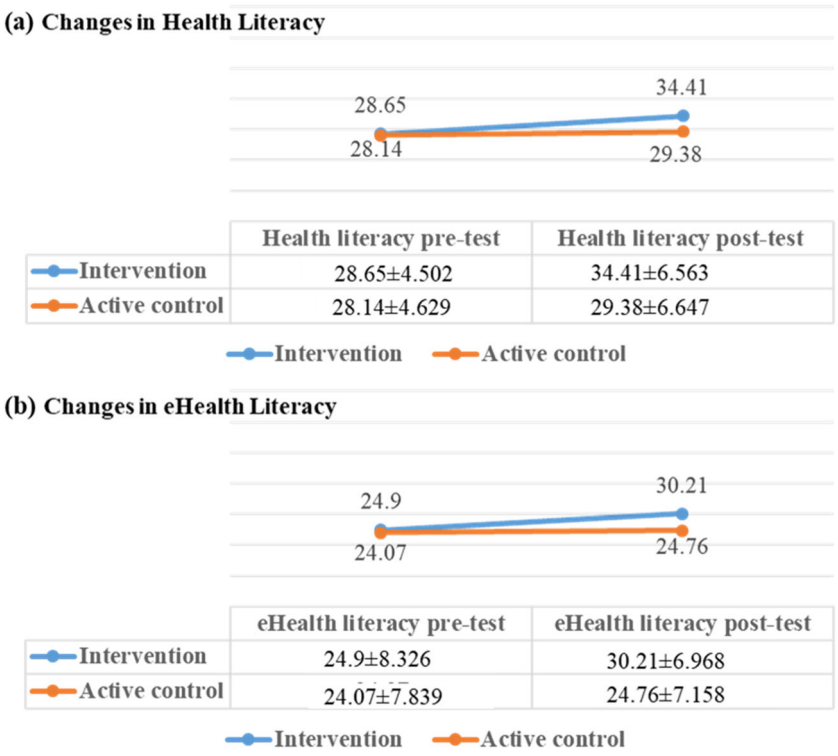

FIGURE 2 | Changes in pretest and posttest mean scores within the groups for (a) health literacy and (b) eHealth literacy.

along with a user guide and introduction video, likely increased participants' interest and focus on the e-Pulse system.

Our study found a medium positive relationship between health and eHealth literacy, suggesting that individuals with higher health literacy are likely to exhibit better eHealth literacy as well. This is supported by two studies that reported similar positive relationships between these literacies (Del Giudice et al. 2018; Singh et al. 2023), indicating a consistent pattern where improvements in understanding health information extend to digital platforms. However, two studies (Busse et al. 2022; Monkman et al. 2017) found no significant correlation between traditional health literacy and eHealth literacy, suggesting that these are distinct constructs requiring different skill sets. This discrepancy could highlight the role of external factors, such as technological access or individual engagement with eHealth resources, which may medium the strength of this relationship. Despite this, the overall trend in the literature suggests that improving health literacy may also enhance individuals' ability to effectively use eHealth tools, though more research is needed to account for potential variations across different populations or contexts.

4.1 | Strengths and Limitations

In the HLS-EU-based education program, the active participation of participants, their interactions with one another, socialization, and information sharing are the strengths of this study. In this study, the diversity and duration of the interventions applied to the intervention group may have influenced the hypotheses. The difference in education duration between the intervention and active control groups could have affected the results obtained. Both groups exhibited an increase in health and eHealth literacy compared to the baseline, with a more significant improvement observed in the intervention group. This increase may be attributed to the comparison of the effects of short-term versus long-term education. Furthermore, these findings provide valuable guidance for field practitioners, offering them various options in terms of both time and cost efficiency. In communities where healthcare resources are often limited, understanding the effective ways to deliver educational content can lead to more sustainable practices.

5 | Implications for Practice

Considering the potential of the HLS-EU-based educational program to enhance health literacy and eHealth literacy, it is recommended that HLS-EU-based uducational program be disseminated to broader audiences through digital platforms and collective educational interventions. This approach aims to facilitate access to health information for diverse demographic groups, thereby improving individuals' levels of health literacy and eHealth literacy. Additionally, the development of education programs that include HLS-EU-based educational modules and user-friendly guides, along with online educational materials, is suggested to enhance eHealth literacy. Incorporating interactive content may particularly benefit older adults, who may be less familiar with technology or have limited eHealth literacy. Programs supporting accessible technology and eHealth literacy should be developed to empower individuals to utilize digital health resources. Encouraging guidance programs aimed at teaching the use of digital devices and technology

TABLE 3 | ANCOVA analysis results on the effects of HLS-EU based e-Pulse education and e-Pulse instructional materials on both health literacy and eHealth literacy.

Tests of between-subjects effects							Pairwise comparisons			
Variables	**Type III sum of squares**	***df*[c]**	**Mean square**	***F***	***p* value**	**Partial η^2**	**Estimated marginal mean ± SE**	**Mean difference ± SE**	***p* value[b]**	***d* (95% CI)**
Health literacy										
Intervention ($n = 70$)	737.285	1-137	737.285	25.215	< 0.001	0.155	34.192[a] ± 0.647	4.597 ± 0.915	< 0.001	0.8492
Active control ($n = 70$)							29.595[a] ± 0.647			(0.5033–1.1951)
eHealth literacy										
Intervention ($n = 70$)	848.002	1-137	848.002	36.134	< 0.001	0.209	29.950[a] ± 0.579	4.929 ± 0.820	< 0.001	1.0175
Active control ($n = 70$)							25.021[a] ± 0.579			(0.6654–1.3696)

Note: Dependent variable: Health literacy posttest for health literacy and eHealth literacy posttest for eHealth literacy. Pairwise comparisons were based on estimated marginal means. R^2: 0.420 (adjusted R^2: 0.411) for health literacy. R^2: 0.594 (adjusted R^2: 0.588) for eHealth literacy.

[a]Covariates appearing in the model were evaluated at the following values: Health literacy pretest score = 28.39; eHealth literacy pretest score = 24.49.

[b]Adjustment for multiple comparisons: Bonferroni.

[c]The degrees of freedom (*df*) represent both the numerator and denominator values (numerator-denominator, respectively).

TABLE 4 | The proportion of sufficient and excellent health literacy and the correlation between health literacy and eHealth literacy.

Health literacy level	Sufficient *n* (%[a])	Excellent *n* (%[a])	Total *N* (%[a])	χ^2 *p* value[a]
Intervention ($n = 70$)	23 (32.9)	9 (12.9)	32 (45.8)	
Active control ($n = 70$)	7 (10)	2 (2.9)	9 (12.9)	< 0.001
Correlation	Pearson *r*	*p* value	*N*	
	0.602	< 0.001	140	

[a]In both groups, percentages and χ^2 analysis was calculated based on the number of participants ($n = 70$).

education will support the improvement of eHealth literacy and may increase individuals' access to digital health platforms and their ability to use these resources effectively.

Future studies should investigate the effects of similar multicomponent interventions and varying intervention durations, as our study demonstrated that the multifaceted educational approach implemented with the intervention group effectively improved both health literacy and eHealth literacy. However, in practical settings, shorter interventions for adults should be tested to evaluate their effectiveness, and research could assess the long-term impacts of short-term educational programs through cost–benefit analysis to enable a comparison of the associated benefits and costs. This would contribute to more efficient resource utilization. Additionally, to gain a clearer understanding of the relationship between health literacy and eHealth literacy, further research is recommended to explore the interactions between these two types of literacy, facilitating the adaptation of health literacy enhancement strategies within digital health environments.

Additionally, further research is recommended to explore the interactions between health literacy and eHealth literacy, to better understand their relationship and facilitate the adaptation of health literacy enhancement strategies within digital health environments.

6 | Conclusions

This study demonstrates that education based on the HLS-EU can significantly improve health and eHealth literacy levels in adults aged 45–64 with inadequate or problematic-limited health literacy. Structured, literacy-focused educational interventions can have a substantial positive impact on individuals' ability to understand and use health information. Implementing such intervention can empower individuals to better manage their health, navigate healthcare systems more effectively, and ultimately achieve better health outcomes.

Author Contributions

Study conception and design: Sebahat Gözüm, Selma Öncel, Ercan Asi, Demet İmamoğlu, and Suzan Kanlı. Data collection: Ercan Asi, Merve Şıklaroğlu, and Süleyman Şahin. Analysis and interpretation of results: Sebahat Gözüm and Ercan Asi. Draft manuscript preparation: Sebahat Gözüm, Selma Öncel, Demet İmamoğlu, Suzan Kanlı, and Ercan Asi.

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Ethics Statement

Ethics approval was obtained from the Clinical Research Ethics Committee of University Medical Faculty (Date: 07.12.2022; Decision No: KAEK-744). Official permission to conduct the research at Konyaaltı Healthy Life Center was obtained from Antalya Provincial Health Directorate (07.03.2023/211187260). Participants were informed about the research by the researcher before the training, and written and verbal consent was obtained from them. Participants have the right to withdraw from the training at any time, and the study poses no risk to them. The study is registered at ClinicalTrials.gov (ID: NCT05831254).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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