



The impact of digital literacy and internet usage on health behaviors and decision-making in Arab MENA countries

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ABSTRACT

Background: Digital literacy is essential for health behaviors and decision-making, particularly in Arab MENA countries, where access to digital resources varies considerably.

Objective: This study investigates the impact of digital literacy and internet usage on health behaviors across ten Arab countries, focusing on demographic and country-specific differences.

Methods: A cross-sectional survey of 12,522 respondents from Bahrain, Palestine, Lebanon, Jordan, Kuwait, the UAE, Saudi Arabia, Egypt, Morocco, and Tunisia was conducted using convenience sampling combined with the SMOTE-ENN technique to ensure balanced representation. The online questionnaire, available in Arabic and English, assessed internet access, digital literacy, and health behaviors.

Results: The findings reveal notable disparities in how digital literacy affects health outcomes. Overall, 40 % reported positive impacts of digital literacy on health behaviors, with males and older age groups showing higher positive perceptions. Notable country differences were observed: Egypt reported the highest positive impact (65.1 %), while Kuwait had the highest negative impact (25.3 %). Urban residents and those with higher education levels experienced more positive effects. Reliable internet access, social media, and health apps positively influenced health outcomes, particularly in Egypt and the UAE.

Conclusion: The findings emphasize the importance of enhancing digital health literacy, particularly for marginalized and underserved groups and communities. Improving internet access, fostering confidence in digital tools, and promoting critical evaluation of health information are crucial for positive health outcomes. This study offers key insights into the role of digital literacy in public health and highlights the need to address disparities in the Arab MENA region.

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1. Introduction

Digital revolution has dramatically reshaped healthcare, with digital technologies becoming increasingly central to how health information is accessed, understood, and utilized. This shift has given rise to the concept of digital health literacy, which is the capacity to seek, comprehend, evaluate, and apply health information obtained from electronic sources to make informed health decisions (Norman & Skinner, 2006). Originally conceptualized by Norman and Skinner (Norman & Skinner, 2006), digital health literacy has emerged as a key determinant of health outcomes, especially as the internet becomes the primary medium for health communication and service delivery.

In recent years, the importance of digital health literacy has grown exponentially, partially driven by global health challenges such as the COVID-19 pandemic. These events have accelerated digital transformation in the healthcare sector and highlighted the need for populations to navigate and critically assess a vast array of online health resources (Arias López, 2023). As digital tools permeate every aspect of healthcare, from telemedicine to health apps, the ability to engage with these resources is increasingly viewed as a social determinant of health (Arias López, 2023), (Tegegne et al., 2023).

The Middle East and North Africa (MENA) region presents a unique context in which rapid advancements in digital infrastructure coexist with significant disparities in digital literacy. Despite progress in internet accessibility and the integration of digital health solutions, variations exist across socioeconomic groups, educational backgrounds, and gender norms (El-Jardali et al., 2023), (Meherali et al., 2021). For instance, studies in Saudi Arabia have demonstrated that individuals with higher digital health literacy are more proactive in seeking health information and engaging in preventive care (Alhur et al., 2023), (AlWatban et al., 2024). Conversely, challenges persist in rural and under-resourced areas, where limited access to technology exacerbates existing health inequities (Bardus et al., 2022), (Jongebloed et al., 2024).

Furthermore, research from diverse contexts has consistently highlighted the role of digital health literacy in shaping health behaviors. Empirical studies reveal that enhanced digital skills facilitate better health decision-making and promote healthier lifestyles and improved patient outcomes (Çetin & Gümüş, 2023), (Thapa et al., 2021). In regions with digital divides, targeted interventions that integrate digital literacy training into public health initiatives have shown promise in bridging gaps and empowering communities (Thapa et al., 2021), (Campanozzi et al., 2023). Gender disparities and cultural factors, as examined by Ahmed and Khalil (Massaad, 2022) and Lee et al. (Chalghoumi et al., 2022), suggest that tailored strategies are essential to address the unique needs of different demographic groups.

2. Literature review

Digital health literacy has emerged as a critical determinant in shaping health behaviors and decision-making globally. In the MENA region, the rapid expansion of digital technologies and increasing internet accessibility have opened new avenues for health information dissemination, enabling individuals to make more informed decisions about their health (Norman & Skinner, 2006), (Ghorbanian Zolbin et al., 2022). Building on Norman and Skinner's foundational work (Norman & Skinner, 2006), which defined eHealth literacy as the essential skills required to access, understand, evaluate, and apply online health information, subsequent studies have expanded on this concept. Del P. Arias López et al. (Arias López, 2023) further identified digital literacy as a new determinant of health, emphasizing that the ability to navigate digital environments is critical for achieving favorable health outcomes.

Research among health professionals also highlights the importance of digital competencies. Tegegne et al. (Tegegne et al., 2023) found that higher levels of digital literacy among health professionals are crucial for the successful implementation of digital health systems, suggesting

that continuous training and support can enhance patient care and system efficiency. These findings highlight that digital literacy is not only essential for consumers but also for healthcare providers to effectively engage with emerging digital tools.

In the context of the MENA region, the rapid adoption of digital technologies faces significant challenges. El-Jardali et al. (El-Jardali et al., 2023) conducted a scoping review in fragile states within the MENA region and reported that despite improvements in digital infrastructure, issues such as limited resources, policy gaps, and socio-political instability hinder the optimal use of digital health technologies. Complementing this view, Meherali et al. (Meherali et al., 2021) demonstrated that while digital literacy can empower vulnerable groups, such as adolescent girls in low- and middle-income countries, it remains unevenly distributed, thereby affecting equitable access to digital health services.

Empirical investigations in Saudi Arabia further illustrate these dynamics. Alhur et al. (Alhur et al., 2023) documented that increased digital health literacy among the Saudi population is associated with more proactive health information-seeking behaviors, which in turn supports preventive care practices. In a related study, AlWatban et al. (AlWatban et al., 2024) described the rapid emergence and growth of digital health in Saudi Arabia as a success story, noting that the integration of digital solutions has significantly improved healthcare delivery despite underlying challenges.

The situation in other MENA countries also reveals varied levels of digital health literacy. Bardus et al. (Bardus et al., 2022) examined eHealth literacy among internet users in Lebanon and found considerable variability, with literacy levels often reflecting underlying socioeconomic disparities. Meanwhile, Jongebloed et al. (Jongebloed et al., 2024) highlighted the digital divide prevalent in rural and regional communities, where limited access to digital technology substantially restricts the use of digital health tools, exacerbating health inequities.

The relationship between digital health literacy and healthy lifestyle behaviors is further supported by cross-generational studies. Çetin and Gümüş (Çetin & Gümüş, 2023) discovered that higher digital health literacy correlates with the adoption of healthier lifestyle practices across different age groups, indicating that digital competencies can foster positive behavioral changes. Thapa et al. (Thapa et al., 2021) reinforced this notion by systematically reviewing the influence of online health information on health decisions, concluding that improved access to credible digital content significantly shapes better health outcomes.

From an equity perspective, Campanozzi et al. (Campanozzi et al., 2023) synthesized existing research to argue that digital literacy is instrumental in achieving health equity; disparities in digital skills contribute directly to broader health inequities. In line with this, Massaad (Massaad, 2022) reported significant gender disparities in healthcare accessibility across the MENA region, suggesting that differences in digital literacy between men and women partly explain these gaps.

Focusing on older populations, Chalghoumi et al. (Chalghoumi et al., 2022) identified critical barriers that older individuals in the Arab region face in accessing and using technology. These challenges further accentuate health inequities, highlighting the need for age-sensitive digital literacy interventions. Supporting this perspective, Zolbin et al. (Ghorbanian Zolbin et al., 2022) conducted a systematic review which found that improved health literacy through targeted interventions leads to enhanced decision-making and better health outcomes.

Moreover, digital communications have the potential to bridge gaps in health literacy by providing accessible and engaging platforms for health education. Fitzpatrick (Fitzpatrick, 2023) demonstrated that leveraging digital communication channels can significantly improve health literacy among both patients and practitioners, leading to more favorable healthcare outcomes. Finally, Ghazal et al. (Ghazal et al.) provided insights into inclusive digital health initiatives in the MENA region, emphasizing that culturally tailored strategies are essential for bridging digital divides and ensuring that all segments of the population

can benefit from digital health advancements.

Collectively, these studies illustrate that while digital health literacy is a critical enabler of improved health outcomes, significant challenges persist. These challenges are especially prominent in resource-limited settings and among vulnerable groups. Addressing these challenges requires coordinated, context-specific interventions that enhance digital literacy across both patients and healthcare professionals, ultimately fostering more equitable and effective healthcare systems.

3. Methods

A cross-sectional study was conducted to evaluate the impact of digital literacy and internet usage on health behaviors and decision-making processes among diverse populations in the Arab region.

3.1. Study design and sampling

The research adopted a convenience sampling technique, selecting participants based on their availability and willingness to participate. The sample targeted at least 300 respondents per country. Conducted in ten Arab countries—Palestine, Lebanon, Jordan, Kuwait, UAE, Saudi Arabia, Bahrain, Egypt, Morocco, and Tunisia—participants were recruited through social media, online forums, community centers, and universities.

To enhance the representativeness of the sample, efforts were made to balance the data by gender and age groups (18–34, 35–44, and 45–64 years). The final sample consisted of 12,522 respondents, providing a substantial cross-section of the region’s population.

Descriptive analysis was carried out to understand the distribution of participants regarding socio-demographics and the relationship between Digital Literacy and its Positive Impact on Healthy Behaviors and Decision-Making Among the Public in the Arab Region. To calculate associations and quantify the strength of relationships, logistic regression was employed, with results expressed as odds ratios (OR) and 95 % confidence intervals (CI). All statistical analyses were performed using SPSS (version 27.0, IBM Corp.).

To address potential imbalances in the collected data, particularly in underrepresented age and gender groups, the Synthetic Minority Over-sampling Technique combined with the Edited Nearest Neighbors (SMOTE-ENN) method was utilized (Xu et al., 2020). The choice of SMOTE-ENN over other resampling techniques was driven by the convenience sampling approach, which risked demographic imbalances, such as unequal distributions of age groups or gender. These imbalances could bias the logistic regression analysis, particularly when examining the impact of digital literacy on healthy behaviors and decision-making.

This dual approach mitigates the risk of overfitting, enhances the generalizability of the results, and ensures a balanced and representative dataset, aligning with the study’s goal of providing robust insights into the Arab region.

3.2. Data collection

Data were gathered using a structured questionnaire that captured socio-demographic information. It was offered in both Arabic and English to accommodate language preferences and made available online through the platform (<https://bcite.org/di/>).

The survey was distributed through university networks in the ten Arab countries, with faculty and researchers further disseminating the link to students, staff, and other community members. Additionally, demographic monitoring was employed to balance age, gender, and nationality, reducing selection bias.

Participants were provided with informed consent information on the first webpage of the questionnaire. By agreeing to participate in the study, they proceeded to answer the study questions. The consent form included all relevant details about the study to ensure participants fully understood its purpose and their rights. Data collection took place from

April 1 to May 17, 2024. The included study variables are illustrated in Table 1.

4. Results

A total of 12,522 participants from ten Arab MENA countries responded to the questionnaire, of which 45.6 % were male (n = 5711) and 54.4 % were female (n = 6811). The participants’ ages ranged from 18 to 64 years, evenly distributed across three age groups: 18–34 years (33.3 %), 35–44 years (33.3 %), and 45–64 years (33.3 %).

4.1. Gender differences and age-related patterns

Table 2 highlights the perceived impact of digital literacy on health behaviors across various demographic groups. 14.4 % of respondents reported a negative impact, 45.6 % reported a neutral impact, and 40 % reported a positive impact overall. Gender-specific trends show that 15.0 % of females reported a negative impact compared to 13.7 % of males. On the other hand, males were more likely to report a positive impact, with 41.5 % of males perceiving positive outcomes from digital literacy, compared to 38.6 % of females.

Age-related differences were also observed. The youngest age group (18–34 years) reported the highest negative impact at 15.2 %, while the oldest group (45–64 years) had the lowest at 13.4 %. The positive impact increased with age, with the 45–64 years group reporting the highest positive impact at 43.8 %, indicating that older individuals might be more adept at using digital tools for health decision-making.

Table 1
The questions designed to collect data related to internet access, digital literacy, and the impact of digital environments on personal health.

Category	Variable	Options
Demographics	Gender	Male, Female
	Age (years)	18-34, 35-44, 45-64
	Country	Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Palestine, Saudi Arabia, Tunisia, UAE
Digital Literacy	Locality	Urban, Non-Urban
	Education level	≤ Secondary, Bachelor, Graduate
	Employment status	Employed, Unemployed, Student
	Internet connection consistency	Unreliable, Moderately Reliable, Reliable
	Impact of internet access on ability to access health services	Low, Moderate, High
	Ability to distinguish reliable vs. Unreliable health information	Low, Moderate, High
	Ability to use internet for health decisions	Low, Moderate, High
	Ability to use social media to access or share health information	Low, Moderate, High
	Ability to use health apps for monitoring or improving health	Low, Moderate, High
	Ability to participate in online forums or communities for health support	Low, Moderate, High
Usage	Searching for general health information	Low, Moderate, High
	Looking up symptoms or conditions	Low, Moderate, High
	Following health and wellness influencers	Low, Moderate, High
	Participating in health-related groups or forums	Low, Moderate, High
	Booking medical appointments online	Low, Moderate, High

Table 2
Distribution of impact levels of digital literacy on health behaviors and decision-making among different demographic groups in the Arab MENA region.

Variables	Impact on healthy behaviors and decision-making		
	Negative n(%)	Neutral n(%)	Positive n(%)
Gender			
Male	855(13.7)	2810(44.9)	2596(41.5)
Female	942(15)	2901(46.3)	2418(38.6)
Total	1797(14.4)	5711(45.6)	5014(40)
Age (Years)			
18–34	635(15.2)	1983(47.5)	1556(37.3)
35–44	603(14.4)	1941(46.5)	1630(39.1)
45–64	559(13.4)	1787(42.8)	1828(43.8)
Country			
Bahrain	78(22.4)	223(64.1)	47(13.5)
Egypt	79(5.3)	440(29.6)	969(65.1)
Jordan	255(11.6)	1099(50)	842(38.3)
Kuwait	346(25.3)	716(52.3)	306(22.4)
Lebanon	146(16.3)	440(49.2)	308(34.5)
Morocco	334(25.5)	591(45.2)	383(29.3)
Palestine	147(12.3)	479(40.1)	568(47.6)
Saudi Arabia	288(15.3)	933(49.5)	663(35.2)
Tunisia	65(10.4)	271(43.4)	288(46.2)
United Arab Emirates	59(4.8)	519(42.6)	640(52.5)
Locality			
Urban	1257(11.5)	5200(47.5)	4487(41)
Non-Urban	540(34.2)	511(32.4)	527(33.4)
Education level			
≤ Secondary	516(25.7)	860(42.8)	633(31.5)
Bachelor	718(12.2)	3013(51)	2173(36.8)
Graduate	563(12.2)	1838(39.9)	2208(47.9)
Employment			
Employed	560(7.4)	3579(47.6)	3387(45)
Unemployed	722(24.1)	1192(39.8)	1084(36.2)
Student	515(25.8)	940(47)	543(27.2)

4.2. Country-specific variations

Table 3 highlights the country-specific variations in the impact of digital literacy. Participants from Egypt reported the lowest negative impact (5.3 %) and the highest positive impact (65.1 %). In contrast,

respondents from Kuwait reported the highest negative impact (25.3 %) and one of the lowest positive impacts (22.4 %). In the United Arab Emirates (UAE), 4.8 % of participants reported a negative impact, while 52.5 % reported a positive impact, suggesting the success of digital literacy initiatives in the UAE.

4.3. Urban vs non-urban localities

Differences between urban and non-urban participants were stark. Urban residents reported a lower negative impact (11.5 %) and a higher positive impact (41.0 %), while non-urban residents had a significantly higher negative impact (34.2 %) and lower positive impact (33.4 %).

4.4. Educational attainment

Educational attainment was a strong determinant of digital literacy’s impact. Participants with lower education levels (≤Secondary) reported the highest negative impact (25.7 %) and the lowest positive impact (31.5 %). In contrast, those with graduate-level education reported the highest positive impact (47.9 %) and the lowest negative impact (12.2 %). This suggests that individuals with lower education levels may face greater challenges in utilizing digital health information effectively.

4.5. Employment status

Employment status was also a significant factor. Employed individuals reported the lowest perceived negative impact (7.4 %) and the highest perceived positive impact (45.0 %). In contrast, 24.1 % of unemployed individuals and 25.8 % of students reported higher negative impacts, with 36.2 % of unemployed individuals and 27.2 % of students reporting lower positive impacts. These findings indicate that unemployed individuals and students may face greater difficulties in accessing and using digital health information.

4.6. Internet access and health information

Table 3 outlines the impact of internet access on health behaviors

Table 3
Digital Literacy Positive impact on Healthy Behaviors and Decision-Making Among the Public in the Arab MENA Region.

		Country n(impact%)									
		Palestine	Jordan	Lebanon	Bahrain	Kuwait	KSA	UAE	Egypt	Morocco	Tunisia
Internet Connection	Unreliable	82(55.4)	29(22.5)	28(21.9)	3(8.1)	59(21.6)	57(33.3)	66(65.3)	25(22.1)	37(13.1)	14(27.5)
	Moderate	194(47.3)	121(28.3)	162(36.7)	8(5.4)	126(19.6)	304(32.4)	39(25.7)	433(58.2)	53(13.8)	170(54)
	reliable	292(45.9)	692(42.2)	118(36.3)	36(22.2)	121(26.7)	302(39)	535(55.4)	511(81)	293(45.7)	104(40.3)
Lack Internet Access	Low	163(51.1)	321(35.2)	33(19.3)	30(24)	109(28.2)	95(27.5)	96(45.7)	27(26.2)	159(30.8)	74(31.6)
	Moderate	108(43.9)	52(16.7)	53(17)	10(13.2)	79(14.8)	137(25)	139(44.3)	128(55.7)	148(32.7)	26(19.3)
	High	297(47.2)	469(48.3)	222(54)	7(4.8)	118(26.3)	431(43.6)	405(58.4)	814(70.5)	76(22.4)	188(73.7)
Limit Access Health	Disagree	163(51.1)	321(35.2)	33(19.3)	30(24)	109(28.2)	95(27.5)	96(45.7)	27(26.2)	159(30.8)	74(31.6)
	Neutral	108(43.9)	52(16.7)	53(17)	10(13.2)	79(14.8)	137(25)	139(44.3)	128(55.7)	148(32.7)	26(19.3)
	Agree	297(47.2)	469(48.3)	222(54)	7(4.8)	118(26.3)	431(43.6)	405(58.4)	814(70.5)	76(22.4)	188(73.7)
Distinguish Information	Low	245(38.1)	137(17.8)	80(15.3)	12(5.8)	105(13)	173(21.3)	167(38.9)	233(42.7)	140(16.3)	156(43)
	Moderate	257(62.7)	375(41.6)	180(61.6)	33(28.4)	156(35.3)	276(41.4)	402(63.2)	463(70.9)	129(40.1)	106(47.3)
	High	66(46.8)	330(63.1)	48(60)	2(7.7)	45(38.1)	214(52.8)	71(46.4)	273(94.5)	114(89.8)	26(70.3)
Internet Decision Making	Low	109(26.8)	261(43.7)	36(19.4)	35(23.8)	71(16.8)	242(33.2)	169(53)	30(17.1)	97(18.8)	92(35.7)
	Medium	250(53.4)	176(20.4)	90(25)	5(4.1)	140(23.7)	207(31.6)	199(46.5)	349(81.5)	88(16.9)	120(51.5)
	High	209(65.5)	405(55)	182(52.3)	7(9)	95(26.7)	214(43)	272(57.7)	590(66.7)	198(73.3)	76(57.1)
Search Engine	Low	73(38.6)	167(34.7)	73(42)	5(14.3)	60(23.2)	171(33.9)	177(67)	258(84.6)	146(44.8)	15(27.8)
	Medium	26(17.6)	1(1.3)	1(1.7)	4(4.8)	29(8.2)	73(26.8)	41(60.3)	10(15.9)	12(7.4)	12(46.2)
	High	469(54.7)	674(41.2)	234(35.4)	38(16.6)	217(28.7)	419(37.8)	422(47.6)	701(62.6)	225(27.5)	261(48)
Social Media Usage	Low	192(48.5)	353(35.4)	45(16.5)	32(19.5)	59(11.6)	112(22)	152(32.3)	22(12.3)	152(21.6)	124(41.8)
	Medium	176(33.8)	203(27.2)	98(30.5)	4(3.1)	131(22.5)	369(35.8)	256(53.6)	290(47.8)	65(18.1)	97(40.4)
	High	200(71.9)	286(63.3)	165(54.8)	11(20)	116(42.2)	182(52.9)	232(85.9)	657(93.6)	166(67.8)	67(77)
Health Monitoring	Low	181(43.3)	206(27.3)	54(16.1)	31(14.8)	87(15.7)	168(30.1)	198(47.6)	81(29.2)	181(24.7)	151(42.7)
	Medium	238(44.5)	247(31.5)	69(27.2)	12(16.4)	105(18.6)	299(34.7)	207(45.1)	300(50.8)	145(32.1)	81(42)
	High	149(61.8)	389(59.1)	185(60.9)	4(6.1)	114(45.8)	196(44.2)	235(68.5)	588(94.8)	57(46.7)	56(72.7)
Online Forums Participation	Low	322(52.1)	502(36.8)	83(21.2)	43(19.5)	149(19.8)	313(29.3)	338(52.2)	74(23.9)	285(28.4)	185(42.7)
	Medium	141(31.1)	227(38.3)	72(25.9)	2(3)	105(25.9)	225(38.4)	242(53.3)	477(66.3)	39(19.3)	89(56.3)

across countries. Reliable internet access was reported by 81 % of respondents in Egypt, 55.4 % in the UAE, and 45.9 % in Palestine. 54 % of participants in Tunisia and 45.7 % in Morocco also reported reliable internet access. However, 70.5 % of respondents in Egypt and 73.7 % in Tunisia cited a lack of internet access as a barrier to making informed health decisions, with similar challenges reported by 47.2 % of participants in Palestine and 54 % in Lebanon.

In countries like the UAE (94.5 %), Egypt (70.9 %), and Tunisia (70.3 %), a higher proportion of participants were able to discern accurate health information. In contrast, only 46.8 % in Palestine and 60 % in Lebanon reported this capability.

4.7. Internet and social media usage

Table 3 also shows the role of internet usage and social media in health decision-making across the Arab MENA region. In Egypt, 81.5 % of respondents reported high internet usage for health-related decision-making, followed by 66.7 % in the UAE. In Palestine, 65.5 % of respondents and 52.3 % in Lebanon also reported significant reliance on the internet for health decisions.

Search engine usage had a notable impact across the region. In Egypt, 62.6 % of respondents reported using search engines to access health information, with 47.6 % in the UAE, 54.7 % in Palestine, and 41.2 % in Lebanon reporting a positive impact from this tool.

Social media emerged as a vital source of health information, particularly in Egypt where 93.6 % of respondents reported positive impacts, and in the UAE where 85.9 % noted similar benefits. 71.9 % of participants in Palestine and 63.3 % in Lebanon also reported high social media usage for health-related decision-making, positively affecting their health behaviors.

4.8. Digital tools and online health forums

The use of digital health monitoring tools was significant across several countries. In Egypt, 94.8 % of respondents used these tools, which had a strong positive impact on health management. Similarly, 68.5 % of participants in the UAE, 61.8 % in Palestine, and 60.9 % in Lebanon reported positive impacts from using digital health monitoring tools.

Participation in online health forums, though less common, still had a positive influence on health behaviors. 90.9 % of participants in Egypt and 42.7 % in Tunisia reported positive outcomes from online forums. In Palestine, 86.1 % of respondents and 68 % in Lebanon also reported positive impacts from engaging in these online communities.

4.9. Country-specific variations in online health activities

Health-related internet activities varied widely across the region. Table 4 provides additional insights into the specific impacts of different online health activities:

- In Palestine, 56.6 % of respondents reported a high positive impact from using the internet to search for general health information. Similar trends were observed in Jordan (55 %), the UAE (61.1 %), and Egypt (66 %). In contrast, Bahrain (5.1 %) and Kuwait (30.5 %) reported notably lower positive impacts.
- When looking up symptoms online, 63.3 % of respondents in Palestine, 77.2 % in Egypt, and 55.9 % in the UAE reported a strong positive impact. Countries like Bahrain (10.4 %) and Jordan (49.5 %) reported lower impacts from symptom checking online.
- Following health influencers on social media also showed varied impacts. 73.4 % of respondents in Egypt, 66.2 % in the UAE, and 55.5 % in Palestine reported a high positive impact. Lower engagement was seen in Lebanon (53.9 %) and Bahrain (12.5 %).
- Participation in health-related online groups had a significant positive effect in Egypt (73.5 %), the UAE (40.7 %), and Tunisia (57.4 %). In Palestine, 53.6 % reported a strong positive impact, though lower compared to other internet activities. Bahrain had no reported impact (0 %), while Jordan reported a high positive impact (67.5 %).
- The ability to book medical appointments online also showed positive trends, particularly in Palestine (63 %), Egypt (70.3 %), and the UAE (62.6 %). However, adoption rates were lower in Morocco (26.9 %) and Tunisia (38 %).

4.10. Logistic regression findings

Table 5 presents the logistic regression analysis, highlighting the influence of various digital determinants on health behaviors and decision-making. The odds ratios (OR) and confidence intervals (CI) provide insights into how these factors influence health outcomes. In Palestine, using the internet for health-related decisions had an odds ratio (OR) of (1.13), and confidence in using search engines had an OR of (1.24), both positively influencing health behaviors.

In Jordan, consistent internet access (OR = 1.11) and searching for health information online (OR = 1.21) were associated with better health outcomes. In Lebanon, the ability to discern reliable from unreliable health information (OR = 1.35) had a significant positive impact, though employment status (OR = .89) and health app usage (OR = .95) were less influential.

In Egypt, social media use had a particularly strong effect (OR = 1.72), as did participation in health-related forums (OR = 1.21).

In Kuwait, consistent internet connections (OR = 1.06) had a positive

Table 4
Internet Usage Positive impact on Health Behaviors and Decision-Making Among the Public in the Arab MENA Region.

		Country n(impact%)									
		Palestine	Jordan	Lebanon	Bahrain	Kuwait	KSA	UAE	Egypt	Morocco	Tunisia
Search Health Info.	Low	96(45.9)	26(11.9)	28(16.9)	9(17.6)	35(11)	86(30.2)	23(16.2)	48(40)	43(25.3)	27(31.8)
	Medium	224(41)	247(26.2)	106(36.7)	31(19.5)	143(22.6)	276(34)	267(53.1)	603(68.1)	125(18.3)	93(32.3)
	High	248(56.6)	569(55)	174(39.6)	7(5.1)	128(30.5)	301(38.2)	350(61.1)	318(66)	215(47.4)	168(66.9)
Lookup Symptoms	Low	64(27.6)	18(6.8)	28(25)	5(4.2)	17(6)	90(23.4)	24(16.6)	6(5.9)	76(34.9)	28(35)
	Medium	228(43.3)	328(35.4)	121(37)	30(26.3)	130(19.4)	283(34.6)	241(60)	408(61.1)	76(12.7)	119(38.5)
	High	276(63.3)	496(49.5)	159(34.9)	12(10.4)	159(38.3)	290(42.5)	375(55.9)	555(77.2)	231(47)	141(60)
Following Influencers	Low	127(41.2)	404(38.8)	66(24)	22(15.4)	94(20.4)	114(25.6)	209(47.9)	24(14.7)	214(28.6)	156(50.6)
	Medium	248(46.1)	238(34.5)	91(26.8)	12(11.9)	87(16.7)	271(34.5)	210(46.9)	653(70.4)	73(22.6)	66(34.9)
	High	193(55.5)	200(42.9)	151(53.9)	13(12.5)	125(32.3)	278(42.6)	221(66.2)	292(73.4)	96(40.3)	66(52)
Groups Participation	Low	282(51.6)	522(32.6)	106(25.5)	38(17)	139(20.4)	261(29.2)	359(50.3)	58(21.5)	196(19)	200(46.6)
	Medium	196(40.8)	187(47.1)	104(38.4)	9(12.3)	115(24.8)	235(38.9)	237(59.8)	590(75.5)	177(79.4)	61(41.2)
	High	90(53.6)	133(67.5)	98(47.1)	0(0)	52(23.3)	167(43.2)	44(40.7)	321(73.5)	10(18.2)	27(57.4)
Booking Appointments	Low	292(47.8)	454(41.5)	170(29.5)	15(9.3)	79(22.5)	102(28.5)	128(34.8)	63(31.8)	279(35.1)	208(43.8)
	Medium	160(40.1)	227(32.6)	99(43.4)	8(9.3)	111(17.6)	233(37)	261(58.1)	587(70.2)	65(17.6)	50(71.4)
	High	116(63)	161(39.9)	39(43.3)	24(23.8)	116(30.1)	328(36.6)	251(62.6)	319(70.3)	39(26.9)	30(38)

Table 5
Linear regression of digital determinants impact of health behavior and decision making among Public from the Arab MENA region.

	Country OR(95 C.I)									
	Palestine	Jordan	Lebanon	Egypt	Morocco	Tunisia	Bahrain	Kuwait	KSA	UAE
Area of Residence	1.03(-.06.128)*	.95(-.153.058)*	.9(-.192;-.028)**	.91(-.213.018)*	.43(-.964;-.733)**	1.13(-.047.289)*	.95(-.246.147)*	.68(-.492;-.275)**	.86(-.261;-.042)**	1.18 (.067.266)**
Edu. Level	.88(-.192;-.057)**	1.17(.11.203)**	.95(-.114.013)*	1.03(-.009.068)*	.94(-.131.004)*	.97(-.133.074)*	1.07(-.013.15)*	1.13 (.068.176)**	.98(-.069.037)*	1.02(-.039.075)*
Employment Status	.83(-.249;-.132)**	.87(-.184;-.092)**	.89(-.172;-.052)**	1.09 (.048.116)**	.92(-.125;-.034)**	1.08(.001.15)**	.98(-.1.054)*	1.05(-.002.092)*	.89(-.163;-.074)**	.94(-.114;-.002)**
Age Group	.96(-.089.016)*	.97(-.059.007)*	.99(-.067.037)*	1.1(.068.127)**	1.01(-.045.059)*	1.09 (.006.158)**	.87(-.209;-.071)**	1.08(.038.12)**	1.02(-.023.057)*	1.04(-.003.081)*
Sex	.82(-.293;-.107)**	.9(-.156;-.047)**	1.27 (.164.312)**	.78(-.292;-.203)**	.77(-.332;-.203)**	1.17 (.059.253)**	.97(-.189.135)*	1.03(-.038.096)*	.98(-.084.044)*	1.08 (.005.143)**
Internet Connection	.91(-.155;-.028)**	1.11(.06.156)**	1.07 (.014.122)**	1.4(.298.38)**	1.17(.11.202)**	1.01(-.069.094)*	1.19 (.076.269)**	1.06 (.004.105)**	1.02(-.026.072)*	1.17 (.105.213)**
Limited Access	1.01(-.038.05)*	1.11 (.078.136)**	1.2(.136.233)**	1.01(-.029.055)*	1.03(-.013.069)*	1.28 (.187.303)**	.75(-.351;-.216)**	.98(-.066.024)*	1.01(-.031.054)*	1.06 (.017.105)**
Distinguish Information	1.03(-.026.09)*	.92(-.123;-.034)**	1.35 (.238.362)**	1.07 (.032.104)**	1.16 (.097.199)**	1.01(-.074.102)*	1.26 (.139.322)**	1.18 (.111.221)**	1.17 (.121.201)**	1.13 (.068.172)**
Internet Use	1.13 (.072.179)**	.85(-.197;-.122)**	1.12 (.057.171)**	.94(-.114;-.017)*	1.33 (.234.335)**	1.09 (.003.164)**	.75(-.361;-.202)**	.98(-.063.031)*	1.12 (.069.151)**	.91(-.134;-.048)**
Search Engines	1.24 (.158.271)**	1.04 (.002.076)**	1.12 (.067.163)**	.94(-.099;-.024)**	1.05(-.004.104)*	.96(-.132.056)*	.98(-.131.087)*	1.07 (.022.118)**	1.03(-.009.07)*	.95(-.096;-.006)**
Social Media	1.17 (.102.211)**	1.11 (.067.144)**	1.02(-.049.09)*	1.72 (.483.599)**	1.11 (.047.153)**	1.18 (.094.241)**	1.03(-.051.114)*	1.18 (.114.223)**	1.07 (.018.118)**	1.31 (.224.318)**
Use of Health Apps	.84(-.243;-.105)**	1.04 (.007.074)**	1.22 (.154.248)**	.94(-.112;-.01)**	1.3(.202.324)**	.97(-.103.049)*	.86(-.231;-.06)**	1.06 (.003.106)**	1.12 (.069.163)**	.99(-.56.32)*
Online Communities	1.05(-.022.125)*	.72(-.378;-.288)**	1.26 (.174.288)**	1.21(.128.25)**	.95(-.107.015)*	1.07(-.041.172)*	1.03(-.068.118)*	1.04(-.011.088)*	.98(-.074.035)*	.85(-.232;-.104)**
Search Health Info.	.73(-.382;-.237)**	1.21 (.143.239)**	1.04(-.027.104)*	1(-.052.061)*	1.1(.033.163)**	1.21 (.087.294)**	.88(-.217;-.032)*	1.11 (.048.158)**	.97(-.078.02)*	1.14 (.078.191)**
Looking Up Symptoms	1.54 (.355.505)**	1.17(.11.208)**	.88(-.184;-.062)**	.82(-.253;-.142)**	.74(-.357;-.249)**	.91(-.184.006)*	1.31 (.183.362)**	1.07 (.009.123)**	1.09 (.032.131)**	1(-.056.061)*
Following Influencers	1.21 (.125.258)**	.93(-.123;-.031)**	1.02(-.038.083)*	1.06(.003.12)**	1.06 (.012.102)**	.91(-.171;-.02)**	1.01(-.084.098)*	.92(-.139;-.036)**	.98(-.064.03)*	1.06 (.009.101)**
Participating in Health-Groups	.85(-.236;-.094)**	1.28(.199.3)**	.94(-.117;-.006)**	.94(-.135.008)*	1.5(.331.476)**	.87(-.238;-.05)**	.95(-.15.049)*	.93(-.127;-.019)**	1.07 (.016.111)**	.94(-.126;-.002)**
Booking Appointments Online	.92(-.144;-.027)**	1.05 (.011.082)**	.83(-.247;-.135)**	1.02(-.027.071)*	.86(-.2;-.096)**	.85(-.234;-.091)**	1.01(-.064.082)*	1.11 (.051.149)**	.94(-.103;-.017)**	1.11(.06.145)**

impact, though the effect of health app usage was lower ($OR = .97$). In Saudi Arabia, health app usage ($OR = 1.06$) and understanding online health information ($OR = 1.13$) were beneficial, though AI tools showed a smaller impact ($OR = .92$).

The UAE saw widespread positive effects from various determinants, notably social media usage ($OR = 1.31$) and participation in health-related groups ($OR = 1.07$). In Morocco, using the internet for health decisions ($OR = 1.33$) and searching for health information ($OR = 1.1$) were influential. In Tunisia, participation in health-related groups ($OR = 1.5$) and AI health apps ($OR = 1.27$) were particularly beneficial.

Lastly, in Bahrain, strong positive effects were observed from online health information sources ($OR = 1.53$), though online forums had a negative association ($OR = .75$).

Among the most influential factors, social media usage to access or share health information stood out, especially in Egypt ($OR = 1.72$) and the UAE ($OR = 1.31$). The ability to distinguish between reliable and unreliable health information also showed a strong positive impact, particularly in Lebanon ($OR = 1.35$) and Morocco ($OR = 1.16$). Consistent internet connection was a critical determinant, with a high positive impact observed in Egypt ($OR = 1.4$) and Morocco ($OR = 1.17$).

Participation in health-related online groups or forums was another key factor, with Tunisia ($OR = 1.5$) and Egypt ($OR = 1.21$) showing significant benefits. These findings demonstrate that digital engagement, especially through social media, reliable internet access, and the ability to critically evaluate health information, were the most impactful factors in improving health behaviors and decision-making across the region.

5. Discussion

This study assessed the relationship between digital literacy, internet usage, and health behaviors in the Arab MENA region, revealing significant variations by demographic group, age, and country. Our findings showed the importance of tailored interventions to address these disparities and improve health outcomes.

The results show a significant gender difference in the impact of digital literacy on health behaviors. Men reported a higher positive impact from digital engagement compared to women (41.5 % vs. 38.6 % of females), while females experienced a slightly higher negative impact (15.0 % vs. 13.7 % of males). This suggests that women may face more barriers in utilizing digital health tools effectively, possibly due to lower confidence, access challenges, or societal norms that shape digital engagement. In contrast, men may engage with digital health resources in a more goal-oriented manner, focusing on fitness, preventive healthcare, and performance optimization, which are more likely to yield positive behavioral changes. Previous studies have identified similar trends, where men tend to report higher levels of digital health engagement, which could be due to greater confidence or familiarity with technology (Meherali et al., 2021), (Bidmon & Terlutter, 2015). Addressing these gender-specific barriers could be critical in closing the gap and enhancing health outcomes for women.

The study reveals significant age-related differences in digital health engagement, with younger adults (18–34 years) reporting the highest negative impact (15.2 %) and older adults (45–64 years) demonstrating the most positive outcomes (43.8 %). Despite their higher digital proficiency, younger individuals are more susceptible to information overload, algorithm-driven content exposure, and misinformation, which can lead to confusion, anxiety, and suboptimal health behaviors. Their reliance on unverified user-generated content further exacerbates these risks, highlighting the challenges of navigating an increasingly complex digital health landscape.

In contrast, older adults benefit from a more selective and discerning approach to digital health tools. Their lower engagement with unregulated health content on social media and greater reliance on authoritative sources, such as government health agencies and professional healthcare platforms, contribute to more effective health decision-

making. Moreover, cognitive and behavioral differences in information processing may play a role, as older individuals tend to exhibit greater skepticism, allowing them to critically assess and apply digital health information in a more meaningful way.

This aligns with existing research showing that while younger people are proficient in technology use, they are more vulnerable to misinformation, which can lead to negative health behaviors (Arias López, 2023), (Ji et al., 2024), (Sundell et al., 2022). This suggests that digital literacy programs should focus not only on facilitating accessibility to online health information but also on educating younger populations to exercise critical evaluation thereof.

Country-specific differences were observed: Egypt showed the highest positive impact of digital literacy (65.1 %), whereas Kuwait exhibited the highest negative impact (25.3 %). These variations reflect differences in digital health infrastructure, government policies, and public health initiatives. Egypt's strong positive outcomes may be attributed to its comprehensive public health campaigns, which leverage digital platforms to improve health literacy (Cairo, 2015). Similar strategies have been successful in other regions, such as Singapore and South Korea, where robust digital health initiatives have led to higher positive health outcomes (Tallah and Helmy), (Bajnaid & Aljasir, 2025) (Ngiam et al., 2022). These findings suggest that countries with less developed digital health infrastructure, like Kuwait and Bahrain, may benefit from more targeted public health strategies that integrate digital tools to improve health literacy and outcomes.

The urban-rural disparity in digital health outcomes in the Arab MENA region underscores key differences in infrastructure, education, and healthcare access. Urban residents experience lower negative impacts (11.5 %) and higher positive outcomes (41.0 %), while non-urban populations face significantly higher negative effects (34.2 %) and lower positive engagement (33.4 %). This divide is largely influenced by disparities in digital infrastructure, as urban areas benefit from better internet access and stable connectivity, facilitating more effective engagement with digital health tools. In contrast, rural areas often suffer from limited broadband access, restricting their ability to access reliable health information and telehealth services.

Educational differences further widen this gap, with urban residents generally possessing higher digital literacy, enabling them to critically assess online health content and reduce their susceptibility to misinformation. Rural populations, on the other hand, often have lower digital literacy levels, making them more vulnerable to misleading health information and less capable of effectively utilizing digital health resources. Additionally, healthcare accessibility plays a crucial role, as urban areas provide well-integrated digital and in-person healthcare services, ensuring that digital engagement complements existing healthcare structures.

This urban-rural gap is well-documented in global health studies, where rural populations often face challenges accessing digital health resources, leading to poorer health outcomes (Chen et al., 2019), (Holt et al., 2020). Addressing this digital divide is essential to ensuring equitable health access, and interventions aimed at improving internet connectivity and digital literacy in rural areas could significantly enhance health outcomes for these populations.

Education played a crucial role in determining the impact of digital literacy on health behaviors. Respondents with higher education levels reported more positive health outcomes, with 47.9 % of those with graduate-level education experiencing positive impacts, compared to those with lower education. This finding is consistent with literature linking higher education to better digital competence and health outcomes (Tegegne et al., 2023). To bridge this gap, integrating digital literacy programs into educational curricula across all levels could be a powerful strategy to improve health outcomes for all education levels.

The data revealed that employed individuals experienced both lower negative impacts and higher positive impacts from digital health tools. Employment likely facilitates better access to digital tools and the skills needed to use them effectively, consistent with findings in other regions

where employed individuals report better health outcomes due to greater access to digital health resources. This finding showed the importance of making digital health tools accessible to all, regardless of employment status.

Reliable internet access emerged as a key determinant of health behavior in the Arab MENA region. Countries like Egypt and Morocco, where respondents had consistent internet access, showed high positive impacts on health behaviors. This is consistent with global research highlighting the importance of internet access as a determinant of health literacy and behavior (Elgamal, 2024), (Zhao et al., 2024), (Andreassen et al., 2007), (Papp-Zipernovszky et al., 2021). Additionally, the use of advanced digital tools like AI health apps and health monitoring devices had a noticeable positive impact, particularly in Tunisia. These findings emphasize the need for further investment in digital infrastructure and the promotion of these tools to improve health outcomes in the region.

The study highlights the increasing role of social media platforms and online health forums as key channels for health communication, with particularly strong impacts observed in Egypt and Tunisia. This trend reflects the broader digital transformation in health information dissemination, where social media serves as both an enabler of health literacy and a potential source of misinformation. The significant influence of these platforms in Egypt and Tunisia can be attributed to several factors, including high social media penetration, shifting health-seeking behaviors, and the evolving digital health ecosystem.

One of the primary reasons for the strong impact of social media on health behaviors in these countries is the widespread use of platforms such as Facebook, Instagram, and WhatsApp, which dominate digital communication in the region. Egypt, with one of the highest social media user bases in the Arab world, has seen increasing reliance on these platforms for health advice, medical consultations, and patient support networks. Similarly, Tunisia's high internet penetration and active digital community facilitate the rapid exchange of health-related information. These platforms have become critical spaces for public health campaigns, peer-to-peer health discussions, and real-time updates on medical advancements. However, while social media enhances accessibility to health information, it also presents risks associated with misinformation and unverified medical content.

Studies have shown that social media can rapidly disseminate health information and create support networks, leading to improved health outcomes (Thapliyal et al., 2024), (Jiang, 2024). However, this also raises concerns about the spread of misinformation, reinforcing the importance of digital literacy programs that teach users how to critically evaluate health information.

The ability to critically evaluate health information significantly impacted health decision-making across the region, particularly in Lebanon and Morocco. Populations with better digital literacy skills, especially the ability to distinguish reliable from unreliable information, showed stronger positive health outcomes. This finding is supported by research that emphasizes the role of digital literacy in promoting informed health decisions (Sundell et al., 2022), (Nu Htay et al., 2022), (Berkowsky & Czaja, 2018).

Overall, the high odds ratios associated with social media use, reliable internet access, and the ability to critically evaluate information underscore the importance of digital engagement in improving health behaviors. These findings are consistent with similar studies in North America, which have identified digital literacy and social media use as strong predictors of health behaviors (Kontos et al., 2014). Future public health initiatives in the Arab MENA region should prioritize enhancing digital literacy, particularly among vulnerable populations, to promote more informed and positive health behaviors.

6. Strategic action plans for advancing digital health literacy

In light of the preceding discussion of our study's findings, we strongly encourage leaders and policymakers to establish programs to enhance individual and communal digital health literacy levels. Aligned

with global literature on past strategies, programs, and insights into digital literacy development, we propose the following action plans: launching Digital Literacy Support programs (DLSSs) specifically catered to marginalized populations, including women, older populations, people in rural areas, and people with disabilities to address the digital divide (Tirado-Morueta et al., 2018), (Heena & Nidhi, 2022), (Estrela et al., 2023), (Irizarry et al., 2002); capitalizing on digital literacy skills for the capacity development of people who are not in education, employment, or training (NEET) to eventually generate more employment (Matli & Ngoepe, 2020); reducing gender-based inequalities in access to mobile phones, education, occupation, and income; enhancing AI digital literacy, especially among younger generations who are more prone to coming into contact with these technologies; increasing internet access, particularly in remote areas and low-income households, to facilitate equitable access to resources that ultimately serve digital health literacy (Paul Onoja & Abayomi Ajala, 2022); creating targeted health e-spaces that users can safely engage with and learn from to eliminate the potential spread of misinformation; and Arabizing and translating digital tools and digital health resources to increase outreach, as language can be a significant barrier to tool usage and health decision-making (Kumar, 2023).

Overall, these strategies aim to serve as a stepping stone for communities, particularly in Arab MENA countries, where digital inequalities are more pronounced. By strengthening digital literacy and skills, populations can make more informed health decisions and thereby adopt healthier behaviors.

7. Strengths, limitations, and future work

This study aimed to establish a data-driven, baseline assessment of the overall digital health literacy levels in the Arab region and to identify the key demographic and digital determinants that inform healthful behaviors and enable better health-related decision-making skills. This study's key strengths lie in its large sample size (12,522 respondents) and broad geographical coverage across ten Arab MENA countries, providing a comprehensive view of digital health literacy in the region. However, future longitudinal studies remain critical to observe the long-term effects of our proposed strategies, as well as to establish an understanding of the trajectory of digital health literacy in the region and the changes and trends it prompts.

The use of the SMOTE-ENN technique ensured balanced representation across demographic groups, enhancing the study's reliability. However, it is important to acknowledge that SMOTE may introduce synthetic instances that do not fully reflect real-world variations in minority populations, potentially leading to overfitting. To address this, future analyses could explore alternative approaches, such as Ensemble Learning Methods (e.g., XGBoost, Easy Ensemble), which have shown promise in handling imbalanced data without generating synthetic samples.

While our findings can be generalized to more Arab countries in the region, they are not necessarily generalizable across the world. We recognize that an accurate assessment of the impact of digital literacy and internet usage on health behaviors and decision-making depends on the specific socio-cultural and economic context from which the data is generated. Accordingly, future studies should compare digital health literacy between Arab countries and other regions to identify unique challenges and common factors that influence health behaviors globally.

8. Conclusion

This study provides insights into the influence of digital literacy on health behaviors and decision-making across the Arab MENA region. Factors such as reliable internet access, confidence in using digital tools, and the ability to critically evaluate health information are crucial for positive health outcomes. The variations observed between countries show the importance of enhancing digital literacy, expanding internet

access, and promoting responsible use of digital platforms for health purposes. The positive impacts seen in countries like Egypt and the UAE demonstrate the benefits of strong digital health strategies, while the challenges in Kuwait and Bahrain reveal the need for further development. These results contribute to understanding digital health literacy's role in improving health outcomes and emphasize the importance of continued efforts to bridge the digital divide and ensure equitable access to digital health resources across the region.

CRedit authorship contribution statement

Reema Tayyem: Writing – original draft, Methodology, Conceptualization. **Radwan Qasrawi:** Writing – original draft, Methodology, Conceptualization. **Haleema Al Sabbah:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Malak Amro:** Writing – review & editing, Software, Methodology, Formal analysis. **Ghada Issa:** Writing – review & editing, Software, Methodology, Formal analysis. **Suliman Thwib:** Writing – review & editing, Software, Methodology, Formal analysis. **Siham Hani Atari:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Khlood Bookari:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Noor Alawadhi:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Sabika Allehdan:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Hana Trigui:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Elie Sokhn:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Yousef Khader:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Eman Badran:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Iman Kamel:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Atiyeh Abdallah:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Mohamed Jemaà:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Emmanuel Musa:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Jude Dzevela Kong:** Writing – review & editing, Investigation, Data curation, Conceptualization.

Ethical considerations

Ethical approval was obtained from the Institutional Review Boards (IRBs) of the participating countries (Approval Date: March 30, 2024; Ref No: 384/REC/2024). Informed consent was obtained from all participants before their involvement in the study. To ensure privacy and confidentiality, all data were anonymized in accordance with ethical guidelines, including the Declaration of Helsinki and relevant local regulations.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Chat GPT 3.5 in order to improve readability and language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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Data availability

Data will be made available on request.

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