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Review Article

Predicting Digital Literacy: A Systematic Review of Digital Competence, Usage, and Transformation

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Information and communication technologies have become an integral part of daily life. However, the increasing reliance on technology in both personal and professional contexts presents significant challenges. Individuals' levels of digital literacy affect their ability to complete everyday and work-related tasks that depend on digital tools. The present systematic review is aimed at identifying the main predictors of digital literacy and understanding how these influence its three levels: digital competence, digital use, and digital transformation. This work (INPLASY Reference 202310053) followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. A literature search covering was conducted across Web of Science, Scopus, Elsevier, PsycInfo, and PubMed using a PICO framework-based search string, from 2017 to 2022. A total of 5342 records were identified, of which 103 underwent full-text screening. A total of 44 articles was included in the review. The analysis revealed that digital competence is primarily associated with higher education, higher socioeconomic status, and older age. Digital use is mainly predicted by access to digital devices and internet connectivity. Digital transformation is often associated with health-related contexts, where individuals are expected to self-manage their health through digital applications. Despite the growing interest in digital literacy, research on its determinants remains scarce and fragmented. Significant challenges and gaps persist, including inconsistent definitions and measurement approaches, limited investigation into digital transformation, a lack of intersectional analyses, and the overrepresentation of WEIRD (western, educated, industrialized, rich, and democratic) populations. There is a pressing need for more systematic, inclusive, and theory-driven research to inform policymakers and practitioners aiming to foster societal development. To address these gaps, we propose an ecological model of development that reflects how interconnected systems can shape digital literacy.

Keywords: determinants; digital competence; digital literacy; digital transformation; digital usage; systematic review

1. Introduction

Systematic reviews on digital literacy are essential for synthesizing knowledge, guiding practice and policy, identifying research gaps, and supporting the development of effective and equitable initiatives. Tinmaz et al. [1] show that, since 2013, there has been a growing number of publications on digital literacy, focusing on four major themes: digital literacy, digital competencies, digital skills, and digital thinking. Despite this increase in research, digital literacy continues to be described in heterogeneous ways, incorporating a wide range of both technical and nontechnical elements [1].

Digital literacy has become a cornerstone of modern life, shaping everything from access to healthcare services and educational opportunities to participation in democratic processes. Digital transition refers to the incremental transformation of practices, technologies, and institutional arrangements driven by the adoption of digital systems, often aligned with policy objectives [2]. As societies move further into digital environments, disparities in digital literacy have significant implications for social equity and individual well-being.

This systematic review is aimed at synthesizing the existing literature on the predictors of digital literacy across multiple domains. Digital literacy encompasses more than the ability to use digital tools; it includes the capacity to use them effectively for learning, problem-solving, and innovation [3]. It is conceptualized as a multilayered competence that integrates technical skills, critical thinking, and the ability to communicate and create content in digital environments [4]. As a dynamic and evolving concept, digital literacy also involves an understanding of digital ethics, privacy, and the broader societal impacts of technology [5]. Despite its growing recognition as a key determinant of social and economic participation, disparities in digital competence remain significant across demographic and geographic groups [6].

While digital literacy encompasses a broad range of competencies, research has primarily focused on specific domains, with *digital health literacy* being particularly prominent. Systematic reviews in this area have examined individuals' ability to access, understand, and apply digital health information. Estrela et al. [7] identified age, education, income, and social support as significant predictors, while gender, race, and place of residence showed limited effects. Arias López et al. [8] highlighted the health consequences of low digital health literacy and emphasized the need for improved assessment tools and greater inclusivity. Similarly, Milanti et al. [9] found associations between eHealth literacy and factors such as education, access to ICT, and native language proficiency. Results on age and gender, however, remained inconclusive. These findings highlight the conceptual overlap between digital health literacy and broader digital literacy, as both involve core competencies such as information seeking, critical evaluation, and digital communication, shaped by access, skills, and motivation [7–10]. Although some tools are specific to the healthcare domain, many digital environments span across multiple areas and rely on similar devices. Thus, digital health literacy can be considered a domain-specific expression of broader digital literacy, with transferable skills essential for full participation in the digital society [1, 3].

In this review, we aim to contribute to a broader understanding of digital literacy by analyzing its determinants across several contexts. We systematically reviewed the literature to identify and synthesize the existing evidence on the key predictors influencing digital literacy in the general population. Our analysis is based on the three levels of digital literacy proposed by Martin and Grudziecki [3]: digital competence, digital usage, and digital transformation.

The first level, digital competence, includes basic technical skills as well as attitudes and awareness. At this level, individuals draw upon digital skills as needed within specific contexts, applying them when faced with challenges. Digital usage, the second level, refers to the practical application of digital competence in particular settings, where situational demands guide digital practices. The third level, digital transformation, while not mandatory for digital literacy, is achieved when digital competence and usage lead to transformative shifts in knowledge and behavior. Unlike digital transition, which typically refers to policy-driven or institutional-level changes [2], digital transformation refers to an individual's capacity to harness digital skills for innovation, creativity, and meaningful change within their context [3]. In sum, this systematic review is aimed at identifying, within the general population (population), the various determinants (intervention and comparison) that influence digital competence, usage, and transformation (outcomes).

2. Method

The protocol for this systematic review was registered in INPLASY under the reference number 202310053. This work followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [11].

2.1. Eligibility Criteria. The inclusion criteria used to identify relevant studies were organized into three main categories: participants, types of literacy (i.e., competence, skill, and use), and predictors. The review focused primarily on correlational and experimental studies on digital literacy. Regarding participants, only studies with samples of individuals of any gender aged 16 years or older were considered eligible. Records were excluded if they did not focus (partially or fully) on digital literacy, if they targeted specific occupational groups or professions, or if they did not report empirical data. Additional exclusion criteria included non-English studies, literature reviews, letters to the editor, editorials, case reports, conference abstracts or presentations, personal opinions, dissertations, book chapters, institutional manuals, articles without full-text availability, and records published before 2017. Further details on the inclusion and exclusion process are summarized in Table 1.

2.2. Search Strategy. Data searches were conducted on January 27, 2022, across four major international databases: Web of Science, Scopus Elsevier, PsycInfo, and PubMed (United States National Library of Medicine). The search terms stemmed from the preestablished PICO (Population, Intervention, Comparison, Outcome) framework, presented in Table 2. These terms were refined three times to broaden the scope within the topic of interest, as initial searches yielded a very low number of records. The final search string was ("digital literacy" OR "technology use" OR "digital competence" OR "digital transformation") AND (predictors OR determinants OR drivers OR obstacles OR barriers OR resources).

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TABLE 1: Inclusion and exclusion criteria of the selected studies.

Inclusion criteria	Exclusion criteria
Participants: Any gender; 16 + Types of literacy (i.e., competence, skill, and use) Predictors of digital literacy Records: Published in English; correlational and experimental studies; published between 2017 and 2022	Not focused on digital literacy Focused on specific occupational groups/professions Not present empirical data Not published in English Literature reviews, letters to the editors, editorials, case reports, conference abstracts and presentations, personal opinions, dissertations, book chapters, and institutional manuals Articles not fully available online Records published before 2017

TABLE 2: Study selection criteria based on PICO.

P (population)	I (intervention)	C (comparison)	O (outcome)
General population	Exposure to factors influencing digital literacy (e.g., predictors, determinants, and drivers)	Different levels of exposure to influencing factors	Levels of digital literacy, specifically digital competence, digital use, and digital transformation

In the Web of Science database, exclusion filters were applied to remove proceedings papers, review articles, editorial materials, book chapters, data papers, letters, retracted publications, meeting abstracts, reprints, book reviews, and corrections, along with a date limitation (2017–2022). In PubMed, only the date limitation was applied, without additional filters. In Scopus Elsevier, filters were used to include only articles, with a date limitation. In PsycInfo, filters were set to include only academic journals within the same date range. No additional manual bibliography search was performed. The eligibility criteria are summarized in Table 1.

2.3. Data Selection and Collection Processes. All records were imported into the *Ryyan* reference manager. After removing duplicates, the remaining records were uploaded to facilitate critical appraisal. Reviewers were randomly selected from the research team to assess whether the studies met the inclusion criteria for this systematic review. First, the reviewers conducted the screening based on titles and abstracts. In cases of disagreement, the researchers discussed whether to include or exclude the record according to the predefined criteria, noting reasons for exclusion. If a conflict persisted, a third reviewer resolved the disagreement. Studies meeting the criteria proceeded to full-text screening.

A total of 5342 records were retrieved: 2025 from Scopus Elsevier, 1961 from Web of Science, 327 from PsycInfo, and 1029 from PubMed (see Figure 1 for more details).

Following the initial search, 2035 duplicate records were removed. After this step, 3307 articles remained and underwent title and abstract screening. This step aimed to identify studies addressing the determinants of digital literacy, resulting in 103 records selected for full-text screening. Two records were unavailable online and therefore were excluded, along with 57 records that did not meet the eligibility criteria. Consequently, 44 studies satisfied the predefined inclusion criteria and were included in this systematic review.

Full-text screening was performed to extract the following key information: authors, publication year, study objectives, population characteristics, data collection methods, methodologies used, and main findings. Details of the included articles are summarized in Table 3. The studies were published between 2017 and 2022, with the vast majority employing a cross-sectional design (84.09%).

2.4. Risk of Bias Assessment. The Joanna Briggs Institute (JBI) critical appraisal tools [56] were used to assess the methodological quality of the studies included in this review and to evaluate the extent to which potential quantitative bias was addressed. A specific checklist was applied for analytical cross-sectional studies (see Figure 2), and a separate checklist was used for mixed methods, descriptive, and quasiexperimental studies (see Figure 3).

Overall, the studies met the essential criteria to be considered credible, relevant, and methodologically robust. Since none of the studies presented a high risk of bias, no studies were excluded from the review. However, it is important to note that few studies provided sufficient data on exposure measurement and confounder assessment. As highlighted in the JBI checklist, identifying and managing confounding factors is particularly challenging in social sciences research, especially in behavioral studies.

Further details are provided in the Supporting Information.

3. Results

Most samples were collected in Turkey, the United States, Spain, India, Greece, and South Korea. These consisted primarily of students (54.54%) and included older age groups (43.18%), with participants of both male and female genders (84.09%). Figure 4 presents a density map illustrating the distribution of articles by country, with a predominance in North America, Europe, South Asia, and Australia. This distribution suggests that digital literacy is a subject of global

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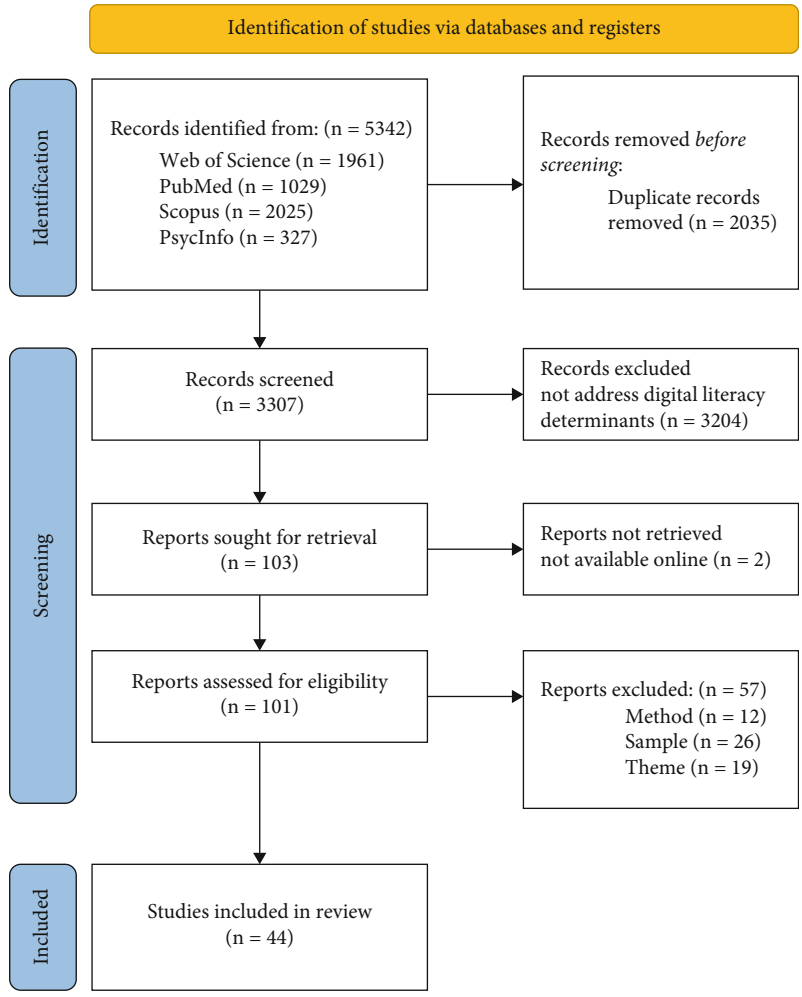


Figure 1: PRISMA flow diagram.

interest and significance, studied in diverse geographical contexts. However, it may also reflect biases related to the inclusion criteria, particularly the restriction to peer-reviewed articles published in English. Consequently, studies from regions with limited academic publishing infrastructure or from non-English-speaking contexts may be underrepresented.

To provide a more detailed description of the included studies, a thematic analysis was independently conducted by two reviewers to identify the determinants of digital literacy and corresponding assessment. The identified determinants were then grouped according to the three domains of digital literacy (competence, use, and transformation) as defined by Martin and Grudziecki [3].

Definitions of digital literacy used in the studies are presented in Table 3, alongside study descriptions. Most conceptualizations emphasized that digital literacy involves not only technical skills but also the cognitive abilities necessary to use digital tools across various life contexts effectively. Common themes included the capacity to locate, evaluate, and create information, as well as the ability to communicate, collaborate, and participate in digital environments. Additionally, most conceptualizations distinguished between competence (i.e., skills and knowledge required to use digital tools) and use (i.e., the application of those skills within specific contexts). Frequently mentioned aspects included accessing, evaluating, and managing information, along with communication and collaboration through digital technologies. Fewer conceptualizations emphasized transformation, defined as the ability to generate new content or use digital tools more creatively and innovatively.

Measures of digital literacy are systematized in Table 4, organized by the literacy level and type of determinant assessed in each study. Across the 44 studies, 55 measures were used. These focused on basic and general digital competences (36.36%), technology use and adoption (16.36%), health status (7.27%), computer proficiency and self-efficacy (7.27%), social media competencies (7.27%), digital citizenship (7.27%), internet literacy and knowledge (5.45%), access and online activities (5.45%), online learning engagement and motivation (5.45%), and Personal Informatization Index (1.82%).

Five categories of determinants emerged and are presented in Table 5: digital skills (23.65%), digital access (22.97%), motivation (20.27%), sociodemographic factors (18.24%), and health (14.86%). The digital skills category

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TABLE 3: Overview of included studies: Sample details, digital literacy definition, and predictors assessed.

ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
1	Zan et al., 2021 [12]	Turkey	Students	Young (50.09% 14–17 years old)	Female (69%), male (31%)	Cross-sectional	"Digital literacy is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, to enable constructive social action; and to reflect upon this process."	Competence: Sociodemographics Use: Sociodemographics, digital access Transformation: —
2	Ester et al., 2021 [13]	Canada	Clinical	Young, older (M = 60.6)	Female (71%), male (28.7%)	Cross-sectional	To assess technology literacy questions were asked about technology access, current usage, and perceived usefulness.	Competence: Sociodemographics Use: — Transformation: —
3	Harati et al., 2021 [14]	Iran	Students	Young (43.5% 18–22 years old)	Female (73%), male (27%)	Cross-sectional	"Digital literacy means the individual's ability to find, evaluate, extract, organize and utilize digital information that requires technical and cognitive skills."	Competence: Skills Use: Digital access Transformation: —
4	Leví-Orta et al., 2020 [15]	Spain and Latin America	Students	Young (37.4% 21–23 years old)	Female (58.6%), male (40.4%)	Cross-sectional	"Digital competence is one of the eight key competences that 'all people need for their personal fulfilment and development' (…) 'competence' entails the secure and critical use of information society technologies (IST) for work, leisure and communication. It is supported in [...] the use of computers in order to obtain, evaluate, store, produce, present and exchange information, and communicate and participate in collaboration networks via the internet."	Competence: Skills Use: Digital access Transformation: —
5	Yildiz Durak and Seferoğlu, 2020 [16]	Turkey	Students	Young (M = 23.04)	Female (57.3%), male (42.7%)	Cross-sectional	"Digital literacy is the skill of being able to use, interpret, inquire, and research the technology and communicate within the context of the status and the aim needed."	Competence: Demographics Usage: Digital access Transformation: —
6	Hernandez-Ramos et al., 2021 [17]	United States	Clinical	Young, older (M = 52.8) (M = 53.6) (M = 50.5)	Female, male (55.8%, 44.2%) (62.5%, 37.5%) (36.4%, 63.6%)	Cross-sectional	"The ability to use emerging information and communication technologies to find, access, create, download and communicate information."	Competence: Digital access Usage: Skills Transformation: Health
7	Laar et al., 2019 [18]	The Netherlands	General population	Young, older (38.3% 31–45 years old)	Female (47.1%), male (52.9%)	Cross-sectional	"21st-century digital skills: Information digital skills, communication digital skills, collaboration digital skills, critical-thinking digital skills, creative digital skills, problem-solving digital skills."	Competence: Sociodemographics and motivation Usage: Motivation Transformation: Skills

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TABLE 3: Continued.

ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
8	Tirado-Morueta et al., 2020 [19]	Spain	Elderly	Older (56.8% 55–64 years old) (24.1% 55–64 years old) (5.8%55-64y) (56.5% 55-64y)	Female, male (49.6%, 50.4%) (44.4%, 55.6%) (43.6%, 56.4%) (36.0%, 64%)	Cross-sectional	"Access to the Internet is defined as a process of appropriation that starts with to having physical and material access and advance to intelligent use and the obtaining of benefits."	Competence: Sociodemographics Use: Digital access Transformation: motivation
9	Sung et al., 2020 [20]	Korea	General population	Young, older (56% 30–39 years old)	Female (83%), male (17%)	Cross-sectional	To assess digital literacy, questions were taken from Son et al. (2011).	Competence: Health Use: Transformation: health
10	Owusu-Ansah, 2021 [21]	Ghana	Students	Young, older (57.8% 21–30 years old)	Female (55.8%), male (44.2%)	Cross-sectional	"Technology literacy and skills are required by users to interact with computers to create, locate, search and use information in digital content."	Competence: Skills Use: Sociodemographics Transformation: Digital access
11	Monteiro and Leite, 2021 [22]	Portugal	Students	Young (35.6% 18–20 years old)	Female (82%), male	Cross-sectional	"The concept of digital literacies (…) includes the three levels (…): digital competence, professional/discipline application, and innovation/creativity."	Competence: Sociodemographics Use: Skills Transformation: Skills
12	Krishnamurthy and Shettappanavar, 2019 [23]	India	Students	Young (53.24% 20-22y)	Female (100%)	Cross-sectional	"Digital literacy refers to the ability to locate, organize, understand, evaluate and create information using digital technologies."	Competence: sociodemographics Use: skills Transformation: -
13	Subaveerapandiyan and Priyanka, 2021 [24]	India	Students	Young, older (48.9% 17–21 years old)	Female (71.1%), male (28.9%)	Descriptive	"Digital literacy comprises the skills of media, computer and internet literacy as well."	Competence: Skills Use: Digital access Transformation: Motivation
14	Lepore et al., 2018 [25]	United States	Clinical	Young, older (60.7% 52–65 years old)	Female (100%)	Cross-sectional	"(…) digital literacy is knowing how technology and digital media are used to communicate with others and gain knowledge and understanding."	Competence: Health Use: Motivation Transformation: —
15	Son et al., 2017 [26]	Australia and Japan	Students	Young, older (M = 28.2) (M = 20.2)	Female, male (61%, 39%) (13%, 87%)	Cross-sectional	"Digital literacy is the ability to use digital technologies at an adequate level for creation, communication, collaboration, and information search and evaluation in a digital society. It involves the development of knowledge and skills for using digital devices and tools for specific purposes."	Competence: Skills Use: Digital access Transformation: —

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TABLE 3: Continued.

ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
16	Soyemi et al., 2018 [27]	Nigeria	Educational	—	—	Cross-sectional	"In this study digital literacy refers to individual's ability to use a computer (hardware and software), using online information and creating and managing online information."	Competence: Skills Use: Digital access and skills Transformation: —
17	Udoh et al., 2020 [28]	Nigeria	Student	—	Female (50.83%), male (49.1%)	Descriptive	"(…) digital literacy is the ability to use digital technology, communication tools or networks to locate, evaluate, use and create information."	Competence: Skills Use: Skills and digital access Transformation: —
18	Arslantas and Gul, 2022 [29]	Turkey	Clinical, students	Young (M = 24.9)	Female (35%), male (65%)	Mixed methods	"(…) a framework with three main intersecting dimensions as 'technical,' 'cognitive,' and 'social-emotional.' The technical dimension is associated with technical and operational skills such as the usage of peripheral devices, protecting files, troubleshooting, searching and installing applications, and transferring data. The cognitive dimension relates to the ability to think critically in searching for and evaluating digital information, selecting appropriate software for specific tasks, and in creating products that best demonstrate new understanding. The social-emotional dimension is about using the Internet appropriately for the purposes of socializing, communicating and learning, and for protecting the safety and privacy of the individual."	Competence: Sociodemographics and Skills Use: Digital access Transformation: —
19	Eri et al., 2021 [30]	Australia and India	Students	Young, older (93% 18–24 years old)	Female (56.8%), male (41.3%)	Mixed methods	"Digital competence refers to the capacity of using digital technologies consciously and critically as users in public and private life conduct problem solving, communicating, information managing, collaborating, and effective knowledge building."	Competence: Sociodemographics and motivation Use: skills Transformation: —
20	Madrigal and Escoffery, 2019 [31]	United States	Clinical	Young, older (M = 50.7)	Female (49.9%), male (49.4%)	Cross-sectional	It was assessed "ownership of different devices (…) internet access, frequency of internet use, as well as engagement of eHealth behaviors such as tracking of health indicators, use of mobile apps for health, health information-seeking behaviors, and other Web-based activities related to health."	Competence: — Use: Digital access Transformation: —
21	Vollbrecht et al., 2020 [32]	United States	Clinical	Young, older (M = 51)	Female (52.8%), male	Cross-sectional	The study pretends to "determine the relationship between health literacy level and technology access, use, and digital capabilities."	Competence: Health Use: Digital access

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TABLE 3: Continued.

ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
								Transformation: health
22	Ertl et al., 2020 [33]	Germany	General population	Young, older (M = 40.73) (M = 36.73) (M = 34.32)	Female, male (45.5%) (41.9%) (59.5%)	Cross-sectional	"Analyzing aspects of digital divide, (…) distinguishes four types of access: material access, that relates to computer and internet access, motivational access as the wish to have a computer and internet access, skills access as comprising of the skills necessary for handling a computer and accessing the internet, and usage access as usage time, diversity, activity and creativity."	Competence: Sociodemographics Use: Digital access Transformation: —
23	Wang et al., 2021 [34]	China	Students	Young (18–25 years old)	Female ($N = 449$), male ($N = 246$)	Cross-sectional	"Digital competence is related to the knowledge, capacities, and attitudes of using digital technologies to consume, evaluate, and create learning information and to collaborate and communicate with others for learning purposes."	Competence: Sociodemographics and skills Use: Digital access Transformation: Health
24	Ko et al., 2019 [35]	Korea	General population	Young, older (M = 56.91) (M = 58.19)	Female, male ($N = 145$, $N = 149$) ($N = 115$, $N = 117$)	Cross-sectional	"(...) the ability to understand and use information from a variety of digital sources and regarded it simply as literacy in the digital age."	Competence: Sociodemographics Use: Sociodemographics Transformation: Motivation
25	Kumpikaitė-Valiūnienė et al., 2021 [36]	Poland, Lithuania, Turkey, and India	Students	Young (M = 25.38) (M = 23.08) (M = 23.33) (M = 22.75)	Female, Male (79%) (50.9%) (59.8%) (48.4%)	Cross-sectional	"(…) according to the European Commission, digital competence includes competencies related to the knowledge and the usage of information, communication and collaboration, the creation of digital content, safety and problem-solving."	Competence: Health Use: — Transformation: —
26	O'Doherty et al., 2019 [37]	Ireland	Educational and Students	Young, older (51% 24–29 years old)	Female, male (57%, 43%)	Mixed methods	"The Internet Skills Scales assesses operational skills, information navigation skills, social skills, creative skills, mobile skills."	Competence: Sociodemographics and skills Use: Skills Transformation: Sociodemographics and skills
27	Soysal et al., 2019 [38]	Turkey	Student and general population	—	Female, male	Cross-sectional	"ICT literacy is the utilization of digital technology, communication mechanisms and networks in order to access, manage, arrange and discover new information sources."	Competence: Sociodemographics Use: Digital access Transformation: —

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TABLE 3: Continued.

ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
28	Martzoukou and Fulton, 2020 [39]	Scotland, Ireland, and Greece	Students	Young, older (49.1% 18–22 years old)	Female (79.3%), male (20.7%)	Mixed methods	"(…) digital literacies as 'capabilities which fit an individual for living, learning and working in a digital society', highlighting a number of areas, including the use of digital tools as well as digital professionalism, communicating ideas effectively, collaborating in virtual networks and using digital technologies to support reflection."	Competence: Sociodemographics and Skills Use: Motivation Transformation: Skills
29	Atoy et al., 2020 [40]	Philippines	Students	—	—	Cross-sectional	"(…) developed the digital literacy framework with eight core components: functional meaning making, critical thinking, creativity, collaboration, finding and selecting information, social and cultural awareness, effective communication, and e-safety."	Competence: — Use: Digital access Transformation: —
30	Jo et al., 2021 [41]	Korea	Elderly	Older (M = 74.2)	Female (55.7%), male (44.3%)	Cross-sectional	Questions were asked about ICT literacy "adopted from the 2018 Digital Divide Survey". It was assessed "knowledge of new technology and attitudes toward the use of technology" and "smartphone utilization skills".	Competence: Health Use: Digital access and Health Transformation: Health
31	Terp et al., 2021 [42]	Denmark	Clinical	Older (M = 81)	Female (52%), male	Cross-sectional	The study explores the participants' competence, preferences, and attitudes toward the use of information and communication technology (ICT).	Competence: Sociodemographics and motivation Use: Digital access and health Transformation: Motivation and health
32	del Rosario García et al., 2022 [43]	Spain	Clinical	Young, older (M = 59.9)	Female (63.9%), male	Cross-sectional	"The web 2.0 tools are those programs or websites available to carry out certain functions on the Internet. These can be applied to other vital aspects such as learning and teaching and can also facilitate interaction between people." To evaluate the degree of digital literacy, it was assessed the proportion of patients using the internet daily using the email at least once a week and with a positive perspective of web 2.0 tools.	Competence: Sociodemographics Use: Digital access Transformation: Health
33	Zhang et al., 2017 [44]	United States	Elderly	Older (M = 72.56)	Female (67%), male	Quasi-experimental	"Computer proficiency refers to skills related to human-computer interaction and is distinct from previous computer experience and frequency of use."	Competence: Sociodemographics Use: Motivation Transformation: —

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TABLE 3: Continued.

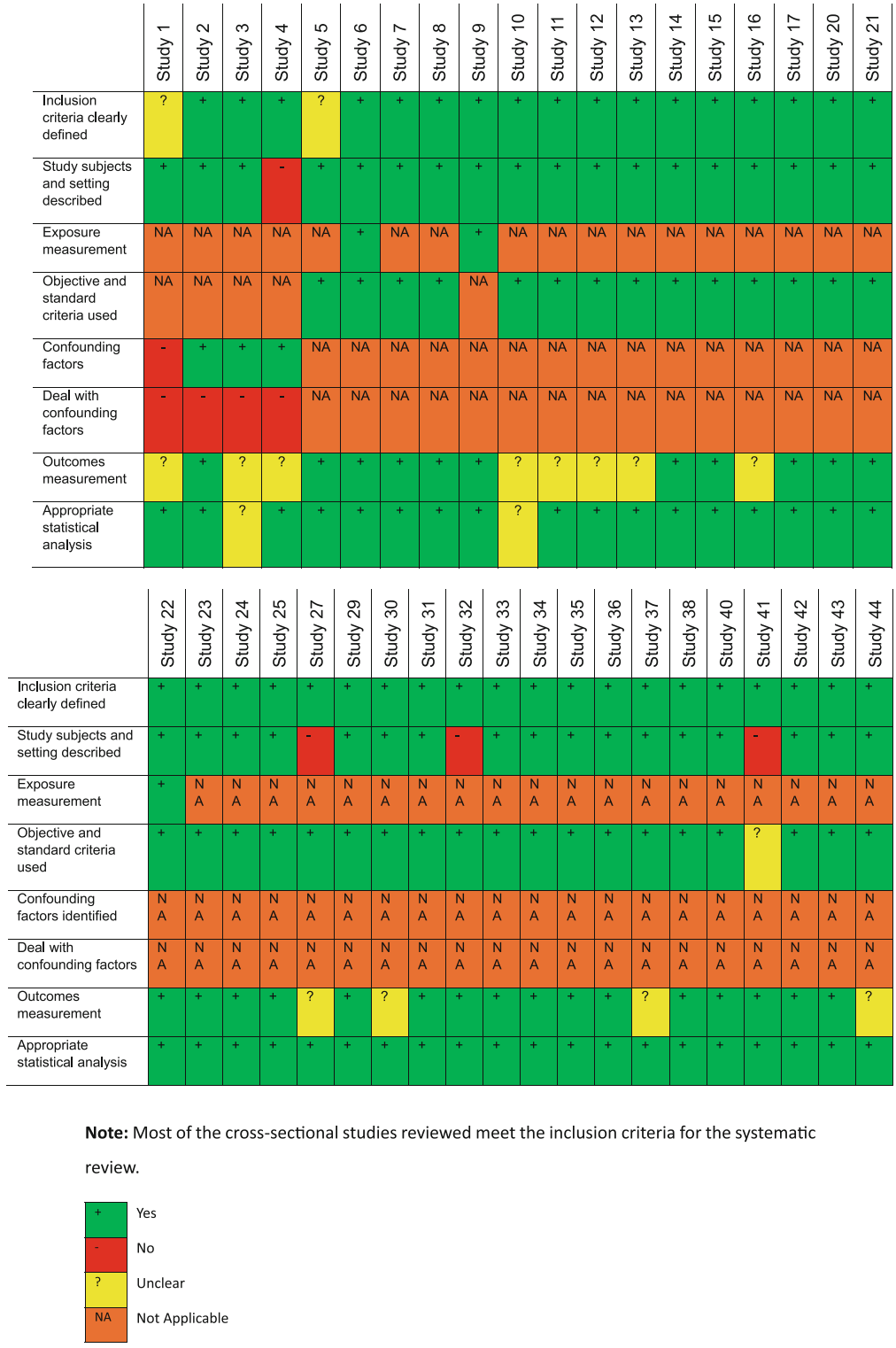
ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
34	Di Giacomo et al., 2019 [45]	Italy	Elderly	Older (M = 69.43)	Female (54.7%), male (45.3%)	Cross-sectional	"Digital skills are now as vital as literacy, and the world needs digitally competent people who are able to not only use but also innovate and lead in using these technologies."	Competence: Health Use: Skills Transformation: —
35	Kara, 2021 [46]	Turkey	Students	—	Female (73.5%), male (26.5%)	Cross-sectional	"(…) the multiplicity of literacies associated with the use of digital technologies and covers learners' ability to use digital tools in offline and online environments."	Competence: Motivation and Health Use: Skills Transformation: Skills
36	Scherer et al., 2017 [47]	Norway	Students	Young (M = 14.8)	Female (50.2%), male	Cross-sectional	"(…) comprises two strands with seven aspects: The first strand refers to 'collecting and managing information' and contains three aspects: (1.1) Knowing about and understanding computer use, (1.2) Accessing and evaluating information, and (1.3) Managing information. The second strand refers to 'Producing and exchanging information' and contains four aspects: (2.1) Transforming information, (2.2) Creating information, (2.3) Sharing information; and (2.4) Using information safely and securely."	Competence: Motivation Use: Digital access Transformation: —
37	Rafi et al., 2021 [48]	Pakistan	Students	—	Female (27.8%), male (72.2%)	Cross-sectional	"The term literacy includes all methods of languages in reading, writing, speaking, listening and thinking, while information literacy uses to identify the problem at hand."	Competence: Digital access Use: Skills Transformation: —
38	Katsarou, 2021 [49]	Greece	Students	Young (96.4% 18–25 years old)	Female (60.7%), male (39.3%)	Cross-sectional	"The acquisition of adequate digital literacy skills has been linked to successful participation in and completion of online learning (99) and they generally represent 'the capabilities required to thrive in and beyond education in a digital age'."	Competence: Motivation and health Use: Skills and Digital access Transformation: —
39	Martínez-Alcalá et al., 2021 [50]	Mexico	Elderly	Older (M = 61.27) (M = 65.44)	Female, male (79.31%, 18.18%) (66.66%, 33.33%)	Quasi-experimental	"(…) when referring to digital literacy, it is understood that it involves information literacy, which is defined as the knowledge and digital skills of a person to locate information in various formats." (…) "Consequently, to be digitally literate, people must be able to identify information to critically analyze it and reconstruct it, developing specific digital skills (data management, navigation, communication, content creation)".	Competence: Motivation Use: Digital access and skills Transformation: —

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TABLE 3: Continued.

ID	Authors and year	Country	Population	Age	Sex	Design	Digital literacy definition	Determinants
40	Marsh, 2018 [51]	United Kingdom	General population	Young, older (M = 38.36)	Female (83.8%), male (16.2%)	Cross-sectional	"Digital Literacy is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process."	Competence: — Use: Motivation Transformation: —
41	Llorent-Vaquero et al., 2020 [52]	Greece	Students	Young, older (87% 18–26 years old)	—	Cross-sectional	"(…) four fields regarding the definition of the term: Technical competence; the ability to use digital technologies in a meaningful way for working, studying and in everyday life; the ability to evaluate digital technologies critically; and the motivation to participate in and commit to digital culture."	Competence: Digital access Use: Skills Transformation: —
42	Xu et al., 2019 [53]	China	Students	—	Female ($N = 557$), male ($N = 189$)	Cross-sectional	"(…) digital citizenship with a digital literacy foundation that focused on (1) respectful behavior online and (2) online civic engagement." (…) "'the norms of behavior with regard to technology use'".	Competence: Skills and digital access Use: motivation Transformation: —
43	Tirado-Morueta et al., 2021 [54]	Spain	Elderly	Older (M = 67.78)	Female (56.7%), male	Cross-sectional	"Five dimensions on which digital inequality can be articulated among older people: variation in the technical means (hardware and connections) by which people access the internet; variation in the extent to which people have autonomy when using the internet; is inequality in the skill that people bring to their use of the internet; inequality in the support available to internet users; variation in the purposes for which people use technology."	Competence: Sociodemographics and Motivation Use: Motivation Transformation: —
44	Menger et al., 2020 [55]	England	Clinical	Young, older (M = 68.9) (M = 69.8)	Female, male ($N = 10$, $N = 15$) ($N = 5$, $N = 12$)	Cross-sectional	"Older adults without aphasia and adults with other disabilities may also have poor knowledge or skills of the Internet and may also be at increased risk of inadequacy of skills or knowledge to enable equality of access to the Internet or Internet-based services. This type of disadvantage is frequently defined in social science research as "digital exclusion."	Competence: Sociodemographics, motivation, and health Use: Digital access Transformation: —

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Note: Most of the cross-sectional studies reviewed meet the inclusion criteria for the systematic review.

FIGURE 2: Assessment of risk of bias in the selected cross-sectional studies. Note: Most of the cross-sectional studies reviewed meet the inclusion criteria for the systematic review.

includes specific abilities such as computing and reading skills, the ability to create digital learning materials, and knowledge of digital resources. The digital access category encompasses access to digital devices and the age at which individuals first began using the internet. The motivation category covers both individual and social aspects, including autonomy, self-efficacy, regulation, resilience, as well as learning and performance goal orientation. The socio-demographic category comprises variables such as age and gender, education level, income, and type of school (e.g.,

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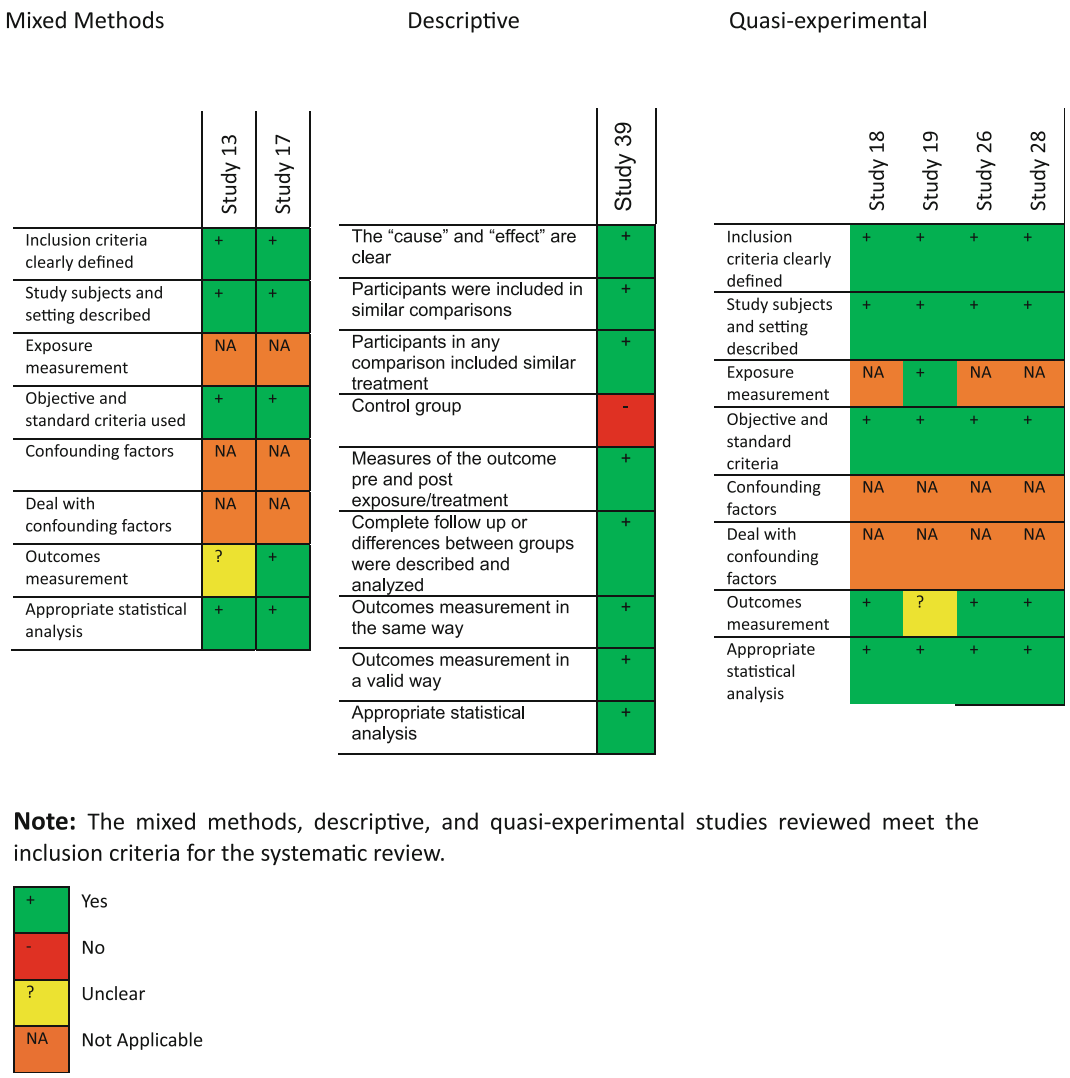


FIGURE 3: Assessment of risk of bias in the selected mixed methods, descriptive, and quasiexperimental studies. Note: The mixed methods, descriptive, and quasiexperimental studies reviewed meet the inclusion criteria for the systematic review.

private school). Finally, the health category includes factors such as clinical diagnoses, burnout, stress, computer anxiety, well-being, mindfulness, affect, fear of missing out, and health literacy. Reviewers further categorized the effects of these predictors as positive, negative, or mixed, based on their influence on the measures of digital literacy.

The distribution of predictors across the studies varies among these categories and the different dimensions of digital literacy. Figure 5 illustrates the variables associated with these predictors, organized by category. Notably, variables related to skills and motivation are exceptions, appearing across all dimensions in relatively similar proportions. Sociodemographic variables are more frequently and positively associated with the competence dimension of digital literacy, mainly through higher education levels and better socioeconomic status. In contrast, digital access variables tend to be more positively linked to the use dimension. Health-related variables are more often considered predictors of the transformation dimension, primarily reflecting studies that demonstrate the positive impact of digital technologies on patients' ability to manage their health conditions.

3.1. Predictors of Digital Competence. Digital competence refers to the essential skills, attitudes, and awareness required to use digital tools across various contexts. Most studies focused on predictors of digital competence, accounting for 44.59% of all identified predictors.

3.1.1. Digital Skills. Research showed that digital competence is strongly linked to digital skills (21.21%), particularly to the acquisition of skills and access to resources that support the improvement of digital knowledge and awareness [14, 15, 21, 26–28, 34, 37, 53]. Consistent with earlier studies, resources must be available from an early age, as earlier access allows individuals to develop their digital literacy skills more effectively [24, 29, 39]. In the university context, Harati et al. [14] emphasized that attending digital courses

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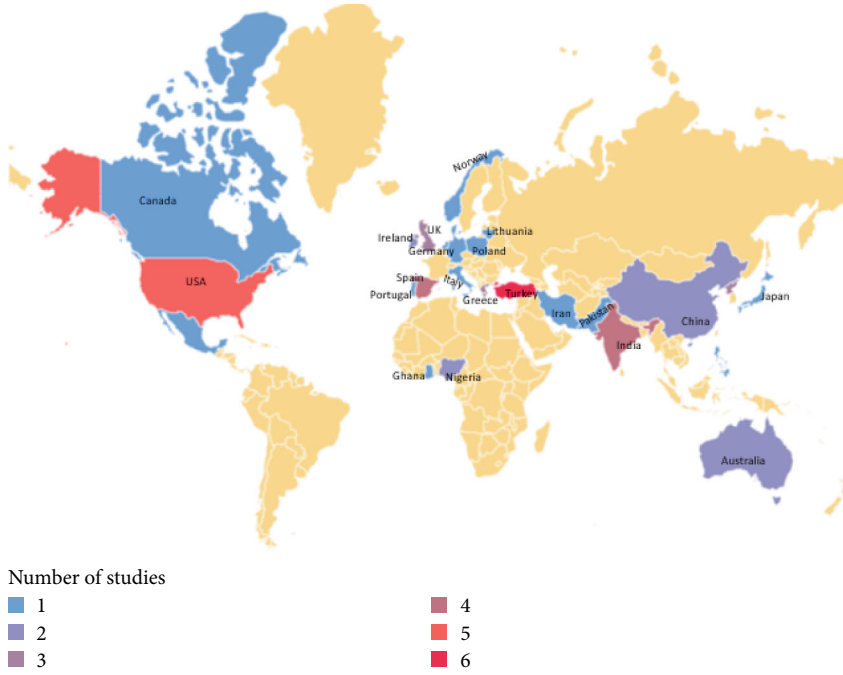


FIGURE 4: Geographical distribution of included articles across countries.

enhances students' digital skills, which are fundamental for learning and conducting academic tasks.

3.1.2. Digital Access. Access to digital tools emerged less frequently as a predictor of digital competence (6.06%). While having digital access, such as Wi-Fi at home or owning a smartphone, plays an important role in digital literacy competence, studies stress that access alone is insufficient since individuals cannot learn or improve skills without access to digital tools [17, 48, 52]. Hernandez-Ramos et al. [17] pointed out that although guaranteeing access is essential, providing training for people with low digital literacy is fundamental; otherwise, they cannot fully benefit from having access. Llorent-Vaquero et al. [52] highlighted the need for students to receive training and educational support to develop digital competence. Similarly, Rafi et al. [48] asserted that while access is essential, it does not guarantee skill acquisition without complementary training and pedagogical support.

3.1.3. Motivation. Motivation was the second most frequent category of determinants within digital competence (22.73%). Digital competence was associated with higher motivation to use digital tools [46], greater autonomy [54], increased self-efficacy [18, 47, 49], and higher resilience [30]. Motivational factors proved especially important in contexts where individuals lacked adequate digital resources but remained motivated to improve their skills. For individuals experiencing low confidence [42, 55], social support from family or community became crucial [42], particularly for older adults [55]. Martínez-Alcalá et al. [50] suggested that elderly individuals need internet access to continue training, sustain motivation, and enhance their digital skills. Motivation also played a significant role among people with clinical conditions. While some perceived their condition as a barrier to skill improvement, for most, it was not an impediment [55].

3.1.4. Sociodemographic. This category contained the most significant number of predictors within digital competence (33.33%). Individuals with higher education levels [16, 44, 54] and those attending schools equipped with digital tools and staffed by digitally literate teachers demonstrated greater digital competence [12, 22, 23, 34]. Soysal et al. [38] noted that disparities in schools' technological resources were linked to differences in students' digital knowledge and skills, thereby exacerbating the digital divide. Regarding socioeconomic status, studies suggested that individuals with better employment conditions, higher income, and greater economic opportunities exhibited superior digital knowledge, skills, and competence [13, 30, 33–35, 38]. Employment type also influenced competence: self-employed individuals showed greater digital knowledge, whereas employees tended to avoid tasks perceived as beyond their abilities [18]. Age was another significant factor, reflecting educational processes and generational differences. Older individuals with higher education had greater digital competence and more access to digital tools [19, 29]. Research indicated that individuals first exposed to digital tools later in life faced greater difficulty learning digital skills [43], which often led to resistance to adopting technology. This, in turn, highlights the need for tailored learning strategies to overcome such barriers [13, 55]. Tirado-Morueta et al. [54] emphasized that for older adults, social support was a key predictor of digital inclusion and connectivity. Regarding gender, most studies focused on binary distinctions, with differences in competence mirroring societal gender roles. Men were generally perceived as more skilled in digital protection [38], spent

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TABLE 4: Digital literacy assessment tools by study.

Measure Questionnaire	Digital literacy dimension tapped Competence	Use	Transformation
Basic and general digital competences			
Basic digital competences 2.0 in university students (COBADI) (registered trademark: 2970648)	41	41	
Computer and information literacy (CIL; Fraillon et al., 2014)	36		
Digital competence profiler (DCP; Blayone, 2018)	25	25	
Digital literacy evaluation (DILE; Martínez-Alcalá et al., 2018)	39	39	
Digital Literacy Questionnaire—Language Learners (DLQ-LL; Son et al., 2017)	38		
Digital Literacy Scale (DLS; Ng, 2012)	1, 18	1, 18	
Digital Literacy Scale (Hamutoglu,et al., 2017)	5	5	
Digital Literacy Scale (Üstündag et al., 2017) (Turkish version of Ng, 2012)	35	35	
Digital Skills Scale (Goldhammer et al., 2013)	8, 43	43	
e-Literacy Support Scale—Individuals' level of internet skills (Eurostat, 2018)	8		
ICT use for different purposes (Frailon et al., 2015)		36	
Perceived ICT Literacy Scale (Lau, 2014)	27	27	
Program for the International Assessment of Adult Competencies—PIAAC data set—German version (Rammstedt et al., 2016)	22	22	
Self-perceived digital competence in the use of mobile devices (MAUDIMO; Leví-Orta et al., 2019)	4	4	
21st-century digital skills (Van Laar et al., 2018)	7	7	7
Likert-type on digital literacy, digital competence, and capabilities	12, 13, 28, 37	12, 13, 28, 37	28, 13
Multiple choice items on digital literacy (ad hoc)	6	6	
Questionnaire on Digital Literacy Skills of Undergraduate Students of Library and Information Science on the Utilization of Electronic Information Resources in Two Federal Universities in Nigeria (QDLSUSLISTFU) (ad-hoc)	17	17	
Questionnaire on digital literacy skills	16	16	
Questionnaire on ICT literacy (adapted from 2018 Digital Divide Survey)	30	30	30
Computer proficiency and self-efficacy			
Computer Proficiency Questionnaire (CPQ; Boot et al., 2015)	33	33	
Computer self-efficacy (CSE; Durndell & Haag, 2002)	38	38	
ICT self-efficacy, interest, and enjoyment (Fraillon et al., 2014)	36	36	
Internet Skills Scale (ISS; Van Deursen et al., 2015)	26	37, 26, 29	
Digital citizenship			
Digital Citizenship Scale (DCS; Al-Zahrani, 2015)	42	42	
Social Relations Scale (Van Deursen & Helsper, 2015)		8	8
Social Interaction Scale (SI, Papacharissi and Rubin (2000)	43	8	8
Social enhancement (SE; Ku et al. (2013)		8	8
Digital health competencies			
Brief Health Literacy Screen (BHLS; Chew et al., 2008)	21		
Questions adapted from Health Information National Trends Survey (National Cancer Institute, 2015)	20	20	20
Questions adapted from The Social life of Health Information (Pew Research Center, 2015)	20		20
Questions adapted from Internet Surveys—Health and Technology in the U.S. (Pew Research Center, 2013)	20	20	20
Technology use and adoption			
Information Systems Continuance Model (ISCM; Bhattacherjee, 2001)		40	
Unified theory of acceptance and use of technology (UTAUT; Venkatesh et al., 2003)		40	
Likert-type scale on technology use (ad hoc)	2, 9, 11, 12, 34	34, 11, 12,	9

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TABLE 4: Continued.

Measure Questionnaire	Digital literacy dimension tapped Competence	Use	Transformation
Questionnaire based on Standards and Guidelines of ALA and Bawden Digital Literacy Model (Bawden, 2008)	3	3	
Likert-type scale on ICT use, social support, digital inequality (items adapted from other scales)	7, 23	7, 23	23
Questionnaire on digital tools use, internet activities, attitudes toward the use of digital technologies, and online safety (Likert-type scale/multiple choice)	15, 19, 22, 44, 10	17, 44,10, 15, 19	32, 10
Semistructured interviews to explore acceptability of remote onboarding procedures			6
Semistructured interviews on the experiences, competencies, and attitudes toward the use of ICT	31	31	31
Questionnaire (open questions) on opportunities, obstacles, and other uses or functions of digital technologies			11
Access and online activities			
Physical access scale—Individuals-internet activities (Eurostat, 2018)		18	
Literacy support—Individuals' level of internet skills (Eurostat, 2019)	43	43	
Focus group interview on engagement with internet/digital		26	26
Online learning engagement and motivation			
Motivation for Learning Scale (Yurdugül & Sirakaya, 2013)	35		
Online Learner Engagement Scale (Ergun & Koçak Usluel, 2015)	35	35	35
Self-Directed Learning Scale (Yurdugül & Sirakaya, 2013)	35		35
Social media competencies 47			
Social Media Competency Scale (SMCS; Albert et al., 2015)	42	42	
Semistructured interview on digital competence, technology use, social media, and creation of content	26	26	26
Usage purpose of social networking sites scale (Karal and Kokoç, 2010)		5	
SMU Attitude Scale (Otrar & Argin, 2016)		5	
Internet literacy and knowledge			
Internet knowledge (iKnow; Potosky, 2007)	14	14	
Pew Internet Project (Pew Research Center, 2016	21	21	21
Likert-type scale on online information searching strategies adapted from Online Information Searching Strategies Inventory (OISSI)		29	
Personal Informatization Index			
Personal Informatization Index (PII): Delphi survey (NIA, 2012)	24	24	24

TABLE 5: Digital literacy determinants across competence, use, and transformation dimensions.

Categories of determinants	Competence				Use				Transformation				Total	
	+	−	±	%	+	−	±	%	+	−	±	%	∑	%
Sociodemographic	20	—	2	33.3	2	2	—	6.1	1	—	—	5.3	27	18.2
Skills	14	—	—	21.2	16	—	—	24.2	5	—	—	26.3	35	23.7
Digital access	4	—	—	6.1	26	—	3	39.4	1	—	—	5.3	34	23
Motivation	11	1	3	22.7	11	—	—	16.7	4	—	—	21.1	30	20.3
Health	6	6	—	16.7	1	2	—	4.5	9	—	—	42.1	30	14.9

Note: + indicates the determinant has a positive effect, − indicates the determinant has a negative effect, and ± indicates the determinant has positive and negative effects.

more time online, and performed more digital tasks [18, 42, 54]. However, in Soysal et al.'s study [38], women scored higher in information literacy.

3.1.5. Health. Better health indicators (16.67%) were generally associated with higher digital competence. Individuals with clinical diagnoses often demonstrated greater

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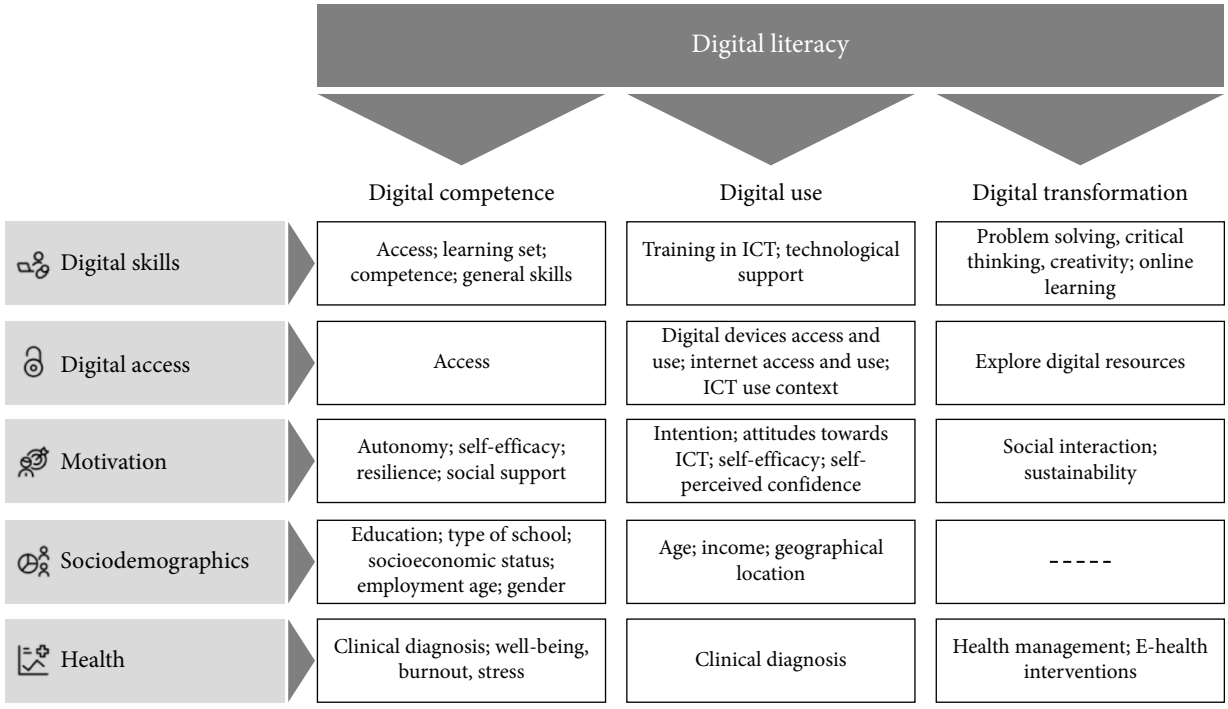


Figure 5: Distribution of digital literacy predictors by category and dimension.

awareness of their condition by seeking information online [41], which improved their digital knowledge and skills [20, 32, 41, 55]. Studies also showed that higher digital literacy was linked to lower levels of burnout, stress [36, 46], and computer anxiety [25, 45, 49].

3.2. Predictors of Digital Usage. Digital usage refers to the actual use of digital tools to find, process information, and seek solutions. This category accounted for 41.22% of the predictors identified in the reviewed literature.

3.2.1. Digital Skills. Digital skills were significant determinants of digital usage (26.23%). Training in ICT provides individuals with contact with digital tools [17], teaches how to use them effectively [50], and helps them understand their impact and advantages [17, 22, 48, 50]. Among older adults, a perceived lack of competence often acted as a barrier to improving digital skills [45]. Consequently, researchers have emphasized that schools and universities should actively work to enhance students' digital skills [23, 27, 28, 30, 36, 37, 46, 48, 52].

3.2.2. Digital Access. Digital access was the most frequently reported predictor within the digital usage dimension (47.54%). Studies showed that internet connectivity is now nearly ubiquitous, with more people owning and using multiple digital devices [15, 32, 41, 52] and spending increasing amounts of time online [26, 43]. Individuals primarily use the internet for information searching [14, 24, 27, 38, 40, 42, 55] and social media browsing [12, 16, 28], maintaining these behaviors across different contexts throughout the day [19, 27, 29, 33, 34, 47, 49, 50]. Professional environments also influence digital access and skill development. Individuals with computer access at work but not at home tend to have lower digital competence than those with access in both contexts [33]. However, Soyemi et al. [27] pointed out that simply having access to devices does not guarantee their use for improving digital skills unless individuals are engaged in learning or actively using them. Moreover, the type of device affects usage patterns: computers and smartphones are generally easier to use and are mainly employed for academic and professional tasks, whereas tablet use tends to correlate with higher digital competence [15].

3.2.3. Motivation. Motivation represented 18.03% of the predictors in digital usage. It was associated with increased digital knowledge [18], greater intention to use digital technologies [57], and more positive attitudes toward digital tools [44, 51]. Internet support groups were effective in motivating and facilitating digital tool usage [25, 53, 54]. Lepore et al. [25] emphasized the importance of assessing individuals' baseline digital literacy and aligning digital learning experiences with their expectations to improve skills. Regarding self-perceptions, higher self-efficacy in everyday tasks correlated with greater self-efficacy in digital tasks [39]. Additionally, higher self-perceived social media competence was linked to increased digital citizenship [53].

3.2.4. Sociodemographic. Sociodemographic factors accounted for 6.56% of the predictors within digital usage. Higher digital use was observed among older adults [12] and individuals with higher income levels [35]. Contextual conditions also played a role, with digital use being lower in communities with poor internet access and among individuals with fewer digital devices [21, 35].

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3.2.5. Health. Health-related indicators (4.92%) were linked to both lower and higher digital use. For older adults, technologies aimed at health management were often perceived as difficult to use [42]. Conversely, individuals with clinical diagnoses were more willing to use medical apps for health self-management [41]. Similarly, hospitalized or more debilitated individuals tended to use digital tools primarily for communication with family members [42]. Overall, these studies generally emphasized general digital literacy rather than health-specific digital literacy.

3.3. Predictors of Digital Transformation. Digital transformation was the dimension of digital literacy with the fewest identified predictors (12.84%). It refers to the use of digital tools to promote innovation, creativity, and foster changes in digital knowledge.

3.3.1. Digital Skills. Digital skills were associated with digital transformation in 26.31% of the predictors. Individuals tended to apply their knowledge to problem-solving [4], enhance critical thinking, and demonstrate creativity within the digital realm [18]. Martzoukou and Fulton [39] emphasized the importance of providing a rich digital learning environment as fundamental to reducing digital inequities. Individual engagement in online courses was emphasized to develop skills for creation and innovation [37, 46].

3.3.2. Digital Access. Digital access was the least studied predictor within the digital transformation dimension (5.26%). Owusu-Ansah [21] illustrated that access to digital resources and the ability to explore and utilize these resources are crucial for creating new digital knowledge.

3.3.3. Motivation. Higher motivation was linked to greater digital transformation (21.05%). Social interaction and social ties were found to motivate people to be digitally innovative and support technology implementation [19]. Additionally, individuals' adoption of new technologies appeared to be driven by concerns related to sustainability [19] and the environment [24, 56], which in turn encouraged the creation of user-generated content.

3.3.4. Health. Health was the most frequently cited category of determinants within the digital transformation dimension (42.10%). People use health apps to improve their overall well-being. Individuals with clinical conditions often utilize digital tools for health management [32, 34, 41], which is empowering [41]. Patients themselves scheduled appointments [42], interacted digitally more with healthcare professionals [447], increased their use of telemedicine [17, 42], and engaged more in digital communication and content sharing within peer support groups [31]. These findings highlight the promising link between digital health literacy and general digital literacy, suggesting a valuable area for further exploration.

4. Discussion

This systematic review underscores the multifaceted nature of digital competence, use, and transformation within the general population, as well as highlighting the complex interplay of diverse predictors. The findings from 44 studies published between 2017 and 2022 were systematically synthesized, with a focus on the predictors of digital literacy across multiple populations and contexts. Most studies employed a cross-sectional design and collected data from a wide range of countries, including Turkey, the United States, Greece, Spain, and South Korea. Although conceptualizations of digital literacy varied, the majority defined it as encompassing both technical skills and cognitive abilities, with a clear distinction between competence and use. Few studies emphasized the dimension of transformation. Five key categories of predictors emerged: digital skills, digital access, motivation, sociodemographic, and health. Each of these categories uniquely contributes to shaping digital literacy outcomes in the general population. Digital skills and motivation consistently influenced all three dimensions of digital literacy (competence, use, and transformation). In contrast, sociodemographic factors were more strongly associated with digital competence, digital access was primarily linked to digital use, and health-related predictors, though less studied, appeared as significant drivers of digital transformation.

4.1. Predictors of Digital Literacy Levels—Competence, Use, and Transformation

4.1.1. Sociodemographic. The literature consistently highlights the critical role of sociodemographic factors, particularly in shaping digital competence. Higher levels of education and attendance at schools equipped with digital tools and supported by digitally proficient teachers were strongly associated with greater digital literacy [12, 22, 23, 34]. Similarly, individuals with higher socioeconomic status, including better income and employment opportunities, tended to demonstrate enhanced digital skills, knowledge, and usage [13, 30, 33, 35, 38, 39]. This relationship may reflect easier access to digital technologies and more frequent engagement in digital environments. Age also significantly influenced digital competence. Younger generations typically exhibited greater proficiency, likely due to early exposure and continuous educational support, whereas older adults often faced challenges acquiring digital skills later in life [19, 29, 43]. Nonetheless, some studies reported relatively high levels of digital use among older populations [12]. Training in ICT skills remains fundamental to bridging these generational gaps, although it may be especially challenging for specific groups such as older adults and minority populations [30, 45]. Gender differences also emerged, with men being generally perceived as more skilled in areas such as digital protection (e.g., cybersecurity awareness and data privacy), while women sometimes scored higher in information literacy, that is, the ability to effectively locate, evaluate, organize, and communicate digital information [38, 42]. These findings suggest that specific components of digital competence may be shaped by gender-related social and cultural norms, as well as context-specific experiences, including the nature of work or digital activities engaged in by each group.

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4.1.2. Motivation. Motivation emerged as a critical determinant, positively associated with digital competence, digital use, and digital transformation, particularly in contexts where digital resources were limited or insufficient [42, 46, 50]. Individual engagement and motivation played a central role in determining whether digital tools were effectively utilized for developing digital skills and competence [27]. The type of device used also influenced digital outcomes, with tablets regularly linked to higher proficiency due to their perceived usability and versatility [15]. Additionally, community-level resources were identified as significant predictors of digital use, emphasizing the influence of local context and infrastructure on digital engagement [21, 35]. Social motivations, including interpersonal interactions and community ties, were also found to foster digital transformation by encouraging innovation and the adoption of emerging technologies, especially in sustainability-oriented and pro-environmental initiatives [24, 34, 35]. Ultimately, motivation drives behavior: it increases the likelihood that individuals will engage meaningfully with digital environments and maintain this engagement over time. Through ongoing learning, exploration, and adaptation, motivation contributes significantly to the development of digital literacy across all its dimensions.

4.1.3. Digital Access. Access to digital tools and resources is a fundamental precondition for developing digital competence, digital use, and digital transformation. Individuals need adequate access to devices and stable internet connections to engage meaningfully with digital environments. However, access alone is not sufficient. The presence of structured support systems, such as training programs and guidance from competent educators, is essential to ensure that access translates into digital literacy development. Educational institutions play a key role in creating the necessary conditions for this process [17, 48, 52]. While less extensively studied, the existing literature provides consistent evidence that access to multiple digital devices and reliable internet connections supports activities such as information seeking, engagement with social media, and professional communication [15, 26, 52]. Similarly, access to digital learning resources is fundamental for building the capabilities required for transformative digital practices [21]. Nevertheless, the presence of digital infrastructure does not guarantee skill acquisition or digital engagement; other contextual and individual factors must also be considered.

4.1.4. Health. Health indicators, such as lower levels of burnout and stress, were positively associated with higher digital literacy levels [36, 46]. These findings suggest that, beyond motivation and opportunity (i.e., digital access), *capacity* is a critical factor in fostering digital literacy development [57]. In other words, as in different learning and performance domains, developing digital competence requires individuals not only to access and be motivated to use digital tools but also to possess the necessary cognitive, emotional, social, and economic resources, along with adequate mental and physical health, to fully engage in the learning process. However, the relationship between health and digital literacy is complex, particularly in the context of digital use. While physical and mental health challenges can act as barriers to digital engagement, in some cases, they also appear to drive increased digital use, particularly for health management purposes. In this regard, health emerged as a key category of predictors related to digital transformation, with individuals leveraging digital tools to manage health conditions, monitor metrics, schedule appointments, and engage in telemedicine. These practices not only promoted autonomy but were also associated with improved health outcomes [17, 42, 43]. For example, cancer patients who engaged in self-monitoring through digital platforms reported improved quality of life and even higher survival rates [43]. These platforms went beyond data recording; they supported knowledge acquisition through digital interaction with healthcare professionals, promoting self-efficacy and empowerment. The use of digital technologies in healthcare has thus been linked to more proactive and informed patient behavior, allowing individuals to access health-related information, track symptoms, make treatment-related decisions, and engage in self-management of their health [42]. Still, some individuals (particularly those introduced to digital technologies later in life) may face significant barriers, such as difficulty understanding digital concepts or low confidence in their skills. These findings underscore the importance of promoting digital literacy as a pathway to enhance health outcomes and reduce exclusion in increasingly digital health systems [42].

4.1.5. Digital Skills. Digital skills also played a vital role, enabling individuals to apply digital knowledge for problem-solving, critical thinking, and creativity [18, 22]. They serve as a bridge between understanding and application, helping users navigate digital environments with greater confidence and autonomy. Several authors emphasized the importance of digital skills in reducing inequalities, suggesting that these can be developed in learning contexts that encourage engagement through creation and innovation [37, 39, 46]. At the same time, the development of digital skills through ICT training promotes use and familiarity with digital tools, increasing understanding of how these tools work and the impact they can have [17, 45, 50]. Acquiring such skills was also found to contribute to digital competence by improving digital knowledge and awareness [14, 21, 26, 27, 37]. In this regard, digital skills emerge as essential resources for functioning in an increasingly digital society and should be cultivated from an early age [14, 24, 29, 39]. Altogether, these findings highlight that developing digital skills is a critical component in enhancing equitable access and active participation in the digital era. Future initiatives should prioritize the integration of digital skills training to ensure that all individuals are able to meet the demands of an increasingly digital world.

4.2. Heterogeneity Across the Included Studies. This systematic review revealed considerable heterogeneity among the included studies, evident in three main areas: (i) variation in definitions and conceptualizations of digital literacy, (ii) differences in the measurement instruments employed, and

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(iii) diversity in sample characteristics and geographical contexts. Regarding definitions and conceptualizations, the included studies adopted a wide range of perspectives on digital literacy: from narrow views centered on technical skills to broader frameworks incorporating critical, creative, and participatory competencies. For example, Harati et al. [14] defined digital literacy in terms of the technical and cognitive skills required to organize and utilize digital information. In contrast, Monteiro and Leite [22] explicitly included digital transformation, linking literacy to creativity and innovation. These conceptual differences pose challenges to comparability, as they shape the studies' focus, methodologies, and interpretation of results.

In terms of measurement instruments, 55 different tools were identified across the 44 studies included in this review. These ranged from basic checklists assessing access and usage [13] to more comprehensive skill-based scales that incorporated elements such as information synthesis and communication [12]. While most instruments measured general digital competencies, others focused on specific constructs such as technology adoption, digital citizenship, self-efficacy, and online engagement. This diversity reflects the underlying theoretical plurality in the field: studies informed by sociocultural frameworks tended to emphasize participatory and civic dimensions, whereas those grounded in cognitive or skills-based models prioritized technical competencies. This fragmentation in measurement appears to stem, at least in part, from differing definitions of digital literacy, which contribute to inconsistencies in findings and underscore the need for standardized, cross-culturally validated tools.

Finally, the reviewed studies were conducted in diverse geographical locations and involved samples with distinct demographic characteristics (e.g., student populations and older adults). These cultural, educational, and technological differences likely influenced the variability in identified predictors of digital literacy. Moreover, there was an overrepresentation of student samples, as observed in studies such as Leví-Orta et al. [15] and Krishnamurthy and Shettappanavar [23], which limits the generalizability of findings to the broader population.

The heterogeneity observed across studies suggests that caution is warranted when generalizing findings. Conceptual, methodological, and contextual discrepancies may account for inconsistencies in reported predictors of digital literacy, constraining the ability to draw universal conclusions. To address these challenges, it is essential to harmonize definitions of digital literacy across the field to foster theoretical clarity and consistency in research approaches. Furthermore, future studies should prioritize the development and validation of standardized assessment tools across cultural contexts to improve comparability and inform evidence-based policymaking.

4.3. Research Gaps. Despite the growing body of literature on digital literacy, research on the determinants of digital competence, use, and transformation remains scarce, fragmented, and largely unsystematic. Few studies have specifically addressed these dimensions, and those that do often produce mixed or inconclusive findings. The existing evidence base is not yet sufficient to enable a comprehensive understanding of the key determinants of digital literacy, which limits our ability to draw meaningful and generalizable conclusions. One of the main contributions of this review lies in the identification of these research gaps, which can serve to guide and inform future investigations.

First and foremost, as highlighted in the previous section, there is a pressing need for conceptual refinement of digital literacy constructs and the standardized operationalization and validation of related measurement tools. Currently, there is no universally accepted definition of digital literacy across studies. For example, while Laar et al. [18] referred to a broad set of "21st-century digital skills," other studies, such as Subaveerapandiyan and Priyanka [24], adopted narrower definitions focused on computer and internet literacy. Achieving greater consistency in how digital literacy is defined and measured is crucial to advancing more robust, theory-driven, and generalizable research in the field. This includes the urgent task of defining and assessing the minimum threshold of digital literacy required for effective participation in an increasingly digital society. Such definitional and methodological clarity is essential for designing and implementing more targeted and equitable interventions aimed at improving digital inclusion and promoting a fairer, more inclusive digital society.

Second, there is a clear need to identify and analyze moderator variables that qualify the effects of known determinants to better understand the conditions under which these factors influence digital literacy. The impact of determinants such as motivation or digital access appears to vary significantly across contexts. For instance, in Owusu-Ansah [21], digital access acted as a driver of digital transformation, whereas in Soyemi et al. [27], access alone was insufficient without the presence of motivational factors. Such inconsistencies in the literature underscore the importance of exploring potential moderating influences that may account for these divergent outcomes. Variables such as individual motivation, technological access, and the quality of digital education likely play a significant role in shaping digital literacy outcomes, yet they remain underexplored. Investigating these moderators is essential for developing a more nuanced and context-sensitive understanding of digital literacy, particularly in diverse social, cultural, and institutional settings.

Third, the dimension of digital transformation remains considerably understudied, limiting our understanding of how individuals innovate, create, and drive change through digital tools. The few studies that addressed this dimension were predominantly situated in the healthcare context, often focusing on health-management applications such as mobile health apps or telemedicine platforms used for patient self-management (e.g., Sung et al. [20] and Jo et al. [41]). While these examples highlight essential applications, they offer only a limited view of digital transformation, overlooking its potential in other critical domains such as education, creative industries, and civic engagement. Digital transformation likely represents a more advanced stage of digital literacy, one that extends beyond technical proficiency to

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encompass innovation, critical thinking, and creative output. It draws not only on cognitive and emotional competencies but may also be influenced by broader personality traits such as creativity and openness to experience. Furthermore, the intersection between digital transformation and wider societal developments, such as globalization, sustainability, and the digitalization of economies, presents a valuable avenue for future research, particularly in understanding how evolving digital literacy contributes to individual empowerment, social inclusion, and societal progress.

Fourth, greater attention is needed to examine the intersectionality among determinants influencing digital literacy. Existing studies tend to analyze predictors such as age, income, or education in isolation, often overlooking how these factors interact to produce compounded disadvantage. For instance, older adults with limited formal education and low income may experience multiple, reinforcing barriers to digital engagement. While some studies, such as Tirado-Morueta et al. [54], illustrate that social support can mitigate these challenges, the complex interaction between structural factors (e.g., socioeconomic status and geography) and psychosocial variables (e.g., motivation and perceived self-efficacy) remains largely underexplored. This lack of intersectional analysis may contribute to persistent digital literacy disparities, particularly in domains such as employment, education, and social inclusion. The interplay of multiple disadvantages can lead to a cycle of exclusion, wherein individuals from lower-income backgrounds, older age cohorts, or rural and isolated communities face limited access to digital infrastructure and training opportunities. This, in turn, can negatively affect their confidence, motivation, and attitudes toward technology use, reinforcing disengagement from digitally mediated environments. Without a nuanced understanding of these intersecting barriers, there is a risk that marginalized groups will be further excluded from the opportunities afforded by an increasingly digital society.

Finally, most of the studies included in this review were conducted in WEIRD (western, educated, industrialized, rich, and democratic) contexts [58], stressing a significant geographical and cultural research bias. This limitation underscores the need for studies in more diverse and underrepresented settings, particularly in regions where access to digital infrastructure is constrained or where sociopolitical conditions shape distinct digital realities. For instance, Owusu-Ansah [21] underlines the importance of resourcefulness and digital library readiness in low-resource contexts, emphasizing that digital literacy development is not solely determined by access or technical skills but also by the broader sociotechnical environment in which individuals operate. In settings where digital resources are limited, whether due to economic hardship or political restriction, alternative dimensions of digital literacy may emerge, prioritizing adaptation, resilience, and improvisation over conventional skill sets [26]. Moreover, digital access is not simply a matter of infrastructure but a critical enabler of democratic participation, social justice, and equality. When access is curtailed by poverty, institutional neglect, or deliberate political control, initiatives to foster digital literacy must account for these structural barriers and promote context-sensitive competencies that empower individuals to engage meaningfully with digital technologies [11, 29, 34]. Despite their importance, these contextual and structural issues are still understudied, limiting the generalizability and global applicability of existing findings.

4.4. Policy Implications. This review draws attention to the pressing need for structured, evidence-based, and context-sensitive policy frameworks to promote digital literacy. As digital technologies become increasingly embedded in critical areas such as health [17], education [22], and access to public services, it is essential that public policies move beyond generic inclusion strategies and adopt adaptive approaches tailored to the diverse needs and constraints of different populations.

Promoting digital literacy involves navigating complex trade-offs between equity, cost-efficiency, and implementation feasibility. While infrastructure development, such as expanding internet connectivity and distributing digital devices, is often seen as foundational to digital inclusion, such initiatives may prove financially unfeasible in remote or underserved regions. In contexts like Ghana [21] or rural communities studied by Ko et al. [35], resource limitations and logistical barriers may call for scalable, community-based alternatives, including mobile digital hubs, digital community libraries, or public–private partnerships [59, 60].

However, as demonstrated by Soyemi et al. [27], access alone is insufficient. Without accompanying interventions that address motivation, cultural relevance, and local support structures, infrastructure investments may yield limited returns. In many cases, targeted interventions (such as intergenerational mentoring for older adults [19] or peer-based digital support groups for cancer survivors [25]) may prove more impactful and cost-effective than broad-scale programs.

A policy agenda grounded in equity would prioritize vulnerable populations who face intersecting disadvantages related to age, income, education, and health status. For instance, older adults often require not only digital access but also psychological support to overcome technophobia [25], as well as tailored, confidence-building training programs [49]. While such initiatives may be resource-intensive, they have the potential to generate significant and lasting benefits, particularly in terms of social inclusion, autonomy, and quality of life [61]. Moreover, institutional integration is crucial to ensure both scalability and long-term sustainability. Embedding digital skill development into existing systems, such as schools, healthcare services, and employment programs, can reduce costs while mainstreaming digital literacy as a transversal policy objective. This, however, requires strategic investments in teacher training, curriculum reform, and staff digital upskilling, which may pose short-term implementation challenges [62].

In sum, effective digital literacy policy must avoid prescriptive, one-size-fits-all models. Instead, policymakers should adopt multilayered, context-responsive strategies that balance infrastructure and targeted interventions, align with community needs and aspirations, and are rooted in a long-term vision for inclusive digital citizenship.

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4.5. Concluding Remarks. Current research on the determinants of digital literacy underscores the urgent need to systematize scholarly efforts and build a more cohesive and robust evidence base. Such efforts are essential for informing both policy and practice, enabling stakeholders to design and implement effective, evidence-based interventions to foster digital inclusion. Achieving this requires the development, standardization, and cross-cultural validation of instruments for measuring digital literacy across diverse populations and national contexts. It also calls for greater interdisciplinary collaboration among fields studying digital literacy and a strategic investment in longitudinal research to monitor developmental trajectories and emerging trends over time [63].

The findings of this review illustrate the multifaceted and dynamic nature of digital literacy and its determinants, revealing a complex interplay among environmental factors, technological access, and individual capabilities and motivations [57]. While a formal predictive model was not developed, this review offers a conceptual structure that consolidates current evidence and provides direction for future empirical testing. To better capture this complexity, we propose a conceptual framework that integrates the three levels of digital literacy (competence, use, and transformation) within Bronfenbrenner's ecological model of human development [64]. This model allows for a nuanced understanding of digital literacy as shaped by multiple interrelated systems. At the microsystem level, digital competence is primarily influenced by individual-level factors, including digital skills, motivation, self-efficacy, and sociodemographic characteristics such as age and educational attainment [16, 54]. These attributes determine an individual's capacity to acquire and apply foundational digital knowledge. The mesosystem reflects the quality of interactions across immediate contexts, such as schools, workplaces, and healthcare settings, where the availability of digital infrastructure (e.g., devices and internet access) and institutional support significantly shape digital use [23, 33]. Social support from peers, family, and professionals further mediates engagement with technology. At the exosystem and macrosystem levels, digital transformation is driven by structural and cultural forces, including socioeconomic conditions, policy frameworks, innovation ecosystems, and prevailing societal values such as autonomy, equity, or sustainability [21, 24, 39]. Importantly, individuals with specific health challenges (such as older adults or patients with chronic illnesses) may become active digital agents by adopting technology to support health self-management and empowerment [41, 42]. Finally, the chronosystem dimension underscores how digital literacy evolves across the lifespan, shaped by both technological change and individual life transitions. This is particularly relevant for understanding the digital trajectories of older populations, whose engagement with technology may fluctuate as they age and as digital environments transform [43]. Rather than positing a predictive model, this framework offers a synthesis of empirical insights from the reviewed studies and serves as a structured basis for hypothesis generation. It affirms that digital literacy is not solely an individual trait but the product of ongoing, dynamic interactions between individuals, technologies, and socioenvironmental contexts. This conceptualization may inform the development of multilevel, integrative strategies aimed at promoting inclusive digital participation, resilience, and well-being in an increasingly digitalized society.

Finally, it is essential to acknowledge that the scientific studies included in this review cover only the period up to early 2022. Given the rapid and ongoing development of the field, the conclusions presented here may be subject to certain limitations. A search for studies published between 2022 and 2025, while applying the same inclusion and exclusion criteria, indicates that research interest in this domain remains active and continues to grow. Although not included in the current systematic analysis, these more recent studies reinforce and deepen the key findings presented here. For instance, they continue to link digital competence to formal education [65], highlight access to resources as a central condition of digital use [66], and emphasize the importance of critical understanding for digital transformation [67]. These contributions further support the notion that digital literacy enables individuals to transform the way they engage with daily activities and to improve their lives through technology [68]. Nevertheless, the conclusions of this review ought to be interpreted with caution, considering the dynamic nature of the field and the exclusion of the most recent literature from the systematic analysis.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Sílvia Luís and Eliana Portugal contributed equally to this work and share first authorship.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. *(Supporting Information)* The supporting information includes information such as the search string used in this systematic review, the databases consulted, examples of the thematic analysis conducted, the digital literacy determinants' categories identified in this review, and lastly, the PRISMA checklist.

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