





BMJ Open Associations of eHealth literacy and knowledge with preventive behaviours and psychological distress during the COVID-19 pandemic: a population-based online survey

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ABSTRACT

Objectives To compare the associations of COVID-19 preventive behaviours and depressive and anxiety symptoms with eHealth literacy and COVID-19 knowledge among Korean adults.

Design A cross-sectional online survey was conducted in April 2020.

Setting Seoul metropolitan area in South Korea.

Participants 1057 Korean adults were recruited.

Main outcome measures Associations between eHealth literacy, COVID-19 knowledge, COVID-19 preventive behaviours and psychological distress were computed using Pearson's correlation and logistic regression analyses. eHealth literacy, COVID-19 knowledge, COVID-19 preventive behaviours and psychological distress were weighted by sex and age distribution of the general population in Seoul Metropolitan area.

Results 68.40% (n=723) perceived high eHealth literacy level (eHEALS ≥ 26), while 57.43% (n=605) had high levels of COVID-19 knowledge (score ≥ 25). No significant association between eHealth literacy and COVID-19 knowledge was identified ($r=0.05$, $p=0.09$). eHealth literacy and COVID-19 knowledge were significantly associated with COVID-19 preventive behaviours (aOR=1.99, 95% CI 1.51 to 2.62; aOR=1.81, 95% CI 1.40 to 2.34, respectively). High eHealth literacy was significantly associated with anxiety symptom (aOR=1.71, 95% CI 1.18 to 2.47) and depressive symptom (aOR=1.69, 95% CI 1.24 to 2.30). COVID-19 knowledge had negative and no associations with the symptoms (aOR=0.62, 95% CI 0.46 to 0.86; aOR=0.79, 95% CI 0.60 to 1.03, respectively). High eHealth literacy with low COVID-19 knowledge was positively and significantly associated with COVID-19 preventive behaviours (aOR=2.30, 95% CI 1.52 to 3.43), and anxiety (aOR=1.81, 95% CI 1.09 to 3.01) and depressive symptoms (aOR=2.24, 95% CI 1.41 to 3.55). High eHealth literacy with high COVID-19 knowledge were significantly associated with more preventive behaviours (aOR=3.66, 95% CI 2.47 to 5.42) but no significant associations with anxiety and depressive symptoms.

Conclusion We identified that eHealth literacy and COVID-19 knowledge were not associated each other,

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ One of the largest online survey platforms in Korea with more than five million survey panel members was used for the research.
- ⇒ The survey data were weighted according to the census data in South Korea, thus enhancing the external validity and reliability of the study findings.
- ⇒ Sampling bias can be caused as we recruited the respondents among panel members from an online survey company who lived in an urban area.
- ⇒ Although survey questions regarding COVID-19 knowledge and COVID-19 preventive behaviours that were developed and used by WHO were adopted, the questions were not validated.

and differently associated with individuals' COVID-19 preventive behaviours and psychological well-being. Public health strategies should pay attention to enhancing both eHealth literacy and COVID-19 knowledge levels in the public to maximise their COVID-19 preventive behaviours and mitigate their psychological distress during COVID-19 pandemic.

INTRODUCTION

Since the WHO was informed of the first COVID-19 cases on 31 December 2019,¹ global healthcare services have encountered unprecedented challenges with more than 235 million confirmed cases, claiming more than 4.8 million lives (as of 5 October 2021) worldwide.² In the midst of fighting against COVID-19, the WHO affirmed that governments and healthcare providers have also been at a war with an Infodemic, in which an excess of COVID-19-related information have flooded numerous media outlets and the Internet,^{3 4} making it difficult for the public to find reliable information from trustworthy sources.⁵ Indeed, the proliferation



of COVID-19 misinformation and conjecture has misled readers to perform harmful health behaviours without scientific evidence support, such as consuming drinks containing bleach to cure COVID-19.^{3 6} A Korean study identified that 67.78% of adults had been exposed to COVID-19 misinformation, and the degree of exposure was associated with misinformation belief and fewer COVID-19 preventive behaviours.⁷ Fewer or incorrect preventive behaviours can lead to ineffective mitigation of COVID-19 transmission and fuel mistrust towards authorities, placing further pressure on the public health-care systems.⁸⁻¹⁰ Furthermore, the over exposure to an overabundance of misinformation, in particular through Social Networking Services and instant messaging, was associated with increasing psychological distress, including depressive and anxiety symptoms.^{7 8 11 12}

Due to the negative impacts brought by misinformation to the public and its respective health systems, the WHO has highlighted the importance of the health literacy to promote appropriate health behaviours, and to prevent the misuse of fiscal resources.¹³ eHealth literacy, the electronic version of health literacy, is the ability of an individual in accessing, understanding, appraising and applying information acquired from electronic sources to make optimal decisions for their health and personal interests, and to tackle health-related problems encountered in daily life.¹⁴ It has therefore gained its recognition as a fundamental component in public health.¹⁵⁻¹⁷ Individuals with high eHealth literacy are perceived to be more capable in making appropriate health-related decisions that may benefit society by building its resilience and narrowing health inequalities.¹⁸ Contrastingly, individuals with low eHealth literacy are in peril of experiencing psychological distress during the pandemic.¹⁷ This is because they would lack the competency to access credible resources regarding the pandemic, making them susceptible to misinformation that fuels psychological distress¹⁹ and leading to fewer correct preventive behaviours,²⁰ such as inappropriate antibiotics use and refusing vaccinations.²¹ Likewise, research has shown that health knowledge is also positively associated with health-related preventive behaviours.²² Particularly, the level of knowledge on disease transmission modes and protective measures against infection is positively associated with attitudes towards disease prevention behaviours such as performing hand hygiene and avoiding group gatherings.²³⁻²⁹

COVID-19-related eHealth literacy and knowledge have both been advocated as potential solutions to mitigate the negative impacts of the COVID-19 pandemic by influencing the adoption of preventive behaviours and maintaining physical and psychological well-being.^{13 16 18 23 28} eHealth literacy is a subjective perception of one's own skills with eHealth information.¹⁴ In the teeth of verifying the authenticity of acquired COVID-19 information, individuals with high eHealth literacy can over-rate or overestimate their ability in interpreting information, but may not necessarily guarantee the development of correct

health-related knowledge.³⁰ Despite of the potential risk, eHealth literacy is more highlighted in literature than disease knowledge including COVID-19 knowledge as the crucial factor in health promotion.^{13 18 29}

A coordinated and comprehensive approach to improve the physical and psychological well-being of individuals is imperative to minimise the adverse impacts COVID-19 has had on society. However, no research has been conducted yet to compare the association of eHealth literacy and COVID-19 knowledge with psychological distress and preventive behaviours. This gap was confirmed through database searches in PubMed and CINAHL using keywords of COVID-19, eHealth literacy, knowledge, depress*, anxiety and prevention. This research aimed to compare the associations of COVID-19 preventive behaviours and psychological distress including depressive and anxiety symptoms with eHealth literacy and COVID-19 knowledge among adults living in the Seoul metropolitan area of South Korea (hereafter Korea).

METHODS

Study design and sampling

A cross-sectional study design was adopted. An online survey company (<http://www.dooit.co.kr>) was hired for data collection (ie, convenience sampling). The company has around five million survey panel members (as of April 2020), making them one of the largest online survey platforms in Korea. The company has conducted over 160 000 online surveys for academic research including Kim *et al.*³¹ and reports for Korea government and industry. The eligible criteria for participants were (1) age ≥ 20 years, (2) a resident in Seoul, Gyeonggi-do and Incheon areas (ie, the Seoul Metropolitan area: more than half of the Korean population live in this area) and (3) a Korea national ID holder. Survey information including the purpose of the survey, participant's rights and a survey website link was sent to survey panel members on 23 April 2020. As of 23 April 2020, 10 708 confirmed COVID-19 cases were reported in Korea, since the first case reported on 24 January 2020. The survey link was available for 1 day in April 2020, due to costs involved. Online consent forms were obtained from participants. To prevent multiple responses from a single participant, each participant's date of birth and mobile number were reviewed to ensure unique entries. In determining the minimum sample size needed for our analysis, we adhered to the commonly utilised guideline proposed by Peduzzi *et al.*³² This guideline recommends having at least 10 events per predictor variable in logistic regression models. Given that our model incorporates nine predictor variables, this rule of thumb stipulates that we should have a minimum of 90 events (10 events multiplied by nine variables) within the smallest outcome group. To adequately account for potential variability in our data, we made a conservative assumption that the prevalence of our outcome of interest is 10% within our study sample. Therefore, our study requires a minimum sample size of 900 participants.

Measurements

Participants' sociodemographic information (ie, sex, age, education level, household arrangement and monthly individual income), the amount of time spent searching for COVID-19 information and the sources of COVID-19 information were investigated.

The eHealth Literacy Scale (eHEALS)³³ consists of eight items and was validated in Korean (Cronbach's $\alpha=0.88$ and acceptable construct validity).³⁴ The internal consistency of eHEALS in this study was 0.90. eHEALS scores (ie, the sum of the items ranging from 8 to 40) ≥ 26 and < 26 indicate high and low eHealth literacy, respectively.³⁵

Five knowledge questions about COVID-19 that were developed and used by the WHO³⁶ were adopted to measure the participants' COVID-19 knowledge levels. Lower scores in the sum of the five items (ranging from 0 to 35) refer to a lower COVID-19 knowledge level. Similarly, the number of COVID-19 preventive behaviours that the participants had performed during the last 3 months were examined using 10 multiple-choice options, adopted from the WHO³⁶ and Korea Centres for Disease Control and Prevention.³⁷ Lower scores in the sum of the options (ranging from 0 to 10) indicate fewer COVID-19 preventive behaviours performed.

Patient Health Questionnaire-4 (PHQ-4) was used to measure the participants' risks of anxiety and depression. PHQ-4 consists of two subscales: each two-question measures anxiety and depressive symptoms (scores ranging from 0 to 6), respectively.³⁸ The anxiety and depressive symptoms are screened with ≥ 3 scores in each subscale. The Korean version of PHQ-4 was validated.³⁹

The questionnaire was reviewed by five Korean adults who did not participate in the survey as well as the research team, before being used in the survey. The online questionnaire is available in online supplemental file 1.

Patient and public involvement

Patients and the public were not involved in the study. However, we will seek their support to disseminate and advocate the study findings among the public in South Korea and elsewhere.

Statistical analysis

Age and sex distributions in the Seoul Metropolitan area⁴⁰ were weighted to the collected data.

Descriptive statistics regarding the study variables were conducted. The associations between eHealth literacy, COVID-19 knowledge, COVID-19 preventive behaviours, anxiety symptoms and depressive symptoms were analysed using Pearson's correlation coefficient.

The associations of the number of preventive behaviours, time spent searching for information, source of information, anxiety symptoms and depressive symptoms (independent variables) with eHealth literacy and COVID-19 knowledge (dependent variables) were investigated using logistic regressions to yield OR and adjusted (sex, age, highest education level, household

arrangement and monthly personal income) OR (aOR). The scores for eHealth literacy and COVID-19 knowledge were categorised into binary groups for the regression analyses according to the cut-off score and mean score, respectively.

Moreover, the aORs of the associations of the number of preventive behaviours, anxiety symptoms and depressive symptoms with four combinations of eHealth literacy and COVID-19 knowledge levels (ie, low literacy with low knowledge; low literacy with high knowledge; high literacy with low knowledge and high literacy with high knowledge) were also computed. All analyses were performed using STATA V.15 (StataCorp, USA).

RESULTS

A total of 1057 Korean adults participated in the online survey. Among them, 57.3% were female and mean age was 39.46 (± 10.47) years; 77.67% received tertiary education or higher education, and 86.38% lived with others (eg, parents and/or children). The majority (59.60%) earned KRW3 000 000 (\approx US\$2500) or below personal income (monthly); 46.83% searched for COVID-19 information using the Internet for 6–30 min during the past 7 days. Majority of the participants obtained COVID-19 information from diverse Internet sources including online media (eg, Television (TV) programmes and newspapers; 98.58%), Internet websites (82.02%), Social Networking Services (71.62%) and instant messaging applications (82.97%); 68.40% believed that they had high eHealth literacy (score range 26–40), while 57.43% had high levels of COVID-19 knowledge (score range 25–35); 61.97% performed ≥ 7 COVID-19 preventive behaviours; 18.83% and 29.52% had anxiety and depressive symptoms, respectively (table 1).

Pearson's correlation coefficient analyses found that eHealth literacy was positively associated with COVID-19 preventive behaviours ($r=0.14$, $p<0.001$), anxiety symptoms ($r=0.09$, $p<0.05$) and depressive symptoms ($r=0.07$, $p<0.05$). COVID-19 knowledge was positively associated with COVID-19 preventive behaviours ($r=0.30$, $p<0.001$), but negatively associated with anxiety symptoms ($r=-0.17$, $p<0.001$), and depressive symptoms ($r=-0.12$, $p<0.001$). No association between eHealth literacy and COVID-19 knowledge was found (table 2).

eHealth literacy was associated with more COVID-19 preventive behaviours (≥ 7 behaviours: aOR=1.99, 95% CI 1.51 to 2.62), longer time spent searching for online COVID-19 information (61 min or more: aOR=3.07, 95% CI 1.91 to 4.95), diverse use of online sources for COVID-19 information (TV/radio/newspaper: aOR=8.53, 95% CI 2.72 to 26.64; other Internet websites aOR=2.70, 95% CI 1.96 to 3.71; SNS: aOR=1.87, 95% CI 1.40 to 2.50; instant messaging: aOR=2.14, 95% CI 1.53 to 2.98), and more risks of anxiety (aOR=1.99, 95% CI 1.51 to 2.62) and depressive (aOR=1.99, 95% CI 1.51 to 2.62) symptoms. COVID-19 knowledge was positively associated with COVID-19 preventive behaviours (≥ 7 behaviours:

Table 1 Participants' demographics, COVID-19 information seeking patterns, eHealth literacy, COVID-19 knowledge and preventive behaviours and psychological symptoms (n=1057)

	N (%)*	Weighted† N (%)*
Total, N	1057	1057
Sex		
Male	451 (42.67)	531 (50.20)
Female	606 (57.33)	526 (49.80)
Age, mean (SD)	39.46 (10.47)	43.5 (12.88)
20–29	202 (19.11)	201 (18.98)
30–39	353 (33.40)	220 (20.85)
40–49	313 (29.61)	245 (23.15)
50–59	148 (14.00)	236 (22.37)
60–69	41 (3.88)	155 (14.65)
Education		
High school or below	236 (22.33)	267 (25.24)
Tertiary or above	821 (77.67)	790 (74.76)
Household arrangement		
Living alone	144 (13.62)	123 (11.63)
Living with others	913 (86.38)	934 (88.37)
Monthly personal income‡ (KRW)§		
3 000 000 or below	630 (59.60)	595 (56.27)
3 000 001–5 000 000	264 (24.98)	261 (24.73)
5 000 001 or high	163 (15.42)	201 (19.00)
Time spent searching for COVID-19 information		
5 min or less	156 (14.76)	156 (14.74)
6–30 min	495 (46.83)	502 (47.49)
31–60 min	218 (20.62)	222 (20.99)
61 min or more	188 (17.79)	177 (16.79)
Source of COVID-19 information¶		
TV/radio/newspaper (online)	1042 (98.58)	1036 (98.01)
Other Internet websites	867 (82.02)	844 (79.89)
SNSs** (eg, Facebook and Instagram)	757 (71.62)	757 (71.58)
Instant messaging	877 (82.97)	871 (82.41)
eHealth literacy, mean (SD)††	28.10 (5.26)	28.20 (5.36)
Low literacy (8–25)	334 (31.60)	328 (30.99)
High literacy (26–40)	723 (68.40)	729 (69.01)
COVID-19 knowledge, mean (SD)	24.66 (2.58)	24.63 (2.71)
Low (0–24)	450 (42.57)	452 (42.76)
High (25–35)	607 (57.43)	605 (57.24)
COVID-19 preventive behaviours, mean (SD)	6.92 (2.44)	6.99 (2.50)
0–6 behaviours	402 (38.03)	394 (37.31)
≥7 behaviours	655 (61.97)	663 (62.69)
Anxiety symptoms, mean (SD)‡‡	1.50 (1.61)	1.51 (1.66)
No	858 (81.17)	859 (81.30)
Yes (≥3)	199 (18.83)	198 (18.70)

Continued

Table 1 Continued

	N (%)*	Weighted† N (%)*
Depressive symptoms, mean (SD)§§	2.02 (1.72)	2.03 (1.78)
No	745 (70.48)	746 (70.60)
Yes (≥3)	312 (29.52)	311 (29.40)

*Calculated percentages were rounded off to one decimal place, accordingly combined percentages can exceed 100%.
†Data were weighted by sex and age distribution of the general population in the Seoul metropolitan area.
‡Average monthly income among employees was KRW2 970 000 in 2018.
§US\$1 ≈ KRW1200.
¶Multiple responses allowed.
**Social network services.
††eHealth Literacy Scale (eHEALS).
‡‡Generalized Anxiety Disorder Questionnaire-2 (GAD-2).
§§Patient Health Questionnaire-2 (PHQ-2).

aOR=1.81, 95% CI 1.40 to 2.34), 6–30 min spent searching for online COVID-19 information (aOR=1.55, 95% CI 1.08 to 2.24), COVID-19 information sources of online TV/radio/newspaper (aOR=4.89, 95% CI 1.72 to 13.91) and lower risks of anxiety (aOR=0.62, 95% CI 0.46 to 0.86) and depressive (aOR=0.79, 95% CI 0.60 to 1.03; marginal association) symptoms (table 3).

The combinations of low literacy with high knowledge; high literacy with low knowledge and high literacy with high knowledge were associated with more COVID-19 preventive behaviours (aOR=2.15, 95% CI 1.37 to 3.37; aOR=2.30, 95% CI 1.52 to 3.43; and aOR=3.66, 95% CI 2.47 to 5.42, respectively), compared with the combination of low literacy with low knowledge. Only the high literacy and low knowledge combination was positively associated with anxiety (aOR=1.81, 95% CI 1.09 to 3.01) and depressive (aOR=2.24, 95% CI 1.41 to 3.55) symptoms (table 4).

DISCUSSION

Through this cross-sectional study, we identified no association between eHealth literacy and COVID-19 knowledge. We found different associations of COVID-19 preventive behaviours, COVID-19 information seeking patterns and psychological distress with eHealth literacy and COVID-19 knowledge.

Our research findings highlighted the distinct independent roles of eHealth literacy and COVID-19 knowledge in influencing individuals' psychological status and COVID-19 preventive behaviours. This would be because COVID-19 knowledge is constructed from the acquisition of evidence-based COVID-19 information which may promote the adoption of preventive behaviours and lower illness expectation.²⁸ Whereas eHealth literacy entails 'self-perceived' skill, competency, motivation and ability in searching, understanding and analysing information acquired from various sources, and making optimal health-related decisions to protect their health

Table 2 Correlations between eHealth literacy, COVID-19 knowledge, COVID-19 preventive behaviours, anxiety symptom and depressive symptom

Measure	1	2	3	4	5
eHealth literacy	–				
COVID-19 knowledge	0.05	–			
COVID-19 preventive behaviours	0.14***	0.30***	–		
Anxiety symptoms	0.09*	–0.17***	–0.03	–	
Depressive symptoms	0.07*	–0.12***	0.00	0.67***	–

*p<0.05, **p<0.01, ***p<0.001.

and psychological well-being.^{13 14 18} It could thereby imply that COVID-19 knowledge and eHealth literacy could be two separate predictors in determining individual's behaviours and psychological status amidst a global pandemic.³⁰

For COVID-19 preventive behaviours, we identified that both eHealth literacy and COVID-19 knowledge were positively associated with COVID-19 preventive behaviours,

while eHealth literacy had a slightly stronger association with preventive behaviours than that of COVID-19 knowledge. Existing studies had also confirmed that both eHealth literacy and COVID-19 knowledge were associated with disease preventive behaviours such as getting vaccinated and performing frequent hand hygiene.^{13 21 30 41} However, considering the existence of the COVID-19 infodemic,³ a study argued that individuals

Table 3 Associations of COVID-19 preventive behaviours, information seeking patterns and psychological symptoms with eHealth literacy and COVID-19 knowledge (n=1057)

COVID-19	eHealth literacy		COVID-19 knowledge	
	OR 95% CI		Crude	Adjusted†
	Crude	Adjusted†		
Number of preventive behaviours				
0–6 behaviours	Ref	Ref	Ref	Ref
≥7 behaviours	1.98 (1.52 to 2.59)***	1.99 (1.51 to 2.62)***	1.84 (1.43 to 2.37)***	1.81 (1.40 to 2.34)***
Time spent searching for information				
5 min or less	Ref	Ref	Ref	Ref
6–30 min	2.12 (1.47 to 3.05)***	2.01 (1.39 to 2.92)***	1.60 (1.11 to 2.30)*	1.55 (1.08 to 2.24)*
31–60 min	3.26 (1.47 to 3.05)***	3.01 (1.91 to 4.74)***	1.22 (0.81 to 1.84)	1.18 (0.77 to 1.79)
61 min or more	3.18 (1.47 to 3.05)***	3.07 (1.91 to 4.95)***	1.05 (0.68 to 1.62)	1.05 (0.68 to 1.62)
Source of information‡				
TV/radio/newspaper	8.94 (2.51 to 31.91)**	8.53 (2.72 to 26.64)**	3.78 (1.19 to 11.94)*	4.89 (1.72 to 13.91)**
Other Internet websites	2.77 (2.01 to 3.82)***	2.70 (1.96 to 3.71)***	0.98 (0.71 to 1.34)	1.02 (0.75 to 1.39)
SNSs	1.62 (1.23 to 2.15)**	1.87 (1.40 to 2.50)***	0.93 (0.71 to 1.22)	0.94 (0.71 to 1.24)
Instant messaging	2.08 (1.50 to 2.88)***	2.14 (1.53 to 2.98)***	0.86 (0.62 to 1.19)	0.93 (0.67 to 1.30)
Anxiety symptoms§				
No	Ref	Ref	Ref	Ref
Yes (≥3)	1.57 (1.10 to 2.24)*	1.71 (1.18 to 2.47)**	0.62 (0.45 to 0.84)**	0.62 (0.46 to 0.86)**
Depressive symptoms¶				
No	Ref	Ref	Ref	Ref
Yes (≥3)	1.50 (1.11 to 2.02)**	1.69 (1.24 to 2.30)**	0.78 (0.60 to 1.02)	0.79 (0.60 to 1.03)

All data were weighted by sex and age distribution of the general population in the Seoul metropolitan area in Korea.

*P<0.05, **p<0.01, ***p<0.001.

†Adjusted for sex, age, highest education level, household arrangement and monthly personal income.

‡Multiple responses were allowed (the reference groups were those who responded 'No').

§Generalised Anxiety Disorder Questionnaire-2 (GAD-2) score ≥3.

¶Patient Health Questionnaire-2 (PHQ-2) score ≥3.

SNSs, social network services.

Table 4 Associations of COVID-19 preventive behaviours and psychological symptoms with levels of eHealth literacy plus COVID-19 knowledge (n=1057)

	Weighted N (%)†	Adjusted‡ OR 95% CI		
		Number of COVID-19 preventive behaviours	Anxiety symptoms	Depressive symptoms
Low L and low K	154 (14.56)	Ref	Ref	Ref
Low L and high K	174 (16.43)	2.15 (1.37 to 3.37)**	0.63 (0.34 to 1.20)	1.09 (0.65 to 1.84)
High L and low K	298 (28.20)	2.30 (1.52 to 3.43)***	1.81 (1.09 to 3.01)*	2.24 (1.41 to 3.55)**
High L and high K	431 (40.82)	3.66 (2.47 to 5.42)***	1.08 (0.65 to 1.79)	1.49 (0.96 to 2.33)

*P<0.05, **p<0.01, ***p<0.001.
†Data were weighted by sex and age distribution of the general population in the Seoul metropolitan area.
‡Adjusted for sex, age, highest education level, household arrangement and monthly personal income.
K, COVID-19 knowledge; L, eHealth literacy.

would perform fewer COVID-19 preventive behaviours due to misinformation belief in one's self-perceived knowledge.⁷ Nonetheless, our findings indicated that individuals with high eHealth literacy outperformed the other subgroups in performing more COVID-19 preventive behaviours although with the existence of COVID-19 misinformation. The reason is potentially due to exposure to a large volume of COVID-19-related information, and the existence of misinformation may perplex individuals and their analysis of the COVID-19 situation, heightening their awareness of the severity of the pandemic as well as self-perceived threat and susceptibility of COVID-19 infection. To safeguard their health, they are therefore more likely to perform more COVID-19 preventive measures.

We identified the positive association of eHealth literacy with both depressive and anxiety symptoms, which are contrary to the finding of existing studies carried out before the pandemic suggesting insignificant association between health literacy and depressive symptoms.^{42 43} Such depressive and anxiety symptoms experienced by individuals with high eHealth literacy in our study can likely be explained by the existence of the COVID-19 infodemic³ and their limited ability in analysing complex scientific information.¹⁷ Despite their perceived eHealth literacy,^{14 30} they were unable to distinguish verified COVID-19 facts from misinformation that had been heavily intertwined within the insurmountable volumes of circulating information, particularly through instant messaging and SNSs,⁸ causing confusion and therefore psychological stress. On further analysis of the data collected, we observed that individuals with high eHealth literacy spent an exponentially greater amount of time (≥ 61 min) in searching for COVID-19 information compared with those with high COVID-19 knowledge, as well as acquiring said information from a wider variety of sources, namely online media (TV/radio/newspaper), websites, instant messaging and SNSs. With a longer duration on searching for COVID-19 information⁴⁴ and the presence of misinformation⁷ from various sources, this may further aggravate individuals' perceived virulence, severity and the uncertainty in face of the COVID-19, together with self-perceived susceptibility to COVID-19

infection, which served only to amplify their psychological distress. Consequently, a vicious cycle is formed, where one's heightened psychological distress triggers the need to further research COVID-19 information or misinformation, thus leading to the further deterioration of their psychological status.^{7 17}

Unlike eHealth literacy, the level of COVID-19 knowledge was negatively associated with anxiety, while there was no significant association with depressive symptoms. Instead, it was positively associated with the number of preventive behaviours performed. Similar to existing studies on disease knowledge with individuals' attitudes towards a disease,^{23 25} knowledge could empower individuals by lowering their perceived risk in facing the uncertainty of COVID-19. We identified that conventional media (ie, TV/radio/newspaper) was a major source of knowledge, sources that tend to report evidence-based COVID-19 information from the authorities.⁹ This may signify that the dissemination of scientifically-proven, verifiable and reliable information was capable of increasing their knowledge level of COVID-19, and most importantly drove them to perform effective COVID-19 preventive measures²⁸ and prevent development of anxiety.

Moreover, a further finding of our study indicated that individuals with the combination of high eHealth literacy and low COVID-19 knowledge show positive association with preventive behaviours, depressive and anxiety symptoms. Indeed, this noteworthy finding emphasised the importance of COVID-19 knowledge in alleviating their psychological distress, as it could empower individuals to assess their own risk of infection and to adopt efficiently by performing appropriate COVID-19 preventive behaviours. Due to the verifiable nature of the information acquired, they would be able to protect themselves through effective preventive behaviours, their perceived and actual risk of infection would diminish, and subsequently their psychological well-being would be safeguarded during the pandemic. This suggests that COVID-19 knowledge is crucial for preventing development of depressive and anxiety symptoms, while eHealth literacy promotes the practice of preventive behaviours to mitigate viral transmission within a community.²⁹

Strengths and limitations

This study utilised one of the largest online survey platforms in Korea, which has over five million panel members, for data collection. Additionally, the survey data were weighted according to the census data in South Korea. These factors contribute to enhancing the external validity and reliability of the study findings. Due to the study design (ie, cross-sectional study), the causal relationships between eHealth literacy, COVID-19 knowledge, COVID-19 preventive behaviours, anxiety symptoms and depressive symptoms cannot be determined.⁴⁵ Although we adopted survey questions regarding COVID-19 knowledge and COVID-19 preventive behaviours that were developed and used by reliable healthcare institutions (eg, WHO), the questions were not validated. Sampling bias can be caused as we recruited the respondents among panel members from an online survey company—for example, the respondents lived in an urban area (ie, Seoul Metropolitan area). Additionally, online survey may exclude those with limited Internet access or low digital competency, potentially leading to selection bias. Due to the inherent nature of the study design, response bias may arise, potentially affecting the study results. The survey response rate is difficult to determine as the survey company not only sent emails to the panel members but also uploaded the participant recruitment information on their notice board, which was accessible to the panel members.

While the data were weighted according to the census data, there were relatively fewer respondents aged 60 years or older. Finally, there is potential recall and social desirability biases of the respondents due to the self-reported data.

CONCLUSION

We provided the first finding that eHealth literacy and COVID-19 knowledge were not correlated, and were differently associated with individuals' COVID-19 preventive behaviours and psychological well-being among the adult population living in the Seoul metropolitan area of Korea. Given that high eHealth literacy with high COVID-19 knowledge was associated with more COVID-19 preventive behaviours without psychological distress, public health strategies should be targeted to enhancing both eHealth literacy and COVID-19 knowledge levels in the public to mitigate COVID-19 transmission and their psychological distress during the pandemic. Moreover, in-depth, follow-up and longitudinal studies that explore mediating factors affecting the process of health behaviour development through eHealth literacy and/or disease knowledge will be beneficial to develop health promotion strategies, particularly on online platforms.

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