eHealth literacy and online health information-seeking behaviors on COVID-19 in Japan: An Internet-based mixed methods study

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Abstract

Background: During the coronavirus disease 2019 (COVID-19) pandemic, much misinformation and disinformation emerged and spread rapidly via the Internet, posing a severe public health challenge. While the need for eHealth literacy (eHL) has been emphasized, few studies have compared the difficulties involved in seeking and using COVID-19 information between adult Internet users with low and high eHL.

Objective: This study examined the association between eHL and online health information-seeking behaviors among adult Japanese Internet users. Moreover, this study qualitatively shed light on the difficulties encountered in seeking and using this information, and to examine its relationship with eHL.

Methods: This cross-sectional Internet-based survey (October, 2021) collected data from 6,000 adult internet users who were equally divided into sample groups by sex, age, and income. We used the Japanese version of the eHealth Literacy Scale (eHEALS). We also used a digital health literacy instrument (DHLI) adapted to the COVID-19 pandemic to assess eHL after we translated it to Japanese. Online health information-seeking behaviors were assessed using a 10-item list of web sources and evaluating ten topics participants searched for regarding COVID-19. Sociodemographic and other factors (e.g. health related behavior) were selected as covariates. Furthermore, we qualitatively explored the difficulties in information seeking and using. The descriptive contents of the responses regarding difficulties in seeking and using COVID-19 information were analyzed using an inductive qualitative content analysis approach.

Results: Participants with high eHEALS and DHLI scores on information searching, adding self-generated information, evaluating reliability, determining relevance, and operational skills were more likely to use all web sources of information about COVID-19 than those with low scores. However, there were negative associations between navigation skills and privacy protection scores when using several information sources, such as YouTube, to search for COVID-19 information. While half of the participants reported no difficulty seeking and using COVID-19 information, participants who reported any difficulties including information discernment, incomprehensible information, information overload, and disinformation had lower DHLI score. Participants expressed significant concerns regarding "Information Quality and Credibility," "Abundance and Shortage of Relevant Information," "Public Trust and Skepticism," and "Credibility of COVID-19 Related Information." Additionally, they disclosed more specific concerns, including "Privacy and Security Concerns," "Information Retrieval Challenges," "Anxieties

and Panic," and "Movement restriction."

Conclusions: Although Japanese Internet users with higher eHEALS and total DHLI scores were more actively using various web sources for COVID-19 information, those with high navigation skills and privacy protection used online information about COVID-19 cautiously compared to those with lower proficiency. The study also highlighted an increased need for information discernment when using social networking sites in the "Health 2.0" era. The identified categories and themes from the qualitative content analysis, such as "Information Quality and Credibility," suggest a framework for addressing the myriad challenges anticipated in future infodemics.

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Keywords: COVID-19; eHealth, health communication; Internet, mixed methods study, adult population, Asia

Introduction

The Internet is a powerful source of information on health behavior, knowledge of health, and medical care. Most of the general adult population uses the Internet in Japan, as in other developed countries [1-3]. Approximately 73% of Japanese Internet users have searched for health information in the past 12 months [4]. However, many websites providing health information are unreliable and may be more linked to promoting commercial goods or private health services [5-7]. Misinformation (false information distributed without the intention to cause harm) and disinformation (false information shared deliberately to cause harm) may negatively affect people's physical and mental health; increase stigmatization and threaten precious health gains, which lead to poor observance of public health measures [8, 9]. Therefore, eHealth literacy (eHL), defined as the ability to seek, find, understand, and appraise health information on the Internet to address or solve a health problem, is essential for accessing and using reliable health information via the Internet.

During the coronavirus disease 2019 (COVID-19) pandemic, an 'infodemic'—an epidemic of misinformation or disinformation—emerged and spread rapidly via the Internet, posing a severe public health problem [10]. The COVID-19 infodemic has highlighted that poor eHealth literacy is a major challenge in using COVID-19 information on the Internet [11]. People with poor health literacy are more likely to be confused by COVID-19 information on the Internet [12]. Therefore, improving health communication strategies for people with poor eHL to access reliable COVID-19 information on the Internet easily is required.

Understanding the COVID-19 information-seeking behavior and identifying the difficulties Internet users with low eHL are confronted with when dealing with those information is essential to improving communication strategies on COVID-19 and other health crises. The COVID health literacy (COVID-HL) network surveyed digital health literacy (DHL), defined to have the same meaning as eHL [13]. Studies of the COVID-HL network revealed that university students with low eHL were more likely to use social media but less likely to use search engines and websites of official institutions than those with high eHL using quantitative data [14-18]. However, few studies have compared the difficulties individuals encounter when seeking and using COVID-19 information identified by qualitative content analysis between Internet users with low and high eHL estimated by assessment tool. In addition, a limitation of these prior studies was that they included only college

students [14-18]. Examining the associations of eHL with health information-seeking behavior among other age groups is needed because the Internet is used not only by younger adults but different age-groups, and older adults are reported to have barriers to health information in Internet[1][2].

Comparing the subjective difficulties in seeking information between Internet users with high and low eHL would help to improve the strategies promoting access to reliable COVID-19 information. Therefore, this study aimed to examine the association between eHL and online health information-seeking behaviors. Additionally, this study aimed to qualitatively shed light on the difficulties encountered in seeking and using this information, and to examine its relationship with eHL.

Methods

Study design and participants

This study used data from a cross-sectional Internet-based survey that has been conducted in October 2021. The study participants were recruited from the registrants of a Japanese Internet research company (MyVoice Communication, Inc.), who were asked to respond to the survey. This research company has approximately 553,719 registers that could respond to this survey and obtain detailed sociodemographic data from each participant upon registration in 2021. This study aimed to collect data from 6,000 men and women aged 20–79 years. The participants were equally divided into 132 sample groups categorized by sex (men and women), age (six categories: 20–29, 30–39, 40–49, 50–59, 60–69, and 70–79 years), and income (11 categories: < 1, 1–< 2, 2–< 3, 3–< 4, 4–< 5, 5–< 6, 6–< 7, 7–<8, 8–<9, 9–<10, ≥10 million yen; 1 USD = 113 JPY, October 2021), with n=45 in each group. The Internet research service company randomly chose 250 potential respondents to collect 45 participants in each group from the registered participants in accordance with the company's response rate data. Likely respondents could log into a protected site area using a unique ID and password. After the desired number of participants voluntarily signed an online informed consent form and completed a sociodemographic data information form, participants were no longer accepted. Reward points valued at 130 JPY were provided as incentives for participation.

Ethics Approval

The Ethics Committees of the Tokyo Metropolitan Institute for Geriatrics and Gerontology (R21-055) and Kyoto University (R3191) approved the study protocol. All procedures followed the ethical guidelines of the Medical and Biological Research Involving Human Subjects established by the Japanese government. Finally, we obtained informed consent from participants before the survey.

Measures

eHealth literacy

The Japanese version of the eHealth Literacy Scale (J-eHEALS) was used to assess eHL using health information on the Internet as a one-way communication channel (Health 1.0) among participants [19-21], which was most widely used as digital health literacy scales [22]. The J-eHEALS utilized a 5-point Likert scale to measure perceived eHL (from 1 = strongly disagree to 5 = strongly agree; score range = 8–40). To validate the J-eHEALS, a confirmatory factor analysis was conducted using data from the survey [19]. We divided the J-eHEALS scores into two categories (high and low) relative to the median score.

Moreover, the Digital Health literacy Instrument (DHLI) adapted to the COVID-19 pandemic was also used to evaluate the eHL levels, including literacy for using social networking sites (SNSs)—such as Facebook and Twitter—referred to as "Health 2.0" [15]. The DHLI was

designed to assess eHL for Health 1.0 and Health 2.0 [21]. The DHLI contains seven subscales: information searching, adding self-generated content, evaluating reliability, determining relevance, operational skills, navigation skills, and protecting privacy. Each subscale included three items to be answered on a 4-point Likert scale (1 = very difficult to 4 = very easy). The COVID-HL network used DHLI adapted to COVID-19 and did not use the subscales of operational and navigation DHLI skills adapted to COVID-19 [13]. However, we included these subscales because they were crucial to accassing health information and navigating the Internet. Moreover, although one recent study developed the DHLI [23], data on these skills adapted to COVID-19 among adult Internet users in Japan were lacking. We divided each subscale and the total score of the DHLI into one of two categories (high or low) relative to the median score based on previous studies [14-18]. Finally, we translated them to Japanese, and we backtraslated it and confirmed the authors (Supplemental table 1).

Online health information-seeking behavior

The measures of online health information-seeking behaviors on the COVID-19 were assessed using a list of ten different web sources: search engines (such as Google, Bing, and Yahoo!), websites of public authorities (such as Ministry of Health, Labour and Welfare and the Japan Medical Association), Wikipedia, web-based encyclopedias, SNSs (such as Facebook, Instagram, and Twitter), YouTube, blogs providing medicine and health-related information, medicine and health-related question and answer (Q&A) sites (such as Yahoo! Answers), medicine and health-related information portals, websites run by physicians or medical facilities, and news portal sites (including information gathered from newspapers and TV stations). These items were answered using a 5-point scale (0 = do not know, 1 = never, 2 = often, 3 = rarely, 4 = sometimes, and 5 = often). They were then assigned to either a "do not know–rarely" or "sometimes–often" category.

Moreover, we asked the participants to indicate from a list of 10 topics what they were searching for regarding COVID-19: the prevalence (such as number of people infected), infection route, symptoms, preventive measures (including disinfection and handwashing), rules and behavior (such as disinfection) assessment of its current status (such as declarations, measures, and stages), and recommendations (including information from the Ministry of Health, Labour and Welfare and municipal governments), refraining from specific actions (such as eating out, travelling, and commuting to work), the economic and social effects, dealing with the psychological stress it causes, and information concerning the vaccine (effectiveness, side effects and vaccination status). Participants answered "Yes" or "No" to these items.

Sociodemographic and other variables

Sociodemographic and other variables were included as covariates in this regression model used by prior studies that examined the factors associated eHL(sex, age groups, equivalent income, education status, marital status, cigarette smoking, alcohol consumption, physical exercise habits, and conditions that could likely lead to severe COVID-19 illness) [19-21]. Equivalent income was estimated by dividing annual income by the square root of the number of families [24]. We divided the equivalent income into 12 categories (< 1–≥ 10 million yen and "not answered"). Education status was divided into four categories (≤ high school graduate, two-year college or career college, higher university education, and "not answered"). Regarding marital status, the participants who answered "married" were categorized as "married." The participants who answered "never married," "widowed," or "divorced" were categorized as "not married." Concerning health behaviors, we assessed three items related to smoking, alcohol consumption, and physical exercise. Regarding smoking status, responses such as "never" or "quit" were categorized as "no smoking," and "smoking" or "sometimes smoking" as "smoking." Alcohol consumption was determined using "yes" or "no" responses and the quantity of alcohol consumed. The participants who answered "no"

or "quit" were categorized as "no." Participants who responded with alcohol intake of < 20 g at once were categorized as "< 20 g/once, and those who drank alcohol ≥ 20 g at once were categorized as "≥ 20 g/once." The physical exercise of participants was assessed subjectively based on a 30 min-physical exercise twice or more weekly for a year or longer ("yes" or "no"). We selected six conditions (hypertension, diabetes, chronic obstructive pulmonary diseases, heart diseases, and chronic kidney diseases; BMI ≥30) to determine the prevalence of becoming severely ill with COVID-19. "Yes" responses to one or more questions concerning the prevalence of conditions that were likely to cause severe illness with COVID-19 were categorized as "Yes."

Difficulties in seeking and using COVID-19 information

We asked the participants the descriptive open-ended question, "What difficulties did you have in seeking and using COVID-19-related information on the Internet?" The item was in the required field, not to remain unanswered.

Analysis Using Mixed Methods Strategy

We used the concurrent triangulation design of mixed methods strategy to analyze both quantitative and qualitative data in the Internet-based survey [25].

Qualitative Content Analysis of Qualitative Data

Descriptive responses to difficulties in seeking and using COVID-19 information were analyzed using the inductive qualitative content analysis approach [26-28]. The contents were inductively organized into codes and categories to achieve trustworthiness [27]. Y Takahashi and S Mitsutake performed the analysis. All the responses were read and interpreted repeatedly. After discussing the meanings of the responses, phrases or sentences were coded for the analysis. The coding frame was changed when new codes emerged, and sentences were re-read using the new structure. This constant comparison process was also used to develop concepts conceptualized into broad categories after further discussion. We finally aggregated categories to themes. We used the MAXQDA Analytics Pro 2022 (ver. 22.4.1) (VERBI Software GmbH, Berlin, Germany) for qualitative content analysis.

Statistical Analysis of Quantitative Data

First, the chi-square test was used to compare the proportion of participants with low and high eHL by assessing the eHEALS and subscales of the DHLI. The internal consistency of the subscales and the total scale were assessed using Cronbach's α. We then examined the eHL levels using web sources of COVID-19 information by conducting a multivariable logistic regression model adjusted for all covariables. In addition, the associations of eHL levels with searching for specific COVID-19 topics were examined using a multivariable logistic regression model adjusted for all covariables. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were estimated. We explored the relationship between eHL and categories of difficulties more thoroughly. eHEALS and DHLI total scores were classified into quartiles to observe the variations in dose-response , followed by the performance of the Cochrane-Armitage test for trend analysis. Two-tailed P-values < 0.05 were considered significant. All analyses were conducted using SPSS version 28.0 (IBM Corp., Armonk, NY, USA).

Results

Study participant selection

Figure 1 illustrates the study's participant selection process. The research company chose 18,493 potential respondents in October 2021, and 6,000 responses were obtained from respondents who provided complete information for the study variables (response rate: 32.4%).

Characteristics of study participant

The proportions of each sex and age group were identical (Table 1). The proportion of participants whose equivalent income was 3–4 million yen was 20.0% (1,199/6,000). About 48.4% (2,907/6,000) of the participants had graduated from university or had higher education, and 54.7% (3,280/6,000) were married. About 16.1% (968/6,000) of the participants reported a cigarette smoking habit, 61.4% (3,687/6,000) consumed alcohol, and 32.8% (1,967/6,000) exercised regularly. Moreover, 23.0% (1,381/6,000) of respondents had one or more health condition likely to lead to severe COVID-19 illness.

Table 1. Characteristics of participants

Characteristic	Total n=6,000, 100 %	
	n	%
Sex		
Men	3,000	50.0
Women	3,000	50.0
Age groups (years)		
20–29	1,000	16.7
30–39	1,000	16.7
40–49	1,000	16.7
50–59	1,000	16.7
60–69	1,000	16.7
≥70	1,000	16.7
Equivalent income (million yen)		
< 1	413	6.9
1–< 2	878	14.6
2–< 3	972	16.2
3–< 4	1,199	20.0
4–< 5	852	14.2
5–< 6	486	8.1
6–< 7	430	7.2
7–< 8	165	2.8
8–< 9	70	1.2
9–< 10	72	1.2
≥10	107	1.8
Not answered	356	5.9
Education status		
≤High school	1,768	29.5
Two-year college or career college	1,298	21.6
University or higher education	2,907	48.5
No answer	27	0.5
Marital status		
No	2,683	44.7
Yes	3,280	54.7
Not answered	37	0.6
Cigarette smoking		
No	5,032	83.9
Yes	968	16.1
Alcohol consumption		
No	2,313	38.6
< 20 g/once	2,053	34.2
≥ 20 g/once	1,634	27.2
Physical exercise habit		
No	4,033	67.2
Yes	1,967	32.8

Conditions that could likely lead to severe COVID-19 illness		
No	4,619	77.0
Yes	1,381	23.0

Scores and internal consistencies of DHLI among this study's participants

Table 2 presents the DHLI scores and internal consistencies among the study participants. The seven subscales' internal consistencies (Cronbach's alpha) ranged from acceptable to good (0.83–0.94). Moreover, the mean DHLI total score was 3.08 (SD: 0.49), and Cronbach's alpha was 0.92.

Table 2. Scores and internal consistencies on the DHLI

Subscales and total score of DHLI	Mean (SD)	Median（25th percentile–75th percentile）	Cronbach's alpha
Information search	3.01 (0.61)	3.0 (2.7–3.3)	.91
Adding self-generated information	2.73 (0.73)	3.0 (2.0–3.0)	.94
Evaluating reliability	2.66 (0.65)	2.7 (2.0–3.0)	.88
Determining relevance	2.87 (0.59)	3.0 (2.7–3.0)	.90
Operational skills	3.31 (0.62)	3.0 (3.0–4.0)	.88
Navigation skills	3.59 (0.73)	4.0 (3.3–4.0)	.83
Privacy Protection	3.42 (0.91)	4.0 (3.0–4.0)	.87
Total score	3.08 (0.49)	3.1 (2.8–3.4)	.92

Abbreviations: DHLI, Digital health literacy Instrument.
Score of subscales and total score of DHLI range = 0–4.

Differences of characteristics by eHL from eHEALS and DHLI subscales

Compared to those with low eHEALS, participants with high eHEALS were more likely to be older (*P*<.001), have higher income (*P*<.001) and education levels (*P*<.001), and be married (*P*=.007) (Table 3). Moreover, they were more likely to have consume alcohol (*P*=.02) and physical exercise habits (*P*<.001) and conditions leading to severe COVID-19 illness (*P*=.004) than those with low eHEALS.

The participants with high total DHLI scores had a higher proportion of men (*P*=.002), those aged 20–39 years (*P*<.001), those with higher equivalent income (*P*<.001) and those with higher education status (*P*<.001). They were more likely to have alcohol consumption (*P*=.02) and physical exercise habits (*P*<.001) and less likely to have conditions that could lead to severe COVID-19 illness (*P*<.001). In addition, participants with higher subscores of DHLI generally had higher proportions of men, higher equivalent income, higher education status, and were more likely to be married. They were more likely to have alcohol consumption and less likely to have conditions that could lead to severe COVID-19 illness. Moreover, participants with higher scores on the information-searching, adding self-generated content, evaluate reliability, and determining the relevance, operational skills were more likely to have exercise habit. However, participants with higher scores on navigation skill and privacy protection were less likely to have exercise habit.

Table 3. Differences of characteristics based on eHL level for eHEALS and the subscales and total score of DHLI, %

Characteristic	eHEALS	Information searching	Adding self-generated	Evaluation reliability

	Low n=2228	High n=3772	P value[a]	Low n=1613	High n=4387	P value[a]	Low n=2702	High n=3298	P value[a]	Low n=2475	High n=3525	P value[a]
Sex												
Men	51.0	49.4	.24	49.2	50.3	.47	48.5	51.2	.04	45.9	52.9	<.001
Women	49.0	50.6		50.8	49.7		51.5	48.8		54.1	47.1	
Age groups (years)												
20–29	18.9	15.3	<.001	16.9	16.6	.83	15.5	17.6	.17	14.6	18.1	<.001
30–39	16.9	16.5		16.6	16.7		16.8	16.6		15.7	17.3	
40–49	16.8	16.6		16.8	16.6		17.8	15.8		16.4	16.9	
50–59	17.4	16.3		15.9	17.0		16.4	16.9		17.1	16.3	
60–69	15.9	17.1		16.3	16.8		16.9	16.5		17.1	16.4	
≥70	14.1	18.2		17.5	16.3		16.7	16.6		19.1	15.0	
Equivalent income (million yen)												
< 1	7.9	6.3	<.001	8.1	6.4	<.001	7.5	6.4	<.001	7.4	6.6	<.001
1–< 2	16.8	13.3		17.3	13.7		17.3	12.4		17.5	12.6	
2–< 3	17.7	15.3		16.7	16.0		17.3	15.3		17.7	15.1	
3–< 4	19.6	20.2		19.8	20.0		19.9	20.1		19.8	20.1	
4–< 5	13.5	14.6		12.9	14.7		13.5	14.7		13.6	14.6	
5–< 6	7.5	8.5		6.8	8.6		7.0	9.0		7.2	8.8	
6–< 7	5.8	8.0		5.8	7.7		5.2	8.8		5.9	8.1	
7–< 8	2.0	3.2		2.0	3.0		2.1	3.2		1.9	3.3	
8–< 9	1.1	1.2		0.9	1.3		1.0	1.3		0.7	1.5	
9–< 10	1.1	1.3		0.9	1.3		0.6	1.7		0.6	1.6	
≥10	0.8	2.4		0.7	2.2		1.0	2.4		0.7	2.5	
Not answered	6.2	5.8		7.9	5.2		7.5	4.7		7.0	5.2	
Education status												
≤High school	32.5	27.7	<.001	32.7	28.3	.001	32.5	27.0	<.001	34.4	26.0	<.001
Two-year college or career college	19.9	22.7		19.9	22.3		21.8	21.5		21.1	22.0	
University or higher	47.3	49.2		46.6	49.1		45.0	51.3		43.9	51.6	
Not answered	0.3	0.5		0.7	0.3		0.6	0.3		0.6	0.3	
Marital status												
No	47.1	43.3	.007	48.0	43.5	.002	46.4	43.4	.03	44.2	45.1	.14

Characteristic	Low	High	P value	Low	High	P value	Low	High	P value	Low	High	P value
Yes	52.5	55.9		51.1	56.0		52.9	56.1		54.9	54.5	
Not answered	0.4	0.7		0.9	0.5		0.7	0.5		0.8	0.5	
Cigarette smoking												
No	83.6	84.0	.63	85.1	83.4	.13	86.2	82.0	<.001	86.0	82.4	<.001
Yes	16.4	16.0		14.9	16.6		13.8	18.0		14.0	17.6	
Alcohol consumption												
No	40.9	37.2	.02	42.2	37.2	<.001	41.3	36.3	<.001	41.7	36.4	<.001
< 20 g/ once	32.8	35.0		34.4	34.1		34.6	33.9		34.6	34.0	
≥ 20 g/ once	26.3	27.8		23.4	28.6		24.1	29.8		23.8	29.7	
Physical exercise habit												
No	75.5	62.3	<.001	71.7	65.6	<.001	72.4	62.9	<.001	72.0	63.9	<.001
Yes	24.5	37.7		28.3	34.4		27.6	37.1		28.0	36.1	
Conditions leading to severe COVID-19 illness												
No	78.3	76.2	.004	74.4	77.9	.004	76.3	77.6	.24	76.1	77.6	.16
Yes	21.7	23.8		25.6	22.1		23.7	22.4		23.9	22.4	

Abbreviations: eHEALS, eHealth literacy scale; DHLI, Digital health literacy Instrument.
a: the chi-square test

(Table 3 continued)

Characteristic	Determining relevance			Operational skills			Navigation skills			Privacy protection			Total score		
	Low n=2051	High n=3949	P value^a	Low n=1076	High n=4924	P value^a	Low n=1905	High n=4095	P value^a	Low n=2206	High n=3794	P value^a	Low n=3264	High n=2736	P value^a
Sex															
Men	51.2	49.4	.17	42.3	51.7	<.001	47.0	51.4	.002	50.3	49.8	.75	48.2	52.2	.002
Women	48.8	50.6		57.7	48.3		53.0	48.6		49.7	50.2		51.8	47.8	
Age groups (years)															
20–29	16.5	16.7	.73	14.8	17.1	<.001	16.4	16.8	<.001	17.1	16.4	<.001	15.3	18.3	<.001
30–39	16.3	16.9		15.1	17.0		16.1	16.9		15.8	17.2		15.7	17.8	
40–49	17.5	16.2		13.7	17.3		14.1	17.9		14.6	17.8		16.1	17.3	
50–59	16.1	17.0		15.6	16.9		15.6	17.1		15.4	17.4		16.4	17.0	
60–69	16.4	16.8		19.0	16.2		15.9	17.0		16.1	17.0		17.1	16.1	
≥70	17.2	16.4		21.8	15.5		21.8	14.3		20.9	14.2		19.3	13.6	
Equivalent income (million yen)															
< 1	7.8	6.4	<.001	9.1	6.4	<.001	7.8	6.4	.005	7.0	6.8	.01	7.5	6.1	<.001

1–< 2	16.6	13.6		19.3	13.6		15.5	14.2		15.4	14.2		16.6	12.3	
2–< 3	16.6	16.0		17.4	15.9		16.4	16.1		17.3	15.6		17.1	15.1	
3–< 4	20.4	19.8		18.7	20.3		20.6	19.7		21.3	19.2		20.2	19.7	
4–< 5	14.3	14.2		12.6	14.5		14.7	14.0		14.3	14.1		14.0	14.4	
5–< 6	6.7	8.8		6.5	8.4		7.4	8.4		7.0	8.8		6.9	9.6	
6–< 7	6.2	7.7		4.4	7.8		6.1	7.6		6.4	7.6		6.1	8.5	
7–< 8	2.0	3.1		1.5	3.0		2.0	3.1		2.3	3.0		2.0	3.7	
8–< 9	0.9	1.3		0.7	1.3		1.2	1.2		1.2	1.2		1.1	1.3	
9–< 10	0.4	1.6		0.4	1.4		0.8	1.4		1.0	1.3		0.8	1.7	
≥10	1.0	2.2		0.8	2.0		1.2	2.1		1.7	1.8		0.9	2.8	
Not answered	7.3	5.2		8.6	5.4		6.2	5.8		5.2	6.4		6.8	4.9	
Education status															
≤High school	31.9	28.2	.007	41.9	26.7	<.001	32.5	28.1	.002	28.0	30.3	.06	32.3	26.1	<.001
Two-year college or career college	20.6	22.2		23.0	21.3		21.5	21.7		20.9	22.1		21.7	21.6	
University or higher	46.9	49.3		33.8	51.6		45.7	49.7		50.6	47.2		45.6	51.9	
Not answered	0.6	0.4		1.2	0.3		0.3	0.5		0.5	0.4		0.5	0.4	
Marital status															
No	44.5	44.8	.04	42.2	45.3	<.001	44.6	44.8	.99	43.8	45.2	.58	44.7	44.7	.44
Yes	54.5	54.7		55.8	54.4		54.8	54.6		55.5	54.2		54.5	54.8	
Not answered	1.0	0.4		2.0	0.3		0.6	0.6		0.6	0.6		0.7	0.5	
Cigarette smoking															
No	84.2	83.7	.61	85.2	83.6	.18	82.6	84.5	.06	83.5	84.1	.56	84.5	83.1	.15
Yes	15.8	16.3		14.8	16.4		17.4	15.5		16.5	15.9		15.5	16.9	
Alcohol consumption															
No	41.2	37.2	.008	47.1	36.7	<.001	37.8	38.9	.05	36.3	39.9	.02	39.9	36.9	.008
< 20 g/ once	33.4	34.6		29.8	35.2		32.9	34.8		35.6	33.4		34.4	34.0	
≥ 20 g/ once	25.5	28.2		23.0	28.1		29.2	26.3		28.1	26.7		25.7	29.1	
Physical exercise habit															
No	72.8	64.3	<.001	70.2	66.6	.02	65.0	68.3	.01	64.1	69.1	<.001	69.7	64.2	<.001

Yes	27.2	35.7		29.8	33.4		35.0	31.7		35.9	30.9		30.3	35.8	
Conditions that could lead to severe COVID-19 illness															
No	75.3	77.9	.02	74.1	77.6	.01	73.3	78.7	<.001	72.7	79.5	<.001	74.3	80.2	<.001
Yes	24.7	22.1		25.9	22.4		26.7	21.3		27.3	20.5		25.7	19.8	

Abbreviations: eHEALS, eHealth literacy scale; DHLI, Digital health literacy Instrument.
a: the chi-square test

Associations of eHL with using web sources for finding COVID-19 information

Figure 2 illustrates the proportion of "sometimes" or "often" answered for using each web source. The most common web sources were search engines (the proportion: 76.9% (4,614/6,000)), followed by news portal sites (55.8% (3,350/6,000)). Participants with high eHEALS were more likely to use all web sources of information about COVID-19 than those with low eHEALS (Table 4). The participants with high scores on DHLI information searching, adding self-generated information, evaluating reliability, determining relevance, and operational skills were also more likely to search for COVID-19 information using all web sources than participants with low scores on these subscales. Participants with high navigation skill scores were more likely to use search engines but less likely to use YouTube to search for COVID-19 information (AOR: 0.88, 95% CI: 0.79–0.99). Moreover, participants with high privacy protection scores were less likely to use websites of public authorities (AOR: 0.80, 95% CI: 0.72–0.89), Wikipedia (AOR: 0.82, 95% CI: 0.74–0.92), SNSs (AOR: 0.74, 95% CI: 0.66–0.83), YouTube (AOR: 0.84, 95% CI: 0.75–0.94), blogs providing medicine and health-related information(AOR: 0.81, 95% CI: 0.72–0.92), Q&A sites (AOR: 0.75, 95% CI: 0.67–0.85), medicine and health-related information portals (AOR: 0.75, 95% CI: 0.67–0.85), and websites run by physicians or medical facilities (AOR: 0.72, 95% CI: 0.64–0.81) for finding COVID-19 information.In addition, participants with high total DHLI scores were more likely to use all web sources of COVID-19 information than those with low total scores.

Table 4. Associations of eHL levels with using the web-sources for finding COVID-19 information

eHealth Literacy		Search engines		Websites of public authorities		Wikipedia, web-based encyclopedias		SNSs		YouTube	
		%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]
eHEALS	Low	71.1	1.00	33.6	1.00	28.8	1.00	28.7	1.00	28.6	1.00
	High	80.4	1.57 (1.38–1.78)	50.5	1.88 (1.68–2.11)	42.2	1.70 (1.51–1.90)	38.4	1.61 (1.43–1.81)	38.2	1.50 (1.34–1.69)
Information search	Low	70.2	1.00	36.6	1.00	28.1	1.00	28.9	1.00	28.0	1.00
	High	79.3	1.54 (1.35–1.76)	47.0	1.44 (1.27–1.62)	40.5	1.66 (1.46–1.89)	37.0	1.41 (1.24–1.60)	37.1	1.47 (1.30–1.67)
Adding self-generated information	Low	73.7	1.00	38.3	1.00	30.1	1.00	29.1	1.00	28.5	1.00
	High	79.5	1.29 (1.14–1.46)	49.1	1.42 (1.27–1.58)	43.0	1.64 (1.47–1.84)	39.5	1.51 (1.35–1.70)	39.7	1.58 (1.41–1.76)
Evaluating reliability	Low	74.7	1.00	37.7	1.00	30.2	1.00	29.2	1.00	29.0	1.00
	High	78.4	1.16 (1.03–	48.7	1.45 (1.30–	42.1	1.56 (1.39–	38.8	1.39 (1.24–	38.6	1.44 (1.29–

eHealth Literacy		%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)
			1.32)		1.61)		1.74)		1.56)		1.62)
Determining relevance	Low	70.6	1.00	37.1	1.00	30.1	1.00	29.4	1.00	29.2	1.00
	High	80.2	1.60 (1.41–1.82)	47.9	1.46 (1.30–1.63)	40.9	1.53 (1.37–1.72)	37.6	1.39 (1.23–1.57)	37.5	1.40 (1.25–1.58)
Operational skills	Low	61.2	1.00	28.8	1.00	24.4	1.00	24.2	1.00	29.9	1.00
	High	80.3	2.43 (2.09–2.82)	47.6	2.07 (1.78–2.40)	40.0	1.90 (1.62–2.21)	37.1	1.67 (1.42–1.96)	35.7	1.22 (1.05–1.41)
Navigation skills	Low	75.4	1.00	44.4	1.00	36.3	1.00	33.8	1.00	36.6	1.00
	High	77.6	1.15 (1.01–1.31)	44.1	1.00 (0.89–1.12)	37.6	1.05 (0.94–1.18)	35.3	1.06 (0.94–1.20)	33.7	0.88 (0.79–0.99)
Protecting privacy	Low	77.3	1.00	48.1	1.00	40.4	1.00	38.8	1.00	37.4	1.00
	High	76.6	1.01 (0.88–1.14)	41.9	0.80 (0.72–0.89)	35.3	0.82 (0.74–0.92)	32.5	0.74 (0.66–0.83)	33.1	0.84 (0.75–0.94)
Total score of DHLI	Low	74.3	1.00	39.9	1.00	32.6	1.00	30.5	1.00	31.9	1.00
	High	80.0	1.34 (1.18–1.52)	49.3	1.38 (1.24–1.54)	42.7	1.46 (1.31–1.63)	39.9	1.39 (1.24–1.56)	38.0	1.25 (1.12–1.40)

(Table 4 continued)

eHealth Literacy		Blogs providing medicine and health-related information		Medicine and health-related Q&A sites		Medicine and health-related information portals		Websites run by physicians or medical facilities		News portal sites	
		%	AOR (95% CI) [a]	%	AOR (95% CI) [a]	%	AOR (95% CI) [a]	%	AOR (95% CI) [a]	%	AOR (95% CI) [a]
eHEALS	Low	13.1	1.00	18.7	1.00	15.1	1.00	16.8	1.00	46.9	1.00
	High	28.8	2.46 (2.13–2.84)	34.5	2.08 (1.83–2.36)	34.1	2.65 (2.31–3.04)	35.6	2.51 (2.20–2.87)	61.1	1.65 (1.48–1.85)
Information search	Low	14.4	1.00	20.6	1.00	18.9	1.00	20.8	1.00	48.9	1.00
	High	26.1	2.00 (1.71–2.35)	31.6	1.71 (1.49–1.97)	30.0	1.73 (1.50–2.00)	31.5	1.65 (1.44–1.90)	58.4	1.40 (1.24–1.57)
Adding self-generated information	Low	16.4	1.00	22.6	1.00	20.2	1.00	21.9	1.00	52.5	1.00
	High	28.4	1.87 (1.64–2.13)	33.6	1.64 (1.45–1.85)	32.7	1.75 (1.55–1.98)	34.2	1.71 (1.52–1.93)	58.6	1.19 (1.07–1.33)
Evaluating reliability	Low	15.3	1.00	22.2	1.00	19.4	1.00	21.3	1.00	51.2	1.00
	High	28.4	2.07 (1.81–2.37)	33.1	1.70 (1.50–1.92)	32.4	1.85 (1.63–2.10)	33.8	1.75 (1.55–1.98)	59.1	1.33 (1.20–1.49)
Determining relevance	Low	16.4	1.00	22.7	1.00	19.8	1.00	21.8	1.00	49.9	1.00
	High	26.4	1.71 (1.49–1.97)	31.7	1.48 (1.30–1.68)	30.8	1.66 (1.46–1.90)	32.2	1.58 (1.39–1.80)	58.9	1.37 (1.23–1.53)
Operational skills	Low	15.1	1.00	20.6	1.00	17.3	1.00	19.0	1.00	40.8	1.00
	High	24.7	1.78 (1.48–2.14)	30.4	1.67 (1.41–1.97)	29.2	1.86 (1.56–2.21)	30.7	1.76 (1.49–2.09)	59.1	2.01 (1.75–2.32)
Navigation	Low	22.6	1.00	29.9	1.00	27.8	1.00	27.7	1.00	55.1	1.00

skills	High	23.2	1.06 (0.93–1.21)	28.0	0.95 (0.84–1.07)	26.7	0.96 (0.85–1.09)	29.1	1.07 (0.95–1.21)	56.2	1.06 (0.94–1.19)
Protecting privacy	Low	25.8	1.00	33.0	1.00	31.1	1.00	33.2	1.00	58.1	1.00
	High	21.3	0.81 (0.72–0.92)	26.1	0.75 (0.67–0.85)	24.7	0.75 (0.67–0.85)	26.0	0.72 (0.64–0.81)	54.5	0.90 (0.81–1.01)
Total DHLI score	Low	18.6	1.00	25.4	1.00	22.6	1.00	24.5	1.00	51.8	1.00
	High	28.3	1.66 (1.47–1.89)	32.4	1.39 (1.24–1.57)	32.3	1.56 (1.39–1.76)	33.6	1.47 (1.31–1.65)	60.6	1.43 (1.29–1.60)

Abbreviations: eHEALS, eHealth literacy scale; DHLI, Digital health literacy Instrument; AOR, adjusted odds ratio

a: Multivariable logistic regression analysis adjusted for all covariates (sex, age groups, equivalent income, education status, marital status, cigarette smoking, alcohol consumption, physical exercise habit, and conditions leading to severe illness due to COVID-19)

Associations of eHL levels with searching specific COVID-19 topics

The most common searching specific COVID-19 topics were infectivity (the proportion: 66.9% (4,015/6,000)), followed by information about vaccine (60.8% (3,650/6,000)) (Figure 3). Participants with high eHEALS were more likely to search for all COVID-19-related topics than participants with low eHEALS (Table 5). Moreover, participants with high total DHLI scores were more likely to search for concerning infectivity and economic and social effects. In addition, participants with higher subscores of DHLI generally were more likely to search for the route of infection, assessment, economic and social effects, dealing with psychological stress, and the vaccine. However, the odds of searching for the route of infection and refrain from certain behaviors among participants with high navigation skills scores were 0.77 times (95% CI: 0.67-0.89) and 0.88 times (0.78-0.99) lower, respectively, than those with lower score. In addition, participants with high privacy protection scores were less likely to search the route of infection (AOR: 0.71, 95% CI: 0.63–0.82), symptoms (AOR: 0.81, 95% CI: 0.73–0.90), preventive measures (AOR: 0.74, 95% CI: 0.66–0.83), rules and behaviors (AOR: 0.87, 95% CI: 0.77–0.99), assessment (AOR: 0.84, 95% CI: 0.75–0.96), refraining from certain behaviors (AOR: 0.78, 95% CI: 0.70–0.88), economic and social effects (AOR: 0.83, 95% CI: 0.72–0.94), and dealing with psychological stress (AOR: 0.77, 95% CI: 0.66–0.90).

Table 5. Associations of eHL levels with searching the specific COVID-19 topics

eHealth Literacy		The infectivity		Route of infection		Symptoms		Preventive measures		Rules and behaviors	
		%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]
eHEALS	Low	62.9	1.00	14.3	1.00	33.9	1.00	24.8	1.00	18.0	1.00
	High	69.3	1.25 (1.11–1.40)	22.6	1.63 (1.41–1.89)	46.1	1.58 (1.41–1.77)	36.2	1.58 (1.40–1.79)	30.0	1.78 (1.56–2.03)
Information search	Low	62.6	1.00	16.9	1.00	40.0	1.00	30.4	1.00	24.1	1.00
	High	68.5	1.25 (1.11–1.41)	20.5	1.21 (1.04–1.41)	42.1	1.06 (0.94–1.19)	32.6	1.07 (0.94–1.22)	26.0	1.08 (0.94–1.24)
Adding self-generated information	Low	65.5	1.00	16.8	1.00	41.6	1.00	30.5	1.00	24.2	1.00
	High	68.0	1.05 (0.94–1.18)	21.8	1.29 (1.12–1.47)	41.5	0.96 (0.86–1.07)	33.2	1.09 (0.98–1.23)	26.6	1.09 (0.97–1.23)
Evaluating reliability	Low	66.9	1.00	16.3	1.00	41.3	1.00	31.2	1.00	24.7	1.00
	High	67.0	0.96 (0.86–	21.8	1.33 (1.16–	41.8	1.02 (0.92–	32.6	1.09 (0.97–	26.1	1.10 (0.97–

		%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)
			1.08)		1.53)		1.14)		1.22)		1.24)
Determining relevance	Low	65.8	1.00	16.8	1.00	40.0	1.00	29.0	1.00	23.1	1.00
	High	67.5	1.03 (0.92–1.16)	21.0	1.23 (1.07–1.42)	42.4	1.05 (0.94–1.18)	33.6	1.18 (1.05–1.34)	26.8	1.16 (1.02–1.32)
Operational skills	Low	58.1	1.00	17.4	1.00	35.8	1.00	26.4	1.00	21.7	1.00
	High	68.8	1.59 (1.38–1.83)	20.0	1.10 (0.92–1.31)	42.8	1.37 (1.19–1.58)	33.2	1.48 (1.27–1.73)	26.3	1.39 (1.18–1.64)
Navigation skills	Low	66.8	1.00	22.7	1.00	43.1	1.00	33.5	1.00	26.6	1.00
	High	67.0	1.06 (0.94–1.19)	18.0	0.77 (0.67–0.89)	40.8	0.96 (0.86–1.08)	31.3	0.98 (0.86–1.10)	25.0	1.01 (0.89–1.16)
Privacy protection	Low	67.5	1.00	23.3	1.00	45.4	1.00	37.0	1.00	28.1	1.00
	High	66.6	1.02 (0.91–1.15)	17.3	0.71 (0.63–0.82)	39.3	0.81 (0.73–0.90)	29.1	0.74 (0.66–0.83)	24.0	0.87 (0.77–0.99)
Total DHLI score	Low	65.6	1.00	18.8	1.00	42.2	1.00	32.3	1.00	25.5	1.00
	High	68.5	1.14 (1.02–1.28)	20.4	1.06 (0.93–1.21)	40.8	0.95 (0.86–1.06)	31.7	1.01 (0.90–1.13)	25.5	1.04 (0.92–1.18)

(Table 5 continued)

eHealth Literacy		Assessment of the current novel coronavirus infection status		Refraining from certain behaviors		The economic and social effects of the novel coronavirus		Dealing with the psychological stress caused by the novel coronavirus		Information about the novel coronavirus vaccine	
		%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]	%	AOR (95% CI)[a]
eHEALS	Low	16.7	1.00	26.0	1.00	14.5	1.00	6.9	1.00	55.2	1.00
	High	28.5	1.81 (1.58–2.07)	35.4	1.43 (1.27–1.61)	24.9	1.83 (1.59–2.11)	16.5	2.47 (2.04–2.98)	64.2	1.43 (1.28–1.60)
Information search	Low	20.6	1.00	30.9	1.00	18.5	1.00	10.4	1.00	59.3	1.00
	High	25.3	1.24 (1.08–1.43)	32.3	1.02 (0.90–1.16)	21.9	1.19 (1.02–1.38)	13.9	1.35 (1.12–1.63)	61.4	1.13 (1.01–1.28)
Adding self-generated information	Low	22.7	1.00	31.8	1.00	19.0	1.00	11.3	1.00	62.6	1.00
	High	25.2	1.05 (0.92–1.19)	32.0	0.94 (0.84–1.06)	22.6	1.18 (1.04–1.34)	14.2	1.23 (1.05–1.44)	59.4	0.91 (0.81–1.01)
Evaluating reliability	Low	22.0	1.00	31.9	1.00	18.7	1.00	11.7	1.00	62.1	1.00
	High	25.6	1.17 (1.03–1.32)	31.9	0.99 (0.89–1.12)	22.6	1.24 (1.09–1.42)	13.8	1.17 (1.00–1.38)	60.0	1.00 (0.90–1.12)
Determining relevance	Low	20.9	1.00	30.0	1.00	19.1	1.00	11.2	1.00	59.6	1.00
	High	25.7	1.22 (1.07–1.40)	32.9	1.09 (0.97–1.23)	22.0	1.14 (1.00–1.31)	13.8	1.19 (1.01–1.41)	61.5	1.10 (0.98–1.23)
Operational skills	Low	16.4	1.00	27.1	1.00	15.2	1.00	11.8	1.00	54.1	1.00
	High	25.8	1.73 (1.44–2.07)	33.0	1.34 (1.15–1.57)	22.3	1.57 (1.30–1.88)	13.2	1.15 (0.93–1.42)	62.3	1.60 (1.39–1.84)
Navigation skills	Low	23.8	1.00	34.7	1.00	22.1	1.00	14.5	1.00	57.4	1.00
	High	24.2	1.07 (0.94–1.22)	30.6	0.88 (0.78–0.99)	20.5	0.94 (0.82–1.08)	12.2	0.86 (0.73–1.01)	62.4	1.30 (1.16–1.45)
Privacy protection	Low	26.7	1.00	36.2	1.00	23.6	1.00	15.1	1.00	59.2	1.00
	High	22.6	0.84 (0.75–0.96)	29.4	0.78 (0.70–0.88)	19.5	0.83 (0.72–0.94)	11.6	0.77 (0.66–0.90)	61.8	1.16 (1.04–1.29)

Total DHLI score	Low	23.0	1.00	32.3	1.00	19.8	1.00	12.4	1.00	60.7	1.00
	High	25.4	1.12 (0.99–1.27)	31.5	0.98 (0.87–1.09)	22.5	1.18 (1.03–1.34)	13.6	1.11 (0.95–1.29)	61.0	1.10 (0.99–1.23)

Abbreviations: eHEALS, eHealth literacy scale; DHLI, Digital health literacy Instrument.
a: the multivariable logistic regression model that adjusted for all covariables (sex, age groups, equivalent income, education status, marital status, cigarette smoking, alcohol consumption, physical exercise habit, and conditions leading to severe illness due to COVID-19)

Difficulties in seeking and using COVID-19 information

Difficulties in seeking and using COVID-19 information were examined using qualitative content analysis of 6,000 valid answers to open-ended questions. Excluding 3,151 participants (52.5%) who responded to perceive no difficulties, we listed the top 50 categories and themes (Table 6). "Information Quality and Credibility" as Theme I included *Information discernment* and *Disinformation.* "Abundance and Shortage of Relevant Information" as Theme II included *Incomprehensible information* and *Information overload*. "Public Trust and Skepticism" as Theme III included *Doubting (local) governments* and *Doubting specialists and doctors*. "Credibility of COVID-19 Related Information" as Theme IV included *Vaccination information*. These themes including top 10 categories were common difficulties among people. "Privacy and Security Concerns" as Theme V included Protecting personal information. "Information Retrieval Challenges" as Theme VI included *Time-consuming information search*. "Anxieties and Panic" as Theme VII included *Anxiety and panic*. "Movement restriction" as Theme VIII included *Time-consuming information search*. The number of categories in Themes V-VIII was fewer than in Themes I-IV, indicating that the latter themes were related with relatively more specific difficulties.

Table 6. Top 50 categories and themes of difficulties in seeking and using COVID-19 information

	Categories	Themes								
		I	II	III	IV	V	VI	VII	VIII	IX
1	*Information discernment*	x								
2	*Incomprehensible information*		x							
3	*Information overload*		x							
4	*Vaccination information*				x					
5	*Disinformation*	x								
6	*Lack of information meeting their needs*		x							
7	*Information without evidence*	x								
8	*Information without credibility or trust*	x								
9	*Lack of detailed patient information*		x							
10	*Doubting (local) governments*			x						
11	*Lack of information concerning their local area*		x							
12	*Not seeking information*									x
13	*Conflicting information*	x								
14	*Lack of up-to-date Information*		x							
15	*Anxiety and panic*								X	
16	*Rabble-rousing information*	x								

#	Item							
17	*Insufficient aggregated information of patients*		x					
18	*Doubting specialists and doctors*			x				
19	*Doubting the media*			x				
20	*Lack of information after infection*		x					
21	*Misinformation*	x						
22	*Information control and manipulation*	x						
23	*Information resources*	x						
24	*Time-consuming information search*						x	
25	*Lack of information on prospects*		x					
26	*Technical terms and jargon*		x					
27	*No answers to unknown virus*				x			
28	*Lack of information about other countries*		x					
29	*Redundant/repetitive information*		x					
30	*Information on infection risk and prevention*				x			
31	*Lack of information on COVID-19 testing*				x			
32	*Doubting the social media*			x				
33	*Lack of information on availability of essential services*		x					
34	*Anti-vaccination and anti-government*	x						
35	*Lack of comprehensive information*		x					
36	*Regulation and self-restraint*							x
37	*Operating PCs and smartphones*						x	
38	*Protecting personal information*					x		
39	*Lack of high-quality information*		x					
40	*The early stage of COVID-19*				x			
41	*Doubting various authorities that lack cooperation*			x				
42	*How to deal with information*	x						
43	*Information on advertisement*		x					
44	*Information on SARS-CoV-2*				x			
45	*Differentiating COVID-19 from a cold*				x			
46	*Lack of information suitable for oneself*		x					
47	*Imbalance in information towards metropolitan areas*		x					
48	*Lack of information for close contacts*		x					
49	*Financial hardship*							x
50	*Trust in authorities*			x				

Theme I: Information Quality and Credibility
Theme II: Abundance and Shortage of Relevant Information
Theme III: Public Trust and Skepticism

Theme IV: Credibility of COVID-19 Related Information
Theme V: Privacy and Security Concerns
Theme VI: Information Retrieval Challenges
Theme VII: Anxieties and Panic
Theme VIII: Movement restriction
Theme IX: Others

Moreover, we analysed the association between eHL and difficulties in seeking and using COVID-19 information (Table 7). The participants with higher total DHLI scores were more likely not to respond and be disinformed and less likely to answer to *information discernment, incomprehensible information,* and *information overload*. Half of the participants (52.5%) reported no difficulty seeking and using COVID-19 information. Participants reporting *none* of difficulties (P for trend = .01) and *incomprehensible information* (P < .001) demonstrated lower eHEALS scores. Regarding DHLI, participants reporting *none* of difficulties (P < .001) demonstrated higher total DHLI score, while those reporting *information discernment* (P < .001), *incomprehensible information* (P < .001), *information overload* (P = .003), and *disinformation* (P = .02) had lower score.

Table 7. Associations of eHL with difficulties in seeking and using COVID-19 information (None and the top five difficulties)

Difficulties	Total	eHEALS (quartile)				P for trend	Total score of DHLI (quartile)				P for trend
		Low			High		Low			High	
	n=6,000	n=1,504	n=1,531	n=1,429	n=1,536		n=1,437	n=1,511	n=1,531	n=1,521	
None	3,151	779	899	707	766	.01	628	738	845	940	<.001
	52.5%	51.8%	58.7%	49.5%	49.9%		43.7%	48.8%	55.2%	61.8%	
Information discernment	409	103	94	115	97	.94	116	135	86	72	<.001
	6.8%	6.9%	6.1%	8.1%	6.3%		8.1%	8.9%	5.6%	4.7%	
Incomprehensible information	348	140	87	66	55	<.001	139	95	67	47	<.001
	5.8%	9.3%	5.7%	4.6%	3.6%		9.7%	6.3%	4.4%	3.1%	
Information overload	272	64	69	70	69	.65	68	89	73	42	.003
	4.5%	4.3%	4.5%	4.9%	4.5%		4.7%	5.9%	4.8%	2.8%	
Vaccination information	261	60	54	75	72	.11	61	73	70	57	.45
	4.4%	4.0%	3.5%	5.3%	4.7%		4.2%	4.8%	4.6%	3.8%	
Disinformation	209	44	56	51	58	.24	41	47	55	66	.02

3.5%	2.9%	3.7%	3.6%	3.8%	2.9%	3.1%	3.6%	4.3%

Abbreviations: eHEALS, eHealth literacy scale; DHLI, Digital health literacy Instrument.

Discussion

The current study using mixed methods is the first to examine the associations between eHL and online health information-seeking behaviors and to identify the difficulties in using health information on the Internet and the related relationship with eHL among adult Internet users. Internet users with high eHEALS and DHLI scores on information searching, adding self-generated content, evaluating reliability, determining relevance, and operational skills were more likely to use all web sources of information about COVID-19 than those with low eHEALS and DHLI scores. However, there were negative associations between navigation skill scores and privacy protection when using several information sources, such as YouTube, to search for COVID-19 information. In addition, participants with high eHEALS and DHLI scores on information searching, adding self-generated information, evaluating reliability, and determining relevance were more likely to search for information about COVID-19 than those with low eHEALS or DHLI scores. However, some participants with high navigation skills and privacy protection skills were less likely to search for information on COVID-19. Furthermore, this study shed light on the difficulties seeking and using COVID-19 information qualitatively. While half of the participants reported no difficulty seeking and using COVID-19 information, participants who reported any difficulties including *information discernment, incomprehensible information, information overload,* and *disinformation* had lower DHLI score. Finally, participants expressed significant concerns regarding "Information Quality and Credibility," "Abundance and Shortage of Relevant Information," "Public Trust and Skepticism," and "Credibility of COVID-19 Related Information." Additionally, they disclosed more specific concerns, including "Privacy and Security Concerns," "Information Retrieval Challenges," "Anxieties and Panic," and "Movement restriction."

The study results suggest that Internet users with higher eHEALS and total DHLI scores were more likely to use a reliable information source, consistent with prior studies [14, 19]. Considering the subscale of DHLI, the ability to determine the relevance and evaluation reliability skills of the assessment is reportedly positively associated with the search for COVID-19 information through a traditional one-way communication channel known as "Health 1.0," involving public institution websites [15-18, 21, 29]. In addition, a previous study showed positive associations of higher skills in information searching and adding self-generated content with using public institution websites [15]. However, to our knowledge, no study has examined the association between operational skills and online health information-seeking behavior because most studies have focused on university students and have not assessed operational information skills [14-18]. Operational skills, which are basic skills required to use computers, are vital for searching for online health information, with implications among people unfamiliar with computers or smartphones, such as older adults. A Japanese Government survey indicated that deficiencies in the basic skills required to use computers or smartphones were barriers to Internet access among older adults [1]. Therefore, this finding suggests that operational skills are critical for using online health information among individuals who are generally less familiar with the Internet.

There were negative associations between navigation and protecting privacy skills o and using several interactive health-related communications channels via social networking sites such as YouTube. Several studies have reported that university students with low DHL scores more likely to

use Health 2.0 channels for health information than university students with high DHLI scores [14, 17]. In addition, the study findings showed that participants with high navigation and protecting privacy skills were less likely to search for information on e.g. the route of infection, or on refraining from certain behaviors. Participants with high navigation and protecting privacy skills used online information about COVID-19 cautiously compared to those with lower navigation and proficiency skills. However, there was no negative association between eHEALS scores and the utilization of Health 2.0 communication channels. This result could be explained by the reason that eHEALS scores did not encompass the skills required to use Health 2.0 [30]. The eHEALS would need to be improved for adaptation to health 2.0 communication channels.

The leading 50 categories related to difficulties seeking and using COVID-19 information were identified using a qualitative approach. Our findings indicate that approximately half of the participants experienced difficulties. Information discernment was the most common issue. Health literacy encompasses functional, interactive, and critical literacies [31]. Information discernment is a crucial aspect of literacy. It concerns an individual's ability to discriminate misinformation from accurate information. It has been assessed by calculating the difference in scores related to discerning accurate information from misinformation [32, 33]. Managing the volume of available information and assessing its quality and reliability are essential digital health literacy skills [34]. Our results revealed that information discernment was not linked to proficiency in terms of eHEALS scores but rather with DHLI scores. This finding underscores a pivotal shift in the Health 2.0 era when basic knowledge of Health 1.0 health literacy is insufficient. Our study highlights the need for an enhanced level of health literacy tailored to facilitate navigation of the complexities and nuances of information in the Health 2.0 landscape.

We qualitatively presented themes related to difficulties in seeking and using COVID-19 information. Themes should be evaluated against the backdrop of previous studies. Several tools or instruments for assessing the quality of health information have been used extensively, such as the JAMA Benchmarks, Sandvik's general quality criteria, DISCERN, HONcode, and quality evaluation scoring tools [35]. Dennis recently developed the 13 Principles for Health-Related Information on Social Media (PRHISM) [36]. The US National Academy of Medicine has proposed three foundational principles to guide the identification of credible sources of health information on social media, namely, that they are science-based, objective, transparent, and accountable [37]. "Information Quality and Credibility" and "Credibility of COVID-19 Related Information" were difficulties identified related to science-based principles, and "Relevant Information" included science-based information. "Skepticism" could arise from lacking objectives, transparency, and accountability. These aspects generally align with the principles of PRHISM. Additionally, our findings highlight the significance of people-centered or narrative information. Relevant information includes detailed patient information, information suitable for patients, and information concerning the local area. Simultaneously, the demand for narrative information could lead to "Privacy and Security Concerns," emphasizing the need to balance this aspect with personal information protection. The categories and themes could be used to develop a comprehensive list of challenges likely to be faced during future infodemics.

Limitations

The present study has some limitations. First, participants were recruited from a single Japanese Internet research service company. These participants were suitable for an Internet-based survey because Internet users need to have adequate eHL, and the participants were equally divided by sex, age, and income and then recruited by a research company. However, the results may have been biased as the participants may have had disproportionately higher eHL skill levels [38-40].

Therefore, the eHEALS scores, DHLI scores, and the proportion of those searching for COVID-19 information identified in this study may have been higher than the case among general Internet users in Japan. Second, the study findings may not be directly generalizable to other countries because of inherent differences in website and SNS environments. Third, although previous studies have objectively evaluated the eHL of participants using performance tests [21, 41], this study did not objectively assess the eHL and DHLI dimensions. Therefore, there may have been inaccuracies in estimating participants' eHL levels. Finally, this study's cross-sectional design means causality remains unknown.

Conclusions

This study revealed that Japanese individuals with higher eHEALS and DHLI scores were more engaged in using various web sources when seeking COVID-19 information. However, proficiency in terms of the eHEALS may not encompass the skills required to use Health 2.0. Higher scores on navigation and privacy protection skills, not included in the eHEALS, correlated with less use of specific sources such as YouTube. Participants with high navigation skills and privacy protection used online information about COVID-19 cautiously compared to those with lower proficiency in these skills. This study also highlights an increased need for information discernment in the Health 2.0 era. The identified categories and themes, such as "Information Quality and Credibility," "Abundance and Shortage of Relevant Information," "Public Trust and Skepticism," and "Privacy and Security Concerns," suggest a framework that could be used to address the myriad challenges anticipated in future infodemics.

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Conflicts of Interest

Disclose any personal financial interests related to the subject matters discussed in the manuscript here. For example, authors who are owners or employees of Internet companies that market the services described in the manuscript will be disclosed here. If none, indicate with "none declared".

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Abbreviations

COVID-19: Coronavirus disease 2019
eHL: eHealth literacy
eHEALS: eHealth Literacy Scale
HL: Health literacy
DHL: Digital health literacy
DHLI: Digital health literacy instrument

SNSs: Social networking sites
CIs: Confidence intervals
AORs: Adjusted odds ratios
PRHISM: Principles for Health-Related Information on Social Media

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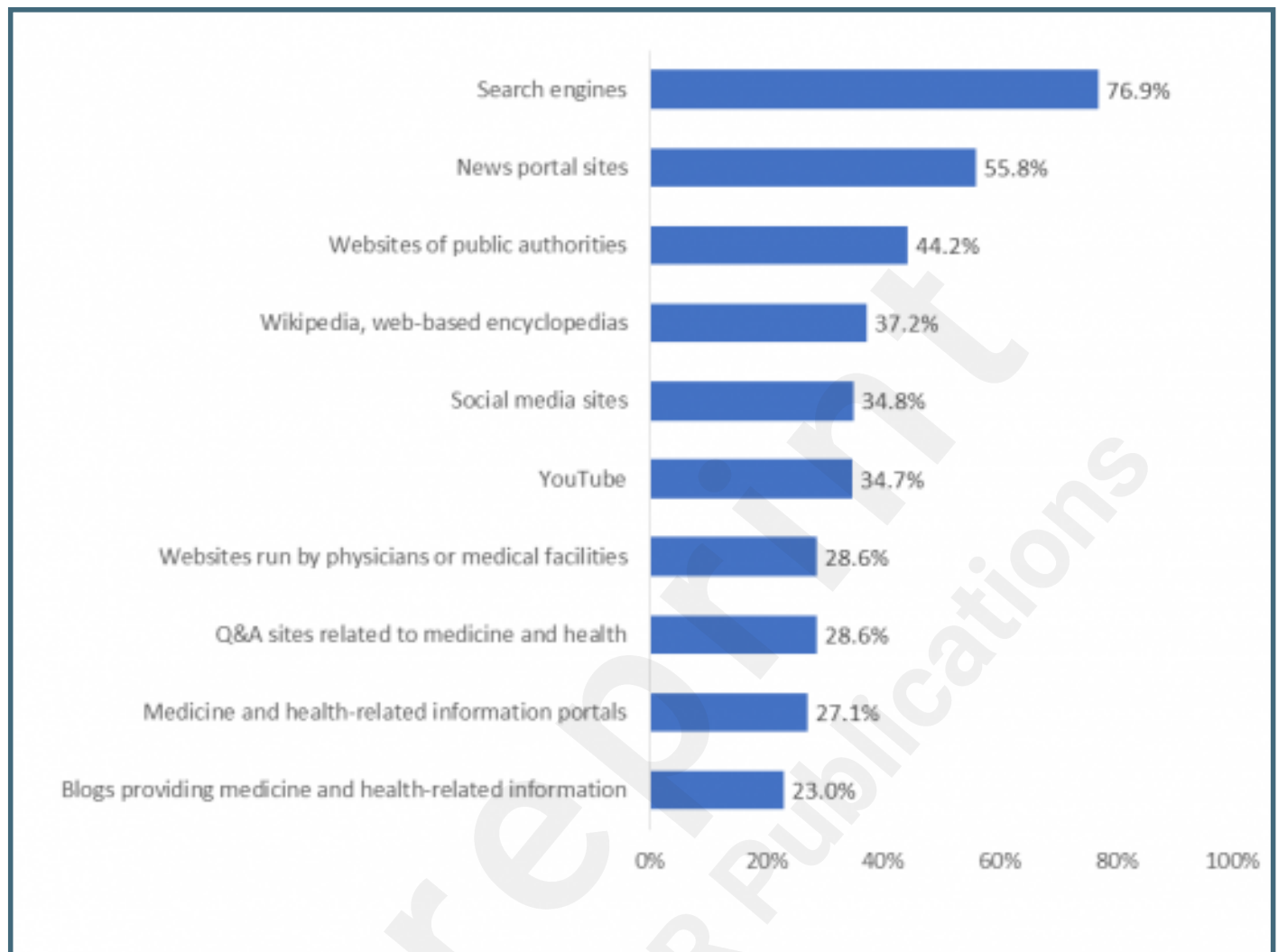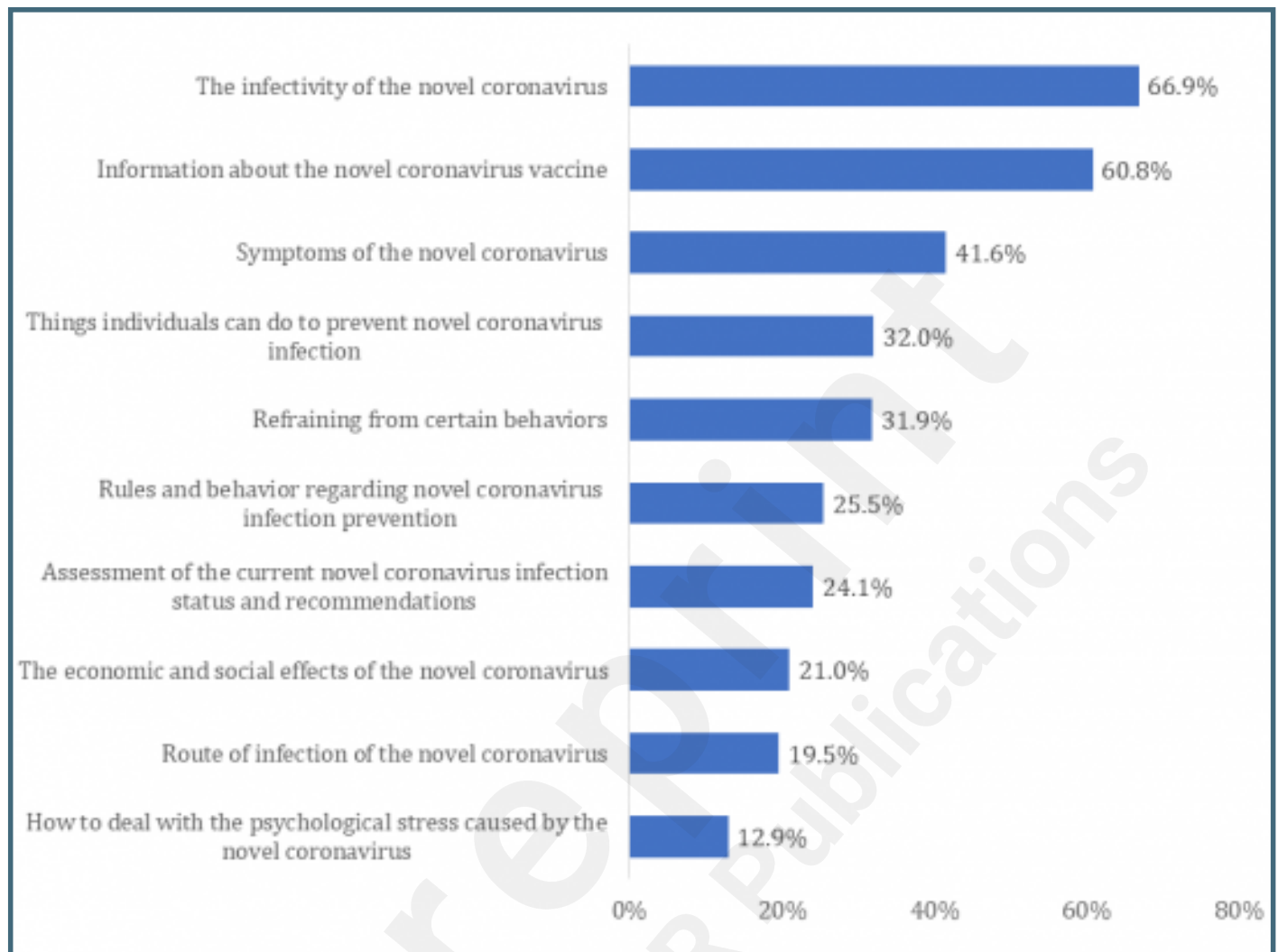
Supplementary Files

Figures

Flow chart of patient selection in this study.
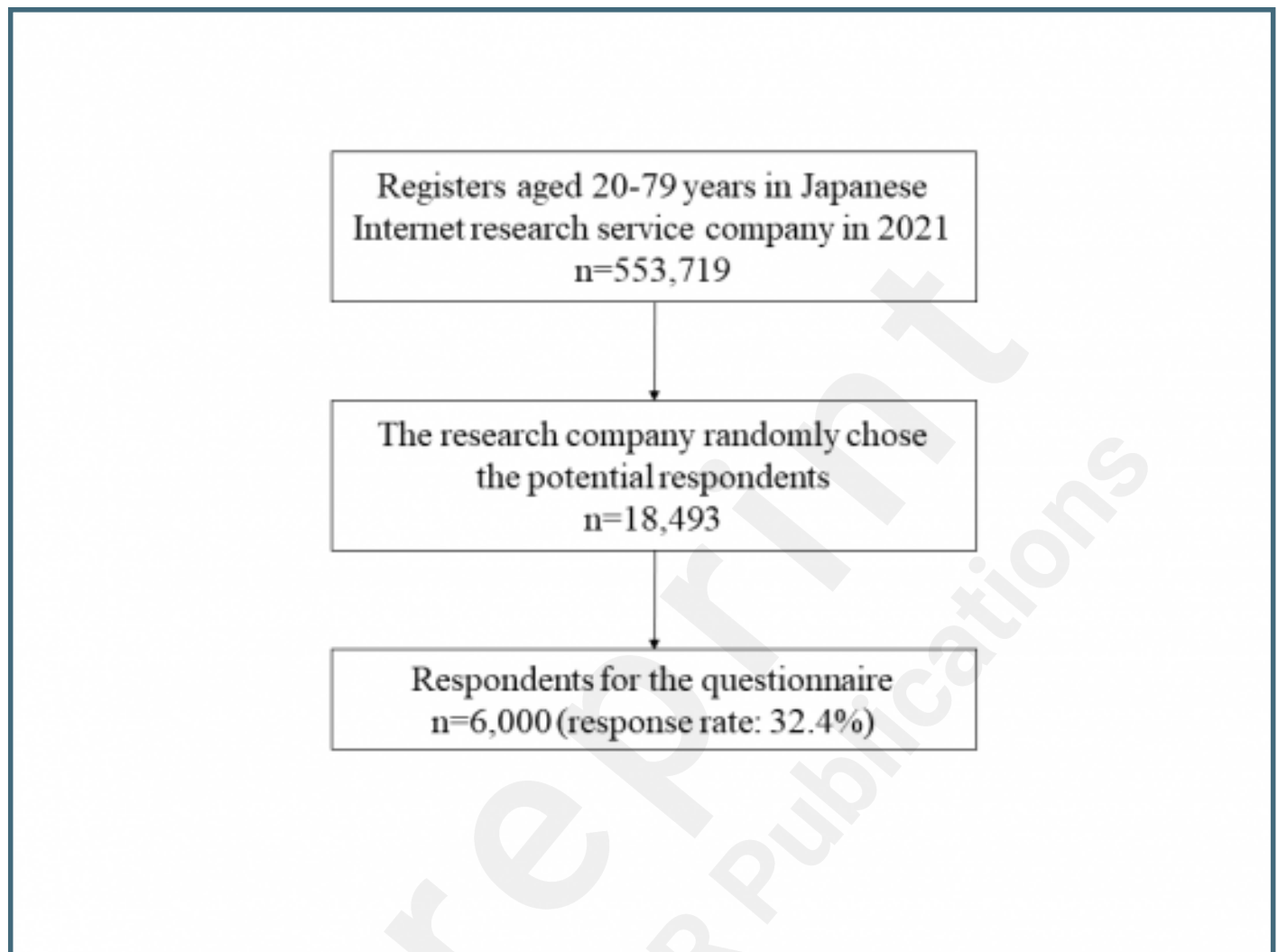
The proportion of "sometimes" or "often" answered for using each web-source.

The proportion of "Yes" answered for searching each topic about COVID-19.

Topic	Percentage
The infectivity of the novel coronavirus	66.9%
Information about the novel coronavirus vaccine	60.8%
Symptoms of the novel coronavirus	41.6%
Things individuals can do to prevent novel coronavirus infection	32.0%
Refraining from certain behaviors	31.9%
Rules and behavior regarding novel coronavirus infection prevention	25.5%
Assessment of the current novel coronavirus infection status and recommendations	24.1%
The economic and social effects of the novel coronavirus	21.0%
Route of infection of the novel coronavirus	19.5%
How to deal with the psychological stress caused by the novel coronavirus	12.9%

Multimedia Appendixes

Digital Health Literacy Instrument adapted to the COVID-19 and online information-seeking behavior on the COVID-19 in Japanese.
URL: http://asset.jmir.pub/assets/acca712a72f9b8587fa6ba0c27b51888.docx