

**Adolescent pursuit of health information online during the COVID-19 pandemic:  
the roles played by eHealth literacy and psychological distress**

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## **Abstract**

COVID-19 has led to an increase in mental health problems for adolescents. In this study we examined the factors related to the eHealth literacy of adolescents and how that impacted their pursuit of health information and mental health information online during the COVID-19 pandemic. We analyzed data from the 2020 Taiwan Communication Survey, which involved a total of 1,250 national representative adolescents who completed an online questionnaire. The results showed that two-thirds of adolescents reported searching health information online, and about half of them reported searching for mental health information online during the COVID-19 pandemic. Multivariate analysis results indicated that adolescents who spent more time learning online, had higher levels of bonding social capital and self-determination, and had higher levels of parental active internet mediation were more likely to have higher levels of eHealth literacy. In addition, multivariate analysis results showed that adolescents who had higher levels of eHealth literacy and had higher depression and anxiety were more likely to seek health information and mental health information online. In conclusion, the levels of eHealth literacy and psychological distress of adolescents play a crucial role in their pursuit of health information and mental health information online during the COVID-19 pandemic.

Keywords: eHealth literacy, online health information seeking, mental health, adolescence

### **Impact statement**

Adolescents are showing an increase in vulnerability to mental health illness, and studies have documented an increase in psychological distress among adolescents during the COVID-19 pandemic. Adolescents spent more time online, and their pursuit of mental health information online has facilitated their autonomy to control their help-seeking journey and allow them to connect with others with more privacy and less stigma. The abundance of misinformation online, however, particularly during the COVID-19 outbreak, has enhanced the need for e-health literacy in seeking health information online, appraising health information, making healthy decisions, and implementing protective behaviors. This study examined the role of factors such as self-determination, e-health literacy, and psychological distress in determining adolescents' pursuit of health/ mental health information online during the COVID-19 pandemic.

## Introduction

Adolescents are showing an increase in vulnerability to mental health illness (Gunnell, Kidger, & Elvidge, 2018), and studies have documented an increase in psychological distress among adolescents during the COVID-19 pandemic (Nearchou, Flinn, Niland, Subramaniam, & Hennessy, 2020). School closures, social distancing measures, and isolation have negatively impacted the mental health of children and adolescents during the COVID-19 pandemic (Meherali et al., 2021). Adolescents tend to be reluctant to seek mental health services in person, but may seek mental health information online due to less stigma and more privacy (Pretorius, Chambers, & Coyle, 2019). Studies have shown that the recent pursuit of mental health information online has been high among adolescents (Park & Kwon, 2018; Rideout, Fox, & Well Being Trust, 2018). Studies have indicated that individuals with psychological distress and mental health problems were more likely to pursue health information online (Gallagher & Doherty, 2009; Pretorius et al., 2019; Rowlands, Loxton, Dobson, & Mishra, 2015). A review study found that for young people with a preference for self-reliance, the pursuit of mental health information online is either therapeutic or acts as a gateway to further help (Pretorius et al., 2019).

Children and adolescents spend more time online than adults, which is a global phenomenon. The 2020 EU Kids Online survey showed that in many countries the

time that children report spending online almost doubled compared with the 2010 findings (Smahel et al., 2020). In particular, during the COVID-19 pandemic adolescents spent more time than ever on the internet, which they used for socializing, entertainment, and learning (Ofcom, 2020). The internet is the main source of information for adolescents, while a review study found that the primary purpose for adolescents' health-related use of the internet is the pursuit of health information (Park & Kwon, 2018). Studies showed that about half of adolescents have reported using the internet to search for health information (Gazibara, Cakic, Cakic, Grgurevic, & Pekmezovic, 2020; Jiménez-Pernett, de Labry-Lima, Bermúdez-Tamayo, García-Gutiérrez, & del Carmen Salcedo-Sánchez, 2010), but many of those adolescents also reported a lack of search skills to find reliable web pages and had difficulties in filtering overabundant content and determining the quality of information (Esmacilzadeh, Ashrafi-Rizi, Shahrzadi, & Mostafavi, 2018; Patterson, Hilton, Flowers, & McDaid, 2019).

The COVID-19 pandemic has provoked a greater number of healthcare organizations to provide eHealth resources and to stress the importance of individual eHealth literacy for the use of eHealth services. The abundance of misinformation online, particularly during the COVID-19 outbreak, has enhanced the role of e-health literacy in appraising online information, making health decisions, and implementing

protective behaviors (Brørs, Norman, & Norekvål, 2020). eHealth literacy refers to an individual's ability to seek out, understand, appraise, and apply electronic health information to solve health problems (Norman & Skinner, 2006). A study has shown that individuals with higher eHealth literacy were more likely to search COVID-19 information online and adopt preventive behaviors (Guo et al., 2021). Prior studies also found a positive association between higher levels of eHealth literacy and the pursuit of health information online (Gazibara et al., 2020), healthy lifestyle behaviors in adolescents (Eyimaya, Özdemir, Tezel, & Apay, 2021; Gürkan & Ayar, 2020), and positive mental health effects (Chen, Zheng, Liang, Xie, & Gu, 2020). Most studies assessed eHealth literacy using self-reporting of perceived skills, while few studies have measured performance-based eHealth literacy through the testing of actual performance to determine eHealth literacy levels such as the completion of computerized simulation tasks. Prior studies showed that perceived and performed eHealth literacy were either moderately (Neter & Brainin, 2017) or weakly correlated (van der Vaart et al., 2011). Some studies have shown a large discrepancy between perceived and performance-based eHealth literacy, which has highlighted the levels of poor critical self-awareness among adolescents (Maitz et al., 2020; McKinnon, P, & Scott, 2020).

Given the current state of the COVID-19 pandemic, parents and adolescents are

living with increased stress (Cluver et al., 2020). Parents have reported increases in the difficulties associated with controlling their children's screen time and increased levels of concern related to the online risks to children (Ofcom, 2021). When adolescents spend more time using the internet, online risks and psychological distress increases (Deslandes & Coutinho, 2020; Guessoum et al., 2020). Parents play a crucial role in the use of the internet by their children. A review study found that the parent-child relationship, parental mediation practices, and parents' own use of media influences children's media use, attitudes, and effects (Coyne et al., 2017). A study found that parental eHealth literacy, active parental internet mediation, and adolescent internet health information literacy all were related to the pursuit of health information online by adolescents (F. C. Chang et al., 2015).

Self-determination theory emphasizes that the satisfaction of basic psychological needs including competence, autonomy, and relatedness were associated with development, health-behavior change, and better mental health (Deci & Ryan, 2000). A prior study associated a higher level of self-determination with seeking online health information (Lee & Lin, 2016). Despite studies that have examined the relationships between eHealth literacy and the pursuit of health information online and related factors, most research has focused on adults. By comparison, only a scant amount of research has explored adolescent pursuit of health

information online and examined the influence of self-determination, eHealth literacy, psychological distress and parental mediation. For the present study, we analyzed data from the 2020 Taiwan Communication Survey conducted during the COVID-19 pandemic. Our aims included (1) an assessment of adolescents' pursuit of health information and health topics online during the COVID-19 pandemic; (2) an examination of the relationships between internet use, self-determination, and parental internet mediation with adolescents' eHealth literacy; and (3) a further examination into how self-determination, eHealth literacy, psychological distress, and parental internet mediation are associated with adolescents' pursuit of health information online (i.e., pursuit of health/ mental health information online and number of health topics searched online).

## **Methods**

### **Participants**

This study analyzed data from the 2020 Taiwan Communication Survey (second phase, fourth wave) (C. C. Chang, 2022). The cluster sampling method was used, while the six socio-economic strata from Taiwan townships (Hou, Tu, Liao, Hung, & Chang, 2008) was adopted as a sampling scheme to draw the sample schools. A total of 19 elementary schools, 20 middle schools, and 23 high schools were randomly

selected from the strata and invited to join the survey. The classes were randomly selected from the sample schools. Teachers gave students consent forms to take home to parents requesting consent for their children to participate in the survey. Students were assured that their information would be protected and anonymous. This study analyzed 1,250 national representative adolescents from 43 middle schools (n=582) and high schools (n=668). Adolescents completed an online self-administered questionnaire between November 2020 and January 2021 during the COVID-19 pandemic. Approval was obtained from the Institutional Review Board at Academia Sinica, Taiwan.

A self-administered questionnaire was developed based on previous studies (Löwe et al., 2010; Nishimura & Suzuki, 2016; Norman & Skinner, 2006; Rideout et al., 2018; Williams, 2006). A group of experts was invited to assess the content validity of the questionnaire. In addition, a pilot survey was conducted at one middle school and two high schools in order to assess the appropriateness of the survey questions and to evaluate the reliability of the data that the questionnaire would yield.

#### *Pursuit of health information online*

Questions concerning the pursuit of health information online were adapted from a study found in the literature (Rideout et al., 2018). Participants were asked

“Have you used the internet to search the following health topics?” If participants answered that they did not use the internet to search any health topics, then they were categorized as not seeking health information online. If participants answered that they use the internet to search for health topics (i.e., exercise, physical fitness, nutrition, sexual health, stress management, depression, anxiety, mental health, and others), then they were categorized as having sought health information online. In addition, if participants answered that they used the internet to search for any mental health topics (i.e., sexual health, stress management, depression, anxiety, and mental health), then they were categorized as having sought mental health information online.

#### *Internet use time*

Internet use time was measured using 6 items. Participants were asked how much time (amount of hours and minutes) they spend on computers, tablets, and/or smartphones for learning and recreation, respectively. Sample questions follow. “How long do you surf the internet using a computer (excluding the usage of smartphones and tablets; only including your internet-surfing screen time) for learning and working purposes every day?” “Excluding your learning and working time online, how long do you surf the internet using a computer for entertainment and leisure purposes every

day on average?” The sum of internet use time on a computer, a tablet, or a smartphone for learning and working purposes was considered internet learning time. On the other hand, the sum of time using the internet on a computer, a tablet, or a smartphone for entertainment and leisure purposes was considered internet entertainment and leisure time.

### *eHealth literacy*

eHealth Literacy (5 items) was measured by adapting a previously developed eHealth literacy scale (Norman & Skinner, 2006) to measure participants' perceived skills at finding, evaluating, and applying electronic health information to health problems. Participants were asked their opinion and experience using the internet for health information. Sample statements follow. “I know how to find helpful health resources on the internet.” “ I know how to use the internet to answer my health questions.” “I know how to use the health information I find on the internet to help me.” “I can tell high quality from low quality health resources on the internet.” “I feel confident in using information from the internet to make health decisions.” The response options were graded on a 5-point Likert-type scale that ranged from strongly disagree (scoring 1) to strongly agree (scoring 5), with higher scores indicating a higher level of eHealth literacy. The Cronbach's alpha of eHealth literacy was 0.87.

*Parental internet mediation*

Parental internet mediation (6 items) was measured by adapting scales from prior studies (Nathanson, 1999; Valkenburg, Krömer, Peeters, & Marseille, 1999). Parental internet mediation included parental restrictive internet mediation (3 items) and parental active internet mediation (3 items). Participants were asked their experience regarding their parents' internet mediation. Parental restrictive internet mediation statements follow. "My parents don't allow me to visit certain websites." "My parents set rules regarding when I can use the internet and when I cannot." "My parents set a limit on how long I use the internet." Active parental internet mediation statements follow. "My parents encourage me to use the internet." "My parents discuss internet use experiences with me." "My parents discuss online stories and events with me." The response options included never (scoring 1), seldom (scoring 2), sometimes (scoring 3), often (scoring 4), with higher scores indicating a higher level of parental restrictive/active mediation. The Cronbach's alpha scores for parental restrictive internet mediation and for active parental internet mediation were 0.76 and 0.68, respectively.

*Bonding social capital*

Bonding social capital (1 item) was measured by adapting an approach from a

social-capital study (Williams, 2006) to measure participants' perceived emotional support and access to resources from strong-tie networks. Participants were asked to complete the following statement. "There are several people I trust to help solve my problems." The response options were graded on a 5-point Likert-type scale that ranged from strongly disagree (scoring 1) to strongly agree (scoring 5), with higher scores indicating a higher level of bonding social capital.

### *Self-determination*

Self-determination (3 items) was measured by factors that included competence, autonomy, and relatedness, and was adapted from a study found in the literature (Nishimura & Suzuki, 2016). Participants were asked their opinion and experience regarding the following statements. "I feel confident that I can do things well." "I feel I have been doing what really interests me." "I feel close and connected with other people who are important to me (e.g. family, friends)." The response options were graded on a 5-point Likert-type scale that ranged from strongly disagree (scoring 1) to strongly agree (scoring 5), with higher scores indicating higher levels of self-determination (competence, autonomy, and relatedness).

### *Depression and anxiety*

Depression and anxiety (4 items) was measured using a scale developed in a

previous study (Löwe et al., 2010). Participants were asked “Over the last week, how often have you been bothered by the following problems? (1) Little interest or pleasure in doing things. (2) Feeling down, depressed or hopeless. (3) Feeling nervous, anxious or on edge. (4) Not being able to stop or control worrying.” The response options ranged from 0 (scoring 0) to 7 days (scoring 7) with higher scores indicating a higher level of depression and anxiety. The Cronbach’s alpha of depression and anxiety was 0.90.

#### *Physical and emotional exhaustion*

To gauge physical and emotional exhaustion, 2 items were adopted from the Copenhagen Burnout Inventory (Kristensen, Borritz, Villadsen, & Christensen, 2005). The questions were “How often are you physically exhausted?” and “How often are you emotionally exhausted (such as feeling helpless or frustrated)?” The response options included never (scoring 1), seldom (scoring 2), sometimes (scoring 3), and often (scoring 4), with higher scores indicating a higher level of physical and emotional exhaustion.

#### *Characteristics of the adolescents*

The characteristics of the adolescents who participated in this study included gender (male or female), age, school type (middle school or high school), and

academic performance (very good, good, average, poor, very poor).

### **Statistical analysis**

SAS was used to perform the statistical analysis. A series of t tests were conducted to compare adolescents' eHealth literacy, internet use time, and related factors by gender and by school type. Chi-square tests were conducted to compare adolescents' pursuit of health information and mental health online. In addition, multiple regression was conducted to examine the factors related to adolescents' eHealth literacy and the number of health topics searched online. Multiple logistic regression was conducted to examine factors related to adolescents' pursuit of health information online and the factors associated with pursuit of mental health information online. A 95% confidence interval (95% C.I.) and p value was presented. The outcome variable was the pursuit of health information online including pursuit of health information online, pursuit of mental health information online, and number of health topics searched online. The independent variables included internet use time, eHealth literacy, parental internet mediation, bonding social capital, self-determination, depression and anxiety, physical and emotional exhaustion. The covariate variables were adolescents' characteristics including gender, age, and academic performance.

## **Results**

### **Internet use by Adolescents**

Of the 1,250 participant students, 655 were boys (52.4%) and 595 were girls (47.6%). The age range of participant students was 12-18 years, while the mean age of middle school students and high school students was 12.9 years, and 16.1 years, respectively. Overall, adolescents spent 29.8 hours per week using the internet for recreation and 12.5 hours per week using the internet for learning. In addition, adolescents mainly accessed the internet via smartphones (22.2 hours/week for recreation and 8.3 hours/week for learning). By gender, boys spent more time using computers to go online than girls. By school type, high school students spent more time using computers and smartphones to go online than middle school students (Table 1).

### **eHealth literacy of adolescents and related factors**

The eHealth literacy of the adolescent participants was above average (Mean=3.69) (Table 1). The participants had higher scores for the searching of health information than for appraising and applying the health information they found. By gender, boys had slightly higher levels of eHealth literacy (Mean=3.73) than girls (Mean=3.64) (Table 1).

Multiple regression results indicated that adolescents who were boys, who spent more time using the Internet for learning, who had higher levels of bonding social capital, who higher self-determination (competence, relatedness), and who had higher levels of active parental Internet mediation were more likely to have higher levels of eHealth literacy (Table 3).

### **Factors related to the pursuit of health information online by adolescents**

Factors related to adolescents' pursuit of health information online are listed in Table 2. Overall, 75.6% of adolescents searched health information online, while 47.7% of adolescents searched mental health information online during the COVID-19 pandemic. The percentage of girls who searched mental health topics online (50.8%) was higher than that for boys (44.9%). The percentage of high school students who searched health topics online (79.5%) was higher than that for middle school students (71.5%). Similarly, the percentage of high school students who searched mental health topics online (60.1%) was higher than that for middle school students (33.5%) (Table 2).

Multiple logistic regression results showed that adolescents who were boys, who had higher levels of eHealth literacy, who had higher levels of depression and anxiety, or who had higher levels of parental active Internet mediation were more

likely to seek health information online. In addition, adolescents who were high school students, who had higher levels of eHealth literacy, who had higher levels of depression and anxiety, and who had higher levels of emotional exhaustion were more likely to seek mental health information online (Table 4).

### **Health topics searched by adolescents and related factors**

The health topics that adolescents searched included exercise (53.0%), mental health (31.8%), stress (31.0%), nutrition (28.2%), depression (23.0%), physical fitness (21.8%), anxiety (19.2%), and sexual health (13.0%) (Table 2). The average number of health topics adolescents searched was 2.2. High school students searched more health topics (mean=2.60) than middle school students (1.76) (Table 1). Multiple regression results showed that adolescents who were high school students, who had higher levels of eHealth literacy, who had higher competence, who had higher levels of depression and anxiety, who had higher levels of physical and emotional exhaustion, and who had higher levels of active parental Internet mediation were more likely to search more health topics online (Table 5).

### **Discussion**

This study found that two-thirds of adolescents searched health topics online during the COVID-19 pandemic. Prior studies conducted in the United States

(Rideout et al., 2018), Serbia (Gazibara et al., 2020), Saudi Arabia (Neumark, Lopez-Quintero, Feldman, Hirsch Allen, & Shtarkshall, 2013), and Spain (Jiménez-Pernett et al., 2010) also found that more than half of adolescents reported seeking health information online. In addition, the results found in this study are consistent with prior studies that found adolescents searched a variety of health topics including exercise, fitness, nutrition, mental and sexual health, while exercise and fitness were the most common health topics searched (Jiménez-Pernett et al., 2010; Neumark et al., 2013; Park & Kwon, 2018; Rideout et al., 2018). These results indicated that online information was an important source for adolescents to obtain health information. However, a study reviewed websites and found that very few webpages were written specifically for adolescents and suggested that governments invest in co-designing excellent-quality and more interactive health information online that better targets an adolescent audience (Ruan, Raeside, Singleton, Redfern, & Partridge, 2021).

In addition, the present study found that half of adolescents searched mental health topics online, and that adolescents who had higher levels of depression and anxiety were more likely to search health information and mental health information online. Prior studies also found that individuals with psychological distress were more likely to engage in seeking help online (Pretorius et al., 2019) and in searching for health information (Gallagher & Doherty, 2009; Rowlands et al., 2015). An Australia

study found that young women experiencing "stigmatized" conditions were more likely to search health information online (Rowlands et al., 2015). A review study indicated that the benefits for young people who use online help-seeking searches of mental health included anonymity, immediacy, ease of access, inclusivity, shared experiences, and a sense of control over the help-seeking journey (Pretorius et al., 2019). These results were consistent with help-seeking models (Rickwood, Deane, Wilson, & Ciarrochi, 2005) that showed when young people had psychological needs and could easily access online mental health information, they were more willing to seek mental health resources online. Studies have established that young people were open to accessing mental health information online, as well as pursuing mental health support online (Horgan & Sweeney, 2010; Oh, Jorm, & Wright, 2009).

Moreover, the results of this study were consistent with those of prior studies (Gazibara et al., 2020; James & Harville, 2016; Wong & Cheung, 2019) that found individuals with better eHealth literacy were more likely to pursue health information online. Another study also found that the internet skill level of adolescents was associated with their pursuit of health information online (Neumark et al., 2013). Results of the present study have shown, however, that adolescents were not as adept at appraising and applying health information as they are at searching for it. Other studies also found that adolescents seldom evaluated search results, had difficulty in

selecting appropriate search strings, and also had difficulty determining the quality of the information they acquired, which suggests an overall lack of appraisal strategies (Esmailzadeh et al., 2018; Freeman, Caldwell, Bennett, & Scott, 2018; Jiménez-Pernett et al., 2010; Walraven, Brand-Gruwel, & Boshuizen, 2009). In addition, in previous studies adolescents judged their own eHealth literacy much higher than its actual value, and those studies suggested implementing education to strengthen adolescents' eHealth and critical literacy (Maitz et al., 2020; McKinnon et al., 2020). At least one study associated exposure to credible sources of health information online with higher eHealth literacy and suggested that credible health information resources online be incorporated into school health education curricula (Ghaddar, Valerio, Garcia, & Hansen, 2012). Schools could implement eHealth literacy combined with critical media literacy programs to strengthen adolescents' eHealth literacy competence and enhance their pursuit of health information online.

This study positively associated active parental internet mediation and bonding social capital with adolescent eHealth literacy. These results indicated the crucial roles of parents and significant others in supporting and providing resources to help adolescents solve online problems and enhance their eHealth literacy. Prior studies have also related active parental internet mediation to adolescent eHealth literacy (F. C. Chang et al., 2015). In addition, previous studies have positively associated

individual social capital with health information self-efficacy, the scope of health information sources, and intentions to pursue health information (Kim, Lim, & Park, 2015). Social capital has also been shown to have a positive effect on technological literacy (Yang, Huang, Lai, Yang, & Yu, 2012). These results underscore the importance of strengthening individual social capital to enhance eHealth literacy. Governments could implement parental internet mediation and eHealth literacy training to improve eHealth and the online pursuit of health information, which would decrease the digital divide and health inequality among children and adolescents.

The results of this study positively associated internet learning time and self-determination factors such as competence and relatedness with higher levels of eHealth literacy among adolescents. Prior studies also positively related self-efficacy to eHealth literacy (Holch & Marwood, 2020; Maitz et al., 2020). These results were consistent with self-determination theory (Deci & Ryan, 2000), which addresses adolescent competence, autonomy and relatedness and shows these factors to be crucial for developing eHealth literacy and enhancing the pursuit of health information online. Our results showed that boys reported higher levels of eHealth literacy than girls, while the difference could have been related to their self-determinism such as when boys perceived higher levels of competence in appraising the information on the internet. In addition, at least one study has applied self-

determination theory and found that the pursuit of health information online offers individuals greater autonomy, competence, and relatedness compared with face-to-face office visits with a physician (Lee & Lin, 2016). Similarly, another study found that individual competence increases with the use of technology, and learning with peers was more engaging when using digital tools to pursue health information to meet health needs (Scott Duncan, Riggare, Koch, Sharp, & Hägglund, 2019). These results suggest that eHealth services design could incorporate a self-determination perspective to promote adolescent eHealth use.

### **Limitations**

This study had some limitations. First, this was a cross-sectional study, which limits the information that can be used to infer causality. Second, this study analyzed the dataset from the 2020 Taiwan Communication Survey, and some variables such as the psychological distress scale had a limited number of items, which could reduce the reliability. Third, eHealth literacy was measured based on the adolescents' perceptions, and gaps could exist between perceived eHealth literacy and actual capabilities of searching and evaluating health information. Future study could assess adolescents in an experimental setting to test their capabilities in searching and appraising health information combined with self-report eHealth literacy. Finally, parental internet mediation was measured based on adolescents' reporting, and future

study could conduct a parent-child dyad study to examine parental influences on adolescents' eHealth literacy, the pursuit of health information online, and physical and mental health outcomes. Despite these limitations, the present study adds to the limited amount of literature that addresses adolescents' pursuit of health information online and the roles of self-determination, eHealth literacy, psychological distress, and parental internet mediation.

## **Conclusions**

During the COVID-19 pandemic adolescents were vulnerable to problems with mental health. The rates of adolescent pursuit of health information/mental health information and health related topics online during the COVID-19 pandemic was unknown, as were the associations of self-determination, eHealth literacy, psychological distress, and parental internet mediation with adolescents' online health and mental health information seeking. Our results showed that two-thirds of adolescents reported searching health information online, and about half of adolescents searched mental health information online during the COVID-19 pandemic. The results of this study revealed the significance of the roles of bonding social capital, self-determination, and parental active internet mediation in enhancing adolescents' eHealth literacy. Adolescents' levels of competence, eHealth literacy,

psychological distress and active parental internet mediation played crucial roles in increasing their pursuit of health and mental health information online. These results implied the need to implement eHealth literacy combined with critical media literacy programs to strengthen adolescents' eHealth literacy competence. Future research could promote a self-determination perspective to develop eHealth literacy intervention and promote the seeking of online health information and underscore the value of appraisal to adolescents.

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### **Author Contribution Statement**

Professor Fong-Ching Chang was responsible for the conception and analysis of the study and for the writing of the manuscript. Professor Ching-Ching Chang was the chair to design the Taiwan Communication Survey and the conception of this work.

Professor Chen-Chao Tao was the co-chair to conduct the Taiwan Communication Survey and the conception of this work. All authors contributed to manuscript preparation and approved the final manuscript.

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### **Declaration of interest statement**

The authors declare no conflicts of interest.

### **Ethics statements**

Approval of this research was obtained from the Institutional Review Board at Academia Sinica, Taiwan.

**Data Availability statement**

The data that support the findings of this study are openly available in the 2020 Taiwan Communication Survey (Phase Two, Year Four): New Communication Technologies & Life Boundary Expansion (D00216) [Data file]. Further information is available from the Survey Research Data Archive, Academia Sinica. doi:10.6141/TW-SRDA-D00216-2 (C. C. Chang, 2022).

Table 1 Adolescent's internet use, e-health literacy, and health status

	Total Mean (SD)	Girl Mean (SD)	Boy Mean (SD)	t-test p value	Middle school Mean (SD)	High school Mean (SD)	t-test p value
Age	14.60 (1.80)	14.51 (1.81)	14.68 (1.79)	0.0987	12.91 (0.84)	16.08 (0.97)	<0.0001
internet learning time (hr/wk)	12.47 (15.98)	12.37 (15.93)	12.57 (16.03)	0.8277	10.14 (14.87)	14.50 (16.63)	<0.0001
Computer(hr/wk)	3.36 (6.97)	2.67 (5.97)	3.99 (7.72)	0.0007	2.13 (5.57)	4.43 (7.84)	<0.0001
Tablet(hr/wk)	0.79 (3.27)	0.63 (2.83)	0.93 (3.61)	0.0936	1.04 (3.90)	0.57 (2.57)	0.0139
Smartphone(hr/wk)	8.32 (12.15)	9.07 (12.93)	7.64 (11.36)	0.0393	6.97 (11.31)	9.50 (12.72)	0.0002
internet recreation time (hr/wk)	29.84 (27.83)	27.65 (25.77)	31.84 (29.46)	0.0075	24.33 (27.15)	34.65 (27.54)	<0.0001
Computer(hr/wk)	5.98 (12.94)	3.41 (8.55)	8.31 (15.56)	<0.0001	3.80 (10.38)	7.88 (14.57)	<0.0001
Tablet(hr/wk)	1.72 (6.98)	1.50 (6.78)	1.92 (7.16)	0.2913	2.18 (8.21)	1.32 (5.67)	0.0335
Smartphone(hr/wk)	22.15 (20.79)	22.74 (20.91)	21.61 (20.69)	0.3355	18.35 (20.78)	25.46 (20.25)	<0.0001
Health topic searches	2.21 (2.06)	2.24 (2.08)	2.19 (2.04)	0.6534	1.76 (1.84)	2.60 (2.15)	<0.0001
E-health literacy	3.69 (0.65)	3.64 (0.60)	3.73 (0.69)	0.0118	3.68 (0.71)	3.70 (0.59)	0.6957
Bonding social capital	3.88 (0.90)	3.90 (0.90)	3.87 (0.89)	0.4889	3.84 (0.98)	3.91 (0.82)	0.1787
Competence	3.47 (0.88)	3.35 (0.84)	3.58 (0.90)	<0.0001	3.47 (0.86)	3.48 (0.89)	0.7647
Autonomy	3.53 (0.96)	3.42 (0.94)	3.62 (0.97)	0.0003	3.59 (0.94)	3.47 (0.97)	0.0189
Relatedness	4.00 (0.87)	4.04 (0.84)	3.96 (0.90)	0.0992	3.94 (0.90)	4.04 (0.84)	0.0393
Depression and anxiety	1.56 (1.66)	1.79 (1.73)	1.36 (1.58)	<0.0001	1.30 (1.56)	1.80 (1.72)	<0.0001
Physical exhaustion	2.88 (0.77)	2.96 (0.75)	2.81 (0.78)	0.0010	2.67 (0.77)	3.06 (0.72)	<0.0001
Emotional exhaustion	2.89 (0.82)	3.02 (0.79)	2.78 (0.82)	<0.0001	2.69 (0.83)	3.07 (0.76)	<0.0001
Parental restrictive internet mediation	2.13 (0.85)	2.10 (0.82)	2.16 (0.87)	0.2171	2.50 (0.86)	1.83 (0.71)	<0.0001
Parental active internet mediation	2.28 (0.76)	2.37 (0.76)	2.18 (0.76)	<0.0001	2.28 (0.76)	2.27 (0.77)	0.8638

Note: Boy n=655 girl n=595, middle school n=582 high school n=668

Table 2 Adolescent's pursuit of health information online and health topics searched

	Total n (%)	Girl n (%)	Boy n (%)	Chi-square P value	Middle school n (%)	High school n (%)	Chi-square p value
Pursuit of health information online				0.0684			0.0015
No	305 (24.4)	159 (26.7)	146 (22.3)		166 (28.5)	139 (20.8)	
Yes	945 (75.6)	436 (73.3)	509 (77.7)		416 (71.5)	529 (79.2)	
Pursuit of mental health information online				0.0379			<0.0001
No	654 (52.3)	293 (49.2)	361 (55.11)		387 (66.5)	267 (40.0)	
Yes	596 (47.7)	302 (50.8)	294 (44.9)		195 (33.5)	401 (60.0)	
Health topics searched							
Exercise	663 (53.0)	272 (45.7)	391 (59.7)		315 (54.1)	348 (52.5)	
Physical fitness	272 (21.8)	96 (16.1)	176 (26.9)		138 (23.7)	134 (20.1)	
Nutrition	352 (28.2)	163 (27.4)	189 (28.9)		145 (24.9)	207 (31.0)	
Sexual health	163 (13.0)	36 (6.1)	127 (19.4)		37 (6.4)	126 (18.9)	
Stress management	388 (31.0)	210 (35.3)	178 (27.2)		110 (18.9)	278 (41.6)	
Depression	288 (23.0)	182 (30.6)	106 (16.2)		83 (14.3)	205 (30.7)	
Anxiety	240 (19.2)	147 (24.7)	93 (14.2)		68 (11.7)	172 (25.8)	
Mental health	398 (31.8)	172 (26.3)	226 (38.0)		126 (21.7)	272 (40.7)	

Note: Boy n=655 girl n=595, middle school n=582 high school n=668

Table 3 Factors related to Adolescent's eHealth literacy

	$\beta$	95% C.I.	p value
Intercept	2.06	1.65-2.48	<.0001
Gender (boy=1, girl=0)	0.10	0.03-0.17	0.0040
Age	0.00	-0.02-0.02	0.9873
Academic performance	0.01	-0.03-0.05	0.7134
Internet learning time	0.01	0.01-0.01	0.0178
Internet recreation time	0.01	-0.01-0.01	0.3104
Bonding social capital	0.17	0.13-0.22	<.0001
Competence	0.10	0.06-0.15	<.0001
Autonomy	0.01	-0.04-0.05	0.7887
Relatedness	0.08	0.03-0.12	0.0010
Parental restrictive internet mediation	-0.01	-0.05-0.03	0.6695
Parental active internet mediation	0.09	0.05-0.14	<.0001

Note: 1. N=1236

2. Multiple regression was conducted.

Table 4 Factors related to Adolescent pursuit of health information online

	Pursuit of health information online			Pursuit of mental health information online		
	OR	95% C.I.	P value	OR	95% C.I.	p value
Gender (boy=1, girl=0)	1.35	1.01-1.79	0.0395	0.90	0.69-1.18	0.4459
Age	1.11	1.02-1.22	0.0207	1.28	1.18-1.39	<.0001
Academic performance	0.93	0.79-1.10	0.4213	0.97	0.84-1.14	0.7383
Internet learning time	1.00	0.99-1.01	0.4833	1.00	0.99-1.01	0.8523
Internet recreation time	1.00	0.99-1.00	0.4968	1.00	1.00-1.01	0.5161
Bonding social capital	0.84	0.70-1.01	0.0647	0.95	0.80-1.13	0.5600
Competence	1.03	0.84-1.25	0.8098	1.11	0.93-1.33	0.2458
Autonomy	1.09	0.92-1.30	0.3195	1.06	0.90-1.24	0.5057
Relatedness	0.93	0.77-1.13	0.4898	1.07	0.89-1.28	0.4701
eHealth literacy	2.19	1.71-2.79	<.0001	1.38	1.11-1.71	0.0032
Depression and anxiety	1.17	1.04-1.32	0.0111	1.34	1.20-1.49	<.0001
Physical exhaustion	1.13	0.91-1.41	0.2553	1.19	0.98-1.45	0.0866
Emotional exhaustion	1.15	0.92-1.44	0.2089	1.67	1.35-2.06	<.0001
Parental restrictive	1.02	0.84-1.22	0.8774	1.03	0.87-1.22	0.7663
Internet mediation						
Parental active internet mediation	1.22	1.01-1.48	0.0443	1.12	0.94-1.33	0.2017

Note: 1. N=1236

2. Multiple logistic regression was conducted.

3. Pursuit of health information online: yes n=931 no n=305, pursuit of mental health information online: yes n=596 no n=640.

Table 5 Factors related to the number of health topics searched online

	$\beta$	95% C.I.	p value
Intercept	-1.94	-5.35 - -2.55	<.0001
Gender (boy=1, girl=0)	0.09	-0.14 - 0.30	0.4795
Age	0.48	0.08 - 0.22	<.0001
Academic performance	-0.11	-0.23 - 0.02	0.0991
Internet learning time	0.01	-0.01 - 0.01	0.7758
Internet recreation time	0.01	-0.01 - 0.01	0.9089
Bonding social capital	-0.10	-0.25 - 0.03	0.1283
Competence	0.18	0.03 - 0.32	0.0214
Autonomy	-0.01	-0.13 - 0.14	0.9576
Relatedness	0.00	-0.14 - 0.15	0.9383
eHealth literacy	0.52	0.34 - 0.69	<.0001
Depression and anxiety	0.28	0.20 - 0.36	<.0001
Physical exhaustion	0.17	0.01 - 0.33	0.0539
Emotional exhaustion	0.26	0.07 - 0.42	0.0052
Parental restrictive internet mediation	0.00	-0.11 - 0.17	0.6572
Parental active internet mediation	0.18	0.03 - 0.32	0.0155

Note: 1. N=1236

2. Multiple regression was conducted.

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