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Would you be healthier if you had more social capital? Focusing on university students' social media use in Japan

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Abstract

Background This study examined how university students' social media use is related to their mental health (subjective well-being [SWB] and loneliness) and perceived physical health. A cognitive bias model and a social network mediation model were used to compare social capital formed via face-to-face and online communication, considering the effects of personality traits (i.e., social skills, generalized trust, and social tolerance).

Methods We conducted a self-report survey with 409 university students in Japan from August to September 2022. Four patterns of social media use were analyzed: (1) Twitter only, (2) LINE + Twitter, (3) Instagram + Twitter, and (4) Discord + Twitter. Relationships between the variables were investigated with a structural equation modeling analysis using SmartPLS 4.0.

Results Overall, regardless of social media use patterns, personality traits had positive direct effects on mental health and also had positive effects on social capital via face-to-face (FTF) communication, which had mediating effects on the improvement of mental health. FTF social capital had a positive relationship with online social capital, which did not have relationships with mental or perceived physical health. Additionally, perceived physical health decreased loneliness but was not associated with SWB. Social media use negatively affected perceived physical health but had no effect on SWB or loneliness. Finally, different relationships between personality traits and social media use, FTF social capital and SWB, social media use and perceived physical health were observed among the four patterns of social media use.

Conclusion This study has implications for improving the health of young adults in the "mobile x social era." In particular, we provide suggestions to help young adults improve their mental health.

Keywords Personality traits, Social capital, Mental health, Perceived physical health, Social media use

Introduction

Research shows that people who believe themselves to be in good physical health are also likely to have good mental health [1]. However, according to UNICEF's survey of children in 38 developed countries, Japanese children (mean age: 15 years) ranked first in terms of physical health (mortality aged 5–14 years and overweight aged 5–19 years) but second worst in mental well-being owing to their poor life satisfaction (15 years) and high suicide rate (15–19 years) [2]. The link between mental and physical health is not apparent in Japanese children, as

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the indices for them were different (the indices of physical health are not from the targeted children). Additionally, Japanese children's social skills, including the ability to make friends, were low (ranked 27th of 38 surveyed countries). These findings indicate that Japanese children may struggle to build fruitful social networks because of their low social skills. Furthermore, their mental health may decline without social networks that provide the necessary support, especially emotional support.

Fukuzawa et al. [3] conducted a longitudinal study of 1,068 people in Japan (mean age: 73.01 years) from 2013 to 2017. They found that older adults can weaken the adverse effect of a decline in human capital on *ikigai* (life worth living) by maintaining or increasing their social networks. Fukuzawa and Sugawara [4] also investigated the relationships between loneliness, social support, social participation, and well-being among people over 75 years of age. They found that *ikigai* and life satisfaction have different relationships with loneliness and social interaction because the concept of *ikigai* includes perceived social roles. Furthermore, Fukuzawa et al. [5] analyzed World Value Survey Wave 6 data on Japanese people aged 20–80 and found that independent self-construal was higher in people older than 55 years despite a worse health status and lower income than younger surveyed individuals. Therefore, they suggested that increasing independent self-construal is important for maintaining the well-being of middle- and older-aged adults. Based on these implications, it is expected that independent self-construal might help improve young adults' mental health if they can establish their independent identities. From the viewpoint of identity development, university students are expected to establish their identities, thus enabling them to have more opportunities to communicate with different people and form more extensive social networks, which are helpful in maintaining their health. In Japan, students in elementary and junior high schools are generally prohibited from bringing smartphones to campus, and high school students are not allowed to use smartphones on campus [6], while university students can use social media via their smartphones to connect with others freely. In this context, social media use is likely to have a stronger effect on university students than on children and adolescents who face smartphone restrictions on their use of social media. Therefore, this study focused on young adults' social media use, targeting participants recruited from universities and its relationship to their health.

Previous studies have reported a relationship between social media use and users' mental and physical health. For instance, while social support can be gained through social media [7], its overuse can be a sign of social media addiction [8]. This may contribute to more mental health concerns, such as impaired life satisfaction, and physical health concerns, such as impaired sleep [9]. Prior research also suggests that personality traits are related to social media use [10, 11]. For example, people with different motivations for using social media may have different relationships with subjective well-being (SWB) [12]. In addition, social capital has been suggested as a mediator of the relationship between social media use and loneliness among first-year university students who use social media to build up their social capital and reduce their loneliness in this new life chapter [13]. Nevertheless, most existing research has not analyzed the issue holistically by considering personality traits' relationships with social media use to understand how these traits relate to mental health and physical health, mediated by social capital. This study addresses this research gap by using a model amalgamated from prior research findings. We focused on the communication behaviors of university students, including the formation of social capital, which has been impacted by the COVID-19 pandemic. In Japan, although there was no strict lockdown, most universities shifted from face-to-face (FTF) to online classes. Extracurricular activities were suspended in 2020 and the first half of 2021 under state of emergency declarations and priority measures to prevent the spread of COVID-19. The public health emergency has gradually subsided due to the COVID-19 vaccination. Since 2022, there have been more FTF activities that allow students to have lifestyles and communication behaviors similar to those before COVID-19. However, there are also post-COVID-19 communication behavior differences. New social media platforms, such as Discord and TikTok, have gained popularity and might have different effects on young adults' interpersonal relationships, especially the formation of social capital and mental and/or physical health.

First, we describe our model based on a prior understanding of social capital. People with more social capital typically receive greater social support [14]. Social capital encompasses social networks, generalized trust, and norms of reciprocity; it can be classified into two types: "bonding" and "bridging" [15]. "Bonding" involves deepening the relationships people already have (i.e., "strong ties"), whereas "bridging" involves creating new relationships beyond the current social circle (i.e., "weak ties"). The difference between bonding and bridging social capital is related to the nature of the relationships or associations in social groups or communities. Bonding social capital occurs within a group or community, whereas bridging social capital occurs between social groups, social classes, races, religions, or those with other important sociodemographic or socioeconomic characteristics. The distinction between bonding and bridging is based

on the range of relationships and network characteristics. For instance, Igarashi [16] found that social skills are helpful in decreasing users' loneliness through the mediation of social networks (strong ties) formed via FTF but have no similar effects on social networks (weak ties) formed via computer-mediated communication (CMC). However, those social networks (weak ties) were binary instances from social networks (strong ties) formed via FTF. This is significantly different from modern communication styles in which people's online and offline social networks, especially young adults, are interconnected [17]. Additionally, social skills were positively related to the formation of social networks via FTF and Twitter, with the latter leading to greater social support from intimate others [18]. Fukuzawa and Ye [19] also found that social skills helped form larger social networks, regardless of academic standing and types of social media use, which improved SWB and decreased loneliness [19]. Although prior research has implications for the effect of social skills on social capital (networks) and mental health, it is unclear whether a similar relationship could be identified for physical health. Therefore, using survey data collected from university students in Japan, this study aimed to clarify whether a relationship exists between young adults' mental and physical health when considering the effects of social skills and social capital configurations.

However, to achieve this aim, two major challenges must be overcome. First, existing research has clarified that university students in Japan with higher levels of social tolerance toward differences of opinions and ideas can build social capital through both FTF and online communications [20]. Users' social tolerance has different effects on their media use, which have different mediation effects on their social network formation [21]. Additionally, university students with higher levels of generalized trust were able to improve their levels of SWB directly; they also helped form larger social networks using Twitter, from which they obtained some emotional support in the early stage of the COVID-19 pandemic [18]. As generalized trust encourages people to approach others to form social relationships, people with a higher level of generalized trust are more likely to cooperate with strangers [22]. It is then plausible that people with higher levels of social skills, social tolerance, and generalized trust will be able to communicate with others, form fruitful social networks, and gain various types of social support, thereby maintaining their mental and physical health. Young adults' social networks via FTF and online communications are interlinked and often overlap. Therefore, it is necessary to examine the effects of social capital formed through both FTF and online communications on mental and physical health, as well as their relationships with each other, considering the effects of generalized trust and social tolerance.

Second, with the decrease in FTF communication and the increase in online communication, online "flame" attacks and slander are increasing worldwide. Compared with FTF interactions, the online world offers higher visual anonymity, a lack of nonverbal information, and reduced concerns about evaluation by others [23]. This occurs much more easily on Twitter and Instagram than on LINE (a viral social media platform in Japan mainly used for connecting with close friends and family members) or on Discord. The Internet and social media have also become key channels through which people maintain their social capital (both online and offline) [24]. Internet literacy is an essential tool for gaining online social capital [25], which can help people access more social support and differentially manage social ties [26]. Therefore, as we aim to understand whether social media use affects users' social capital, Internet literacy must be included as part of social media use. As mentioned earlier, LINE, Twitter, Instagram and Discord are the top four social media platforms used by young people to communicate with others in Japan. University students frequently use Twitter to share interests and Instagram to post photos and videos. They mostly use LINE and Discord to communicate with their friends, although Discord is also often used to share interests [27]. Thus, in this study, we compared the relationships between these four social media platforms and mental and physical health.

Literature review

This study defined mental health in terms of SWB and loneliness. SWB is considered a positive aspect of mental health. Mental health has well-known hedonic and eudemonic aspects related to meaning in life [28], and SWB refers to this hedonic aspect. SWB is an indicator in many studies examining the relationship between mental health and social media use (e.g., [29]). Longitudinal research has shown that SWB is an indicator of university students' mental health and can predict health status, career development, and good interpersonal relationships [30]. Loneliness, considered a negative aspect of mental health, has also been identified as an important indicator of mental health related to university students' dropout intentions [31]. Therefore, SWB and loneliness are suitable indicators for examining university students' mental health. Physical health, in this study, refers to "perceived physical health." This definition focuses on people's perceptions of their physical health rather than objective results from a medical assessment. This naturalistic definition is appropriate as most scales assessing

physical health are based on respondents' perceptions (e.g., [32]).

Two decades ago, Igarashi [16] investigated the effect of social skills on loneliness using a social network mediation model and a cognitive bias model. He found that social skills had a direct effect on loneliness. This effect was mediated by social networks via FTF. Alternatively, social networks via CMC were affected by social skills but had only weak mediating effects on loneliness. He suggested that the lack of nonverbal cues in CMC could explain the weak effects of social networks on loneliness. Based on these findings, Ye and Ho [18] examined the effects of social networks via FTF communication and Twitter use on SWB. They considered users' social skills, generalized trust, and social support (with different levels of intimacy) received from both social networks. The results indicate that (a) both social skills and generalized trust have positive effects on SWB regardless of the type of social network, and (b) university students with lower generalized trust tend to use Twitter to form somewhat intimate social networks, providing a source of social support. However, this social support did not relate to SWB.

More recently, Ye et al. [33] and Ye and Ho [34] investigated factors related to university students' SWB, including self-consciousness, friendships, and desire for self-presentation. Collectively, their findings demonstrated that various factors such as (i) Internet use (e.g., usage time) and social media (e.g., frequency of reading and posting content and the types of content posted), and (ii) personality traits (e.g., generalized trust and different aspects of self-consciousness, friendships, and desire for self-presentation) and social support were related to SWB. Additionally, these previous studies found that personality traits had more substantial effects on SWB than media use. Thus, we propose the following hypothesis:

> H1: Personality traits, such as social skills, generalized trust, and social tolerance, improve young adults' perceived physical health and SWB and decrease their levels of loneliness.

Social capital may play an essential role in young adults' physical and mental health. Social media use by young people has increased rapidly over the past two decades. Literature has shown that social media can influence social capital formation and maintenance. Ellison et al. [24] demonstrated that Facebook use strengthens social capital. Forest and Wood [35] showed that social media can help people with low self-esteem express themselves more straightforwardly and improve their interpersonal lives, thereby helping them gain more social capital. Other studies suggested that social capital is a social determinant of health [36] and can improve physical and mental health, albeit with a small effect size [37]. However, prior research has not always distinguished between FTF and online social capital because it is difficult to separate them [38]. This is likely because of correlations between online and offline social networks and social cognition [39]. Furthermore, the effect of online social capital on mental health may be related to whether a person uses social media actively or passively [40].

Some studies have found that online social capital may worsen users' physical and mental health. For example, social support obtained from online health communities sometimes provides biased information and serves a group agenda [41]. Additionally, the addictive properties of social media have negative effects on mental health, producing greater reliance on online social support and less reliance on social support via FTF [42]. Other studies have also reported that social media use has negative effects on physical health [43] because social media algorithms can trigger addictive use [44]. Based on these results, we posit that people with more FTF social capital use social media less. For these people, social media use has fewer negative effects on their mental and perceived physical health.

Furthermore, research has demonstrated that social networks are becoming increasingly smaller among younger generations, both before and during the COVID-19 pandemic [18, 21, 45]. Smaller social networks are found among people with lower social tolerance and sociability [46]. Therefore, we hypothesized that young adults with more social skills, generalized trust, and social tolerance would have more FTF social capital. This, in turn, would decrease loneliness and improve SWB and perceived physical health. However, young adults who lack FTF social capital would increase their reliance on social media and their online social capital, thereby increasing loneliness and decreasing SWB and perceived physical health.

Internet literacy is essential when using social media. It may also be necessary for the formation of social capital via online communications. Therefore, Internet literacy may affect people's health. People with higher levels of Internet literacy are good at communicating with others. They have better communication skills and higher operational ability. They are also more capable of critically judging information [17]. They can form more extensive social networks and receive more social support. The four most popular social media platforms among the younger generation in Japan are LINE, Twitter, Instagram, and Discord. Twitter offers the greatest visual anonymity, followed by Discord, Instagram, and LINE. Over 99% of the younger generation in Japan uses LINE [27] to communicate with their families, close friends, and classmates. This communication uses their real names

and phone numbers. Therefore, unlike other social media platforms, a person can have only one LINE account. People use LINE to generate online social capital based on their FTF communication. Additionally, over 80% of young people in Japan also use Twitter. This platform is used to communicate with friends known through FTF but also with people only known online who share their interests [34, 47]. Although Instagram communications use people's real names, young people use it to post pictures and videos that present their personal and social lives positively. This is because of their higher levels of desire for approval and social comparison [48, 49]. Thus, Instagram use might have more negative effects on health than other platforms, especially mental health.

Young people in Japan use Discord to communicate with their friends and share interests [27]. People can have multiple accounts because registration does not require a phone number. Thus, we posit that Discord use differs significantly from that of LINE and Instagram. Therefore, we assume that young adults will be able to generate online social capital with higher levels of online communication skills and increased operational ability to communicate with different people at different levels of intimacy. These young adults will also be more capable of critically appraising information for its authenticity. Consequently, this will positively affect (or reduce the negative effects) mental and perceived physical health. As people generally use more than one social media platform, it is appropriate to examine platform combinations. This study aims to investigate the effects of both "bonding" and "bridging" social capitals on mental and perceived physical health. Hence, we chose Twitter as the reference platform as it is more commonly used in the world than LINE, although LINE has the highest usage rate in Japan. We compare the following four patterns: (a) Twitter only, (b) Twitter + LINE, (c) Instagram + Twitter, and (4) Discord + Twitter.

Thus, based on the above, we propose the following hypotheses:

H2: Young adults with higher levels of social skills, generalized trust, and social tolerance will have more FTF social capital. This will lead them to use social media less. If they have higher levels of Internet literacy, their low social media use may have fewer negative effects on their mental and perceived physical health. Their social media use will have stronger effects on their mental health than on perceived physical health. These effects will differ between SWB and loneliness.

H3: Young adults with higher levels of social skills, generalized trust, social tolerance, and more FTF social capital will have more online social capital. Both online and FTF social capital will affect SWB, perceived physical health, and loneliness.

H4: The two hypotheses above will be most noticeable when using Twitter only. Significant differences will be observed with respect to H2 and H3 for those using Discord + Twitter compared to other platform combinations.

To examine these four hypotheses, we developed the analytical model shown in Fig. 1.

Methodology

Cross-sectional survey

University students enrolled in the Kanto region of Japan were surveyed from the beginning of August to the end of September 2022 using REAS (https://reas3.ouj.ac.jp/cgi-bin/WebObjects/top). The survey participation link was disseminated to mailing lists within the first author's college with the support of faculty members. It was also sent to those who participated in other surveys within the same project. In addition, we invited faculty members

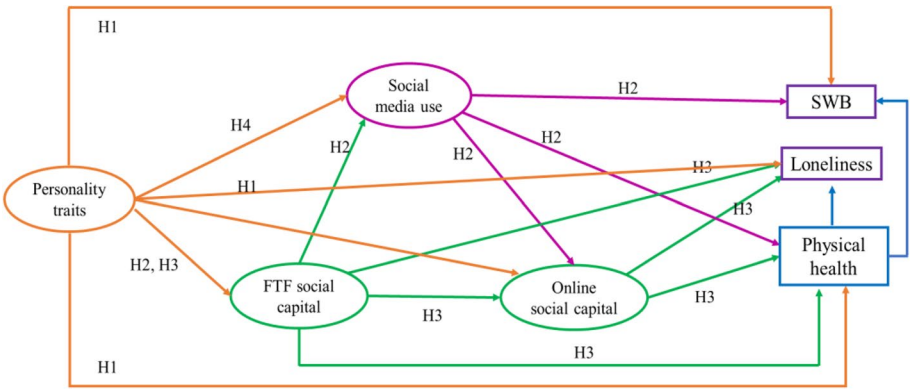

Fig. 1 Model Analyzed in this Study

at other universities to identify participants by sending emails and introducing surveys in classes. Responses were solicited from a wide range of participants enrolled at national and private universities. A total of 409 complete responses were received.

Before answering the survey, participants were provided with written instructions on how to complete the survey. They were also given key study information, including the study's ethical approval, purpose, methods, data storage and sharing policy, and privacy and protection of their personal information. The researcher's contact details were provided. The voluntary nature of participation was emphasized, as well as participants' right to withdraw responses. Participants were told where research results would be published. Informed consent was then obtained from willing participants. A consent form was completed before proceeding with the study.

The questionnaire consisted of three parts in Japanese, which are described below.

Part A collected demographic information such as gender, age, academic standing, affiliation, residence status, and part-time job status. It also collected levels of social skills, generalized trust, and social tolerance. Social skills were measured using 12 items extracted from Shimamoto and Ishii [50]. Yamagishi and Yamagishi's [22] 6-item scale was used to measure generalized trust. Social tolerance was measured based on items from Kobayashi and Ikeda [51]. This included 20 items that reflected participants' social situations at the time of the survey. Specifically, the items asked about the extent to which participants felt that they should share their opinions with their family, friends, seniors, and others. This included opinions on issues such as international and domestic politics, social issues, inflation, and lifestyle. All responses were rated on a 5-point Likert scale (5 = very applicable; 3 = neither; 1 = not applicable at all), except for social tolerance, which used a 4-point Likert scale (1 = having the same opinion is better, 2 = having a different opinion is quite awkward, 3 = having a different opinion is slightly awkward, and 4 = having different opinions is acceptable).

Part B collected information on social media use and Internet literacy. Participants were asked to report the amount of time they spent on different social media platforms (i.e., LINE, Twitter, Instagram, and Discord) per day, their frequency of posting, and the content of their posts. Participants could select multiple post content types, such as shared interests, their personal and social lives, photos and videos, chats with friends, maintaining everyday friendships, academic progress and grades, self-deprecating content, COVID-19-related information, anxiety about COVID-19, job-hunting information, and others. Participants could also indicate that they do not post and merely view others' posts. The survey evaluated Internet literacy with Ye et al.'s measure [17], rated on a 5-point Likert scale (5 = strongly agree, 3 = neither, 1 = strongly disagree).

Part C asked participants to report the number of social groups that they belonged to and to describe their interactions with them. This included the frequency of interactions via FTF and online (Twitter) (1 = I do not belong to any group; 3 = I interact with everyone several times per week; 5 = I interact with everyone every day), intimacy (1 = I am not close to several members, 2 = I am not close to one member, 3 = I have close relationships with everyone), and satisfaction (5 = very satisfied; 3 = neither; 1 = not satisfied at all). We also measured the participants' perceived physical health using 12 items modified from Yamauchi et al. [52]; their SWB was evaluated using 15 items from Ito et al. [53], and their loneliness was assessed using 20 items from Moroi [54]. All of these items were rated on a 5-Likert point scale.

Analysis

The data was analyzed using SPSS version 29 for descriptive statistics, analysis of variance (ANOVA), and factor analysis. Next, we used SmartPLS 4.1.02 [55] to analyze the model shown in Fig. 1 using the partial least squares method. In this model, personality traits included social skills, generalized trust, and social tolerance (family, older adults, intimate friends, and others). Social media use included the time spent using each social media platform, posting frequency, total number of content topics posted on each social media platform, number of Twitter accounts owned, and Internet literacy. Mental health considered both SWB and loneliness, whereas physical health in Fig. 1 refers to perceived physical health. In addition to analyzing the overall effects across all four social media platforms, we analyzed and compared four platform patterns (Twitter only, LINE + Twitter, Instagram + Twitter, and Discord + Twitter).

Results

Information for analyzed participants

Table 1 presents the demographic characteristics of the participants. Two-tailed *t*-tests (independent samples) showed that the average age and part-time work hours (per week) were not significantly different between the male and female participants. Chi-squared tests confirmed that there were no significant gender differences in the distribution of academic years, residence type, or residence status.

Table 1 Participant demographics and characteristics

Demographic	Overall (*n* = 409)	Males (*n* = 195)	Females (*n* = 214)
Average age (in years)	20.3	20.4	20.3
Academic year			
First	24.2%	23.1%	25.2%
Second	20.5%	22.1%	19.2%
Third	21.3%	19.0%	23.4%
Fourth or higher	33.5%	35.4%	31.8%
Others (including working or further studies)	0.5%	0.5%	0.5%
Residence type			
Dormitory	16.1%	15.4%	16.8%
Apartment	54.0%	56.9%	51.4%
Parents' home	27.4%	26.2%	28.5%
Share-house	2.2%	1.0%	3.3%
Others	0.2%	0.5%	0.0%
Household composition			
Living alone	64.1%	67.2%	61.2%
Living with others	35.9%	32.8%	38.8%
Average hours of part-time work per week	8.6	8.0	9.2

Social media use

Table 2 summarizes the topics posted by participants on each platform. LINE was mostly used to chat with friends, possibly because it is the most commonly used social media platform for connecting with close friends and relatives. However, because Twitter provides a certain level of anonymity, people are more likely to use it to share information while also posting photos and videos and chatting with friends. Instagram was primarily used to share photos and videos, showcase personal and social lives, and maintain everyday friendships while also sharing interests. Discord was used to share interests and chat with friends.

Table 3 shows social media platform use based on the overall dataset and within the four social media platform patterns. The distribution of gender was fairly balanced for Twitter only and LINE + Twitter. However, the Instagram + Twitter pattern included more female users, whereas the Discord + Twitter pattern included more male users. We noted that Discord + Twitter was likely the most active pattern, considering individuals with this pattern had the longest usage time, most topics posted, and the highest posting frequency on Twitter.

Table 2 Post contents by social media platform

Post Contents	LINE (*n* = 345)	Twitter (*n* = 354)	Instagram (*n* = 298)	Discord (*n* = 102)
Shared interests	20.9%	49.2%	38.6%	36.3%
Personal and social life	9.6%	20.1%	50.0%	5.9%
Photos, videos, etc	29.9%	37.0%	69.5%	11.8%
Chatting with friends	45.5%	32.8%	14.8%	30.4%
Maintaining everyday friendships	25.8%	27.1%	37.9%	13.7%
Academic progress and grades	14.5%	16.9%	4.0%	6.9%
Self-deprecating content	1.7%	21.2%	2.7%	1.0%
Information about COVID-19	2.0%	3.7%	1.0%	0.0%
Anxiety toward COVID-19	0.5%	1.7%	0.0%	0.0%
Job hunting	4.9%	5.4%	1.3%	1.0%
Others	3.2%	11.9%	2.0%	9.8%
Does not post	36.2%	31.4%	18.5%	20.6%

Table 3 Comparison of social media use by gender and platform pattern

Distributions	Overall (*n* = 409)	Twitter Only (*n* = 354)	LINE + Twitter (*n* = 316)	Instagram + Twitter (*n* = 270)	Discord + Twitter (*n* = 101)
Gender					
Male	195	167	153	113	69
Female	214	187	163	157	32
Average Usage Time (hours/month)[a]					
LINE	32.5		38.4		
Twitter	46.5	41.0	53.7	51.8	65.1
Instagram	29.9			40.9	
Discord	11.4				46.0
Average Number of Topics Posted[b]					
LINE	1.4		1.6		
Twitter	2.0	2.3	2.2	2.3	3.2
Instagram	1.6			2.2	
Discord	.3				1.2
Average Posting Frequency (in days/month)[c]					
LINE	15.7		18.2		
Twitter	12.6	14.6	14.6	14.8	17.6
Instagram	6.8			9.4	
Discord	2.1				8.4

[a] The usage time per day for social media was converted to a monthly rate as follows: Do not use was 0 h; 0–2 h was 30 h, 2–4 h was 90 h, 4-6 h was 150 h, 6–8 h was 210 h, 8–10 h was 270 h, 10–12 h was 330 h, and 12 h or more was 360 h

[b] The "number" of topics is a count of the dummy variable of 11 types of common posting content (including "others"). This was determined using a series of yes-or-no questions, counting "yes" as "1" and "no" as "0"

[c] For calculating the frequency of participants' social media posts, we considered the following responses and their respective scores: never or seldom = 0 day/month; once per month = 1 day/month; once a week = 5 days/month; several times a week = 15 days/month; and almost every day = 30 days/month

Scale reliability

The reliability of our measures of personality traits (social skills, generalized trust, and social tolerance), mental health (SWB and loneliness), perceived physical health, and Internet literacy were examined using Cronbach's alpha coefficients. Following previous studies (e.g., [17]), we conducted a factor analysis of the Internet literacy scale. As a result, four subscales were obtained, namely, communication skills, operation ability, information judgment and Internet skepticism. When computing Cronbach's alpha coefficients for the scales and subscales, we found that one of the Internet literacy subscales (Internet skepticism) did not converge and had a low alpha value of 0.42. Therefore, we excluded it from further analysis. The results for the scales and subscales are summarized in Table 4. As the items measuring perceived health were negatively worded,[1] we reversed these scores when computing the scale total.

The overall score and pattern scores were similar for personality traits. However, considering the scores for mental health, the Twitter only pattern had the lowest score for SWB, while Discord + Twitter had the highest score for loneliness. Although the pattern scores were similar for perceived physical health, the overall score was lower. In addition, the overall group's Internet literacy scores were lower than those in the four patterns on all three sub-scales, while the Discord + Twitter pattern's scores were significantly higher than other pattern scores for Internet literacy on all three subscales. An independent two-tailed *t*-test was conducted to compare its average scores with the average of the second-highest pattern scores and found that there were significant differences in terms of communication skills (Discord + Twitter [3.04] vs. Instagram + Twitter [2.71], $t[453] = 2.69$, $p = 0.007$) and operational ability (Discord + Twitter [3.63] vs. Instagram + Twitter [3.42], $t[369] = 2.17$, $p = 0.003$).

Social capital configurations

Table 5 reports FTF and online social capital (from Twitter) measure scores in the overall dataset and within the four patterns. Less social capital was found in the overall dataset than in specific patterns. The Instagram + Twitter patterns had the most FTF social capital; Discord + Twitter had the most online social capital.

[1] As an example of negative wording, participants were asked whether they felt unhealthy or sick, or whether they had concerns about their health..

Table 4 Average scores and reliability of measurements

Constructs (Cronbach's α)	Overall (*n* = 409)	Twitter Only (*n* = 354)	LINE + Twitter (*n* = 316)	Instagram + Twitter (*n* = 270)	Discord + Twitter (*n* = 101)
Personality traits					
Social skills (.82)	46.61	46.49	46.34	46.89	46.93
Generalized trust (.88)	19.70	19.71	19.90	19.86	19.49
Social tolerance: Overall (.90)	72.21	71.96	71.90	72.05	71.30
Social tolerance: Others (.89)	18.88	18.80	18.77	18.84	18.56
Mental health					
SWB (.88)	49.03	48.64	48.83	49.11	48.99
Loneliness (.91)	45.64	45.82	45.89	44.70	45.98
Perceived physical health (.90)	43.02	43.37	43.63	43.52	43.76
Internet literacy					
Communication skills (.92)	2.51	2.63	2.62	2.71	3.04
Operational ability (.84)	3.35	3.41	3.40	3.42	3.63
Information judgment (.74)	3.39	3.46	3.43	3.39	3.62

Table 5 Social capital measurements

	Overall (*n* = 409)	Twitter Only (*n* = 354)	LINE + Twitter (*n* = 316)	Instagram + Twitter (*n* = 270)	Discord + Twitter (*n* = 101)
FTF social capital					
Number of FTF groups joined	3.00	3.02	2.78	3.37	3.03
Total number of groupmates[a]	4.71	4.82	4.82	5.05	4.98
Frequency of interaction with groupmates[b]	10.97	11.03	11.11	11.72	10.89
Intimacy with groupmates[c]	18.86	19.03	19.08	20.06	19.01
Satisfaction with groupmates	3.58	3.61	3.63	3.73	3.67
Online social capital (Twitter)					
Number of online groups involved	.48	.55	.55	.58	1.12
Total number of groupmates[a]	1.66	1.84	1.83	1.82	3.17
Frequency of interaction with groupmates[b]	3.33	3.81	3.80	3.93	6.49
Intimacy with groupmates[c]	5.06	5.83	5.70	6.30	8.71
Satisfaction with groupmates	1.06	1.21	1.17	1.24	2.04

[a] The total number of people in a group was converted as follows: less than 5 people = 2.5 people; between 5 to 10 people = 7.5 people; and 11 or more people = 12.5 people

[b] The frequency of interaction with groupmates was converted as follows: "I don't belong to a group" = 0; "I hardly interact with any members" = 5; "several times per week with some members" = 10; "several times per week with all the members" = 15, "every day with several members" = 20; and "every day with everyone" = 30

[c] Intimacy with member was converted as follows: "I do not belong to a group" = 0; "I am not close to several members" = 5; "I am not close to one member" = 15; and "I have close relationships with everyone" = 30

However, significant differences between patterns were only found for online social capital. The Discord + Twitter pattern scored significantly higher for online social capital than other patterns. This was established with an independent two-tailed *t*-test comparing its average score with that of the second-highest pattern for the respective sub-items. Significant differences included the number of groupmates (Discord + Twitter [3.17] vs. Twitter only [(1.84], $t[453] = 3.13$, $p = 0.002$); the frequency of interaction with groupmates (Discord + Twitter [6.49] vs. Instagram + Twitter (3.93), $t[369] = 2.85$, $p = 0.005$); and satisfaction with groupmates (Discord + Twitter [2.04] vs. Instagram + Twitter [1.24], $t[369] = 3.37$, $p < 0.001$). For the number of online groups joined, the Discord + Twitter pattern scored significantly larger than the third- and fourth-highest patterns ($p < 0.05$) but only marginally larger than the second-highest pattern (Discord + Twitter [1.12] vs. Instagram + Twitter [0.58], $t[369] = 1.89$, $p = 0.059$). Similar results were obtained when comparing intimacy with groupmates: Discord + Twitter [8.71] vs. Instagram + Twitter [6.30], $t[369] = 1.76$, $p = 0.079$).

Structural equation model analysis results

SmartPLS 4.1.02 [55] was used to analyze the model shown in Fig. 1 using the partial least squares method. Figure 2 depicts the results for all participants (i.e., the results obtained from analyzing the overall dataset). Figures 3, 4, 5, 6 show the results for the four social media use patterns.

All the results are contained in Table 6. The correlation matrix of the results from the overall dataset is included in the Appendix.

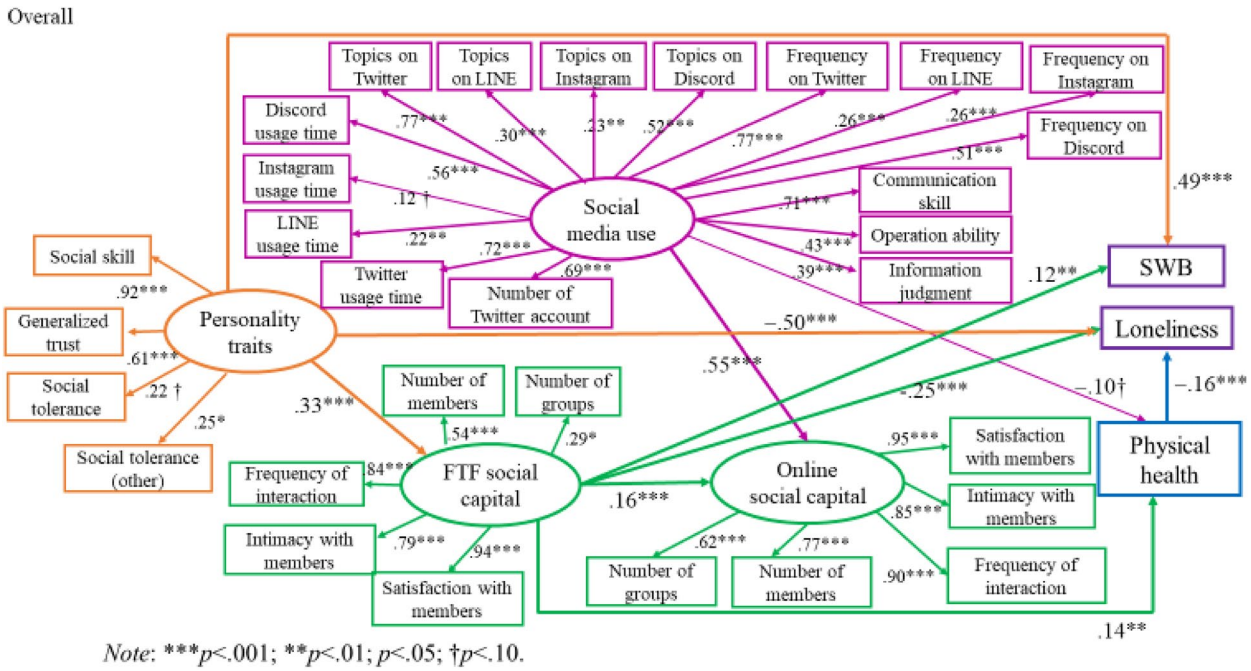

Fig. 2 Results for Overall Dataset

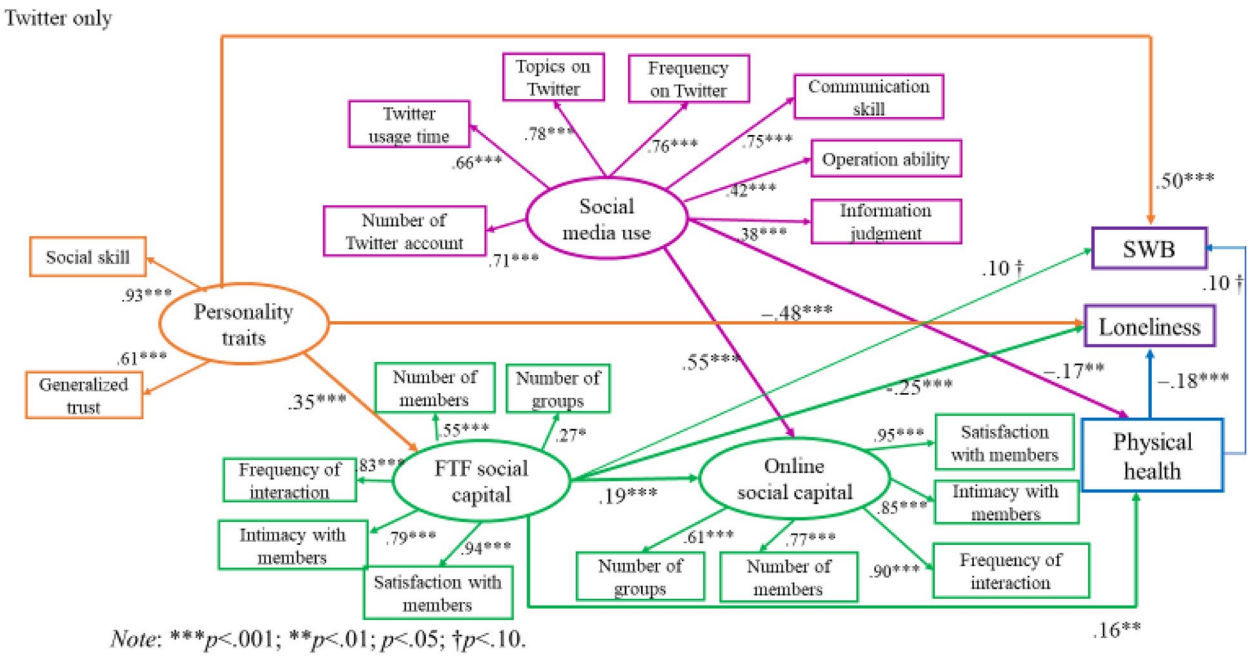

Fig. 3 Results for Twitter Only Pattern

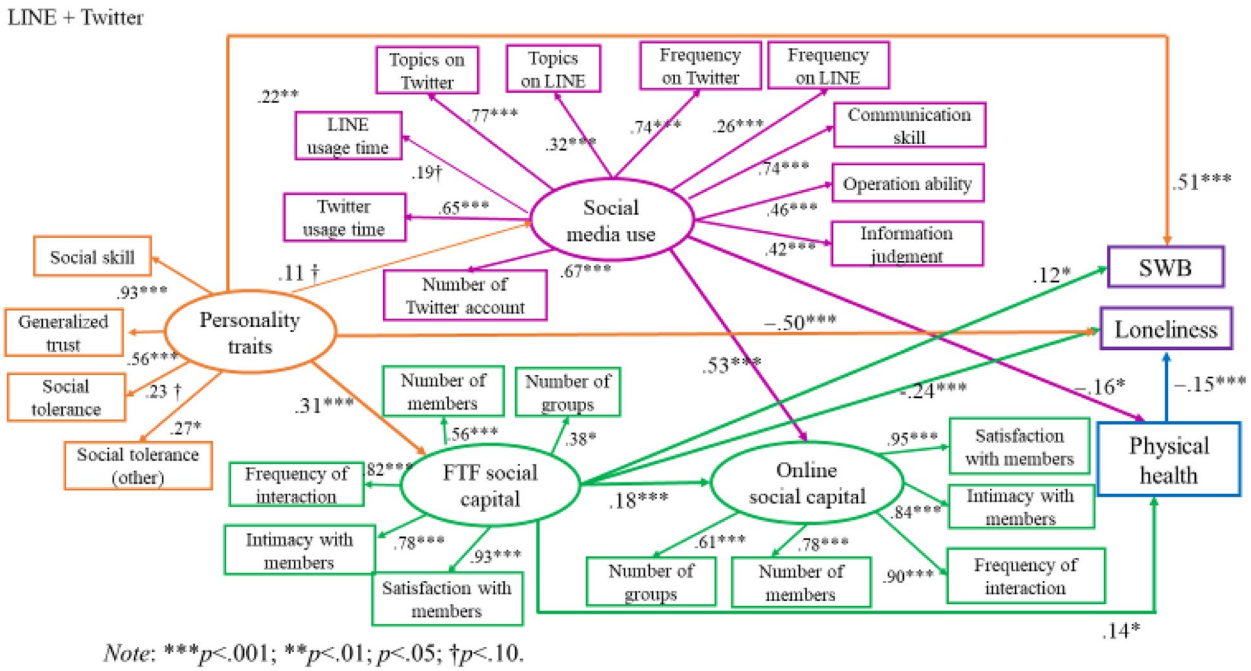

Fig. 4 Results for LINE + Twitter Pattern

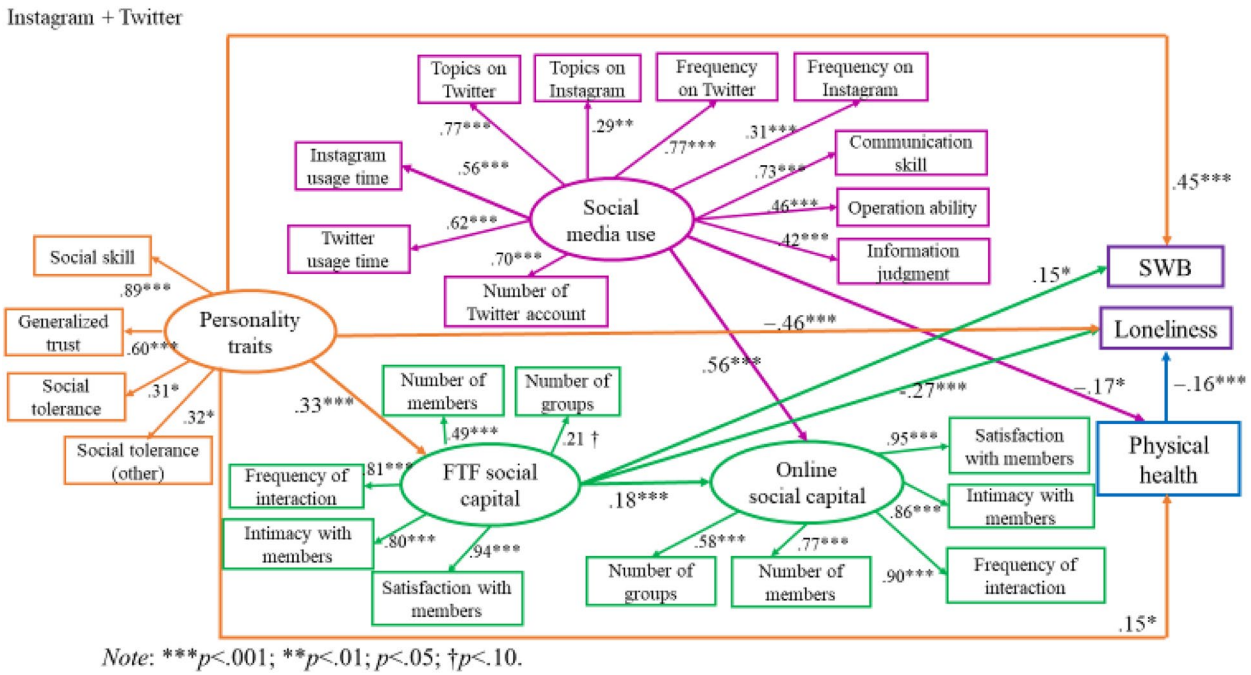

Fig. 5 Results for Instagram + Twitter Pattern

Personality traits had strong direct effects on improving SWB and decreasing loneliness, but there were no relationships with perceived physical health. Although perceived physical health decreased loneliness, no relationship was observed with SWB. Additionally, personality traits had direct positive effects on the formation of FTF social capital, which had mediating effects on improving SWB and decreasing loneliness. Furthermore, FTF social capital and social media use positively related to the formation of online social capital. However, online

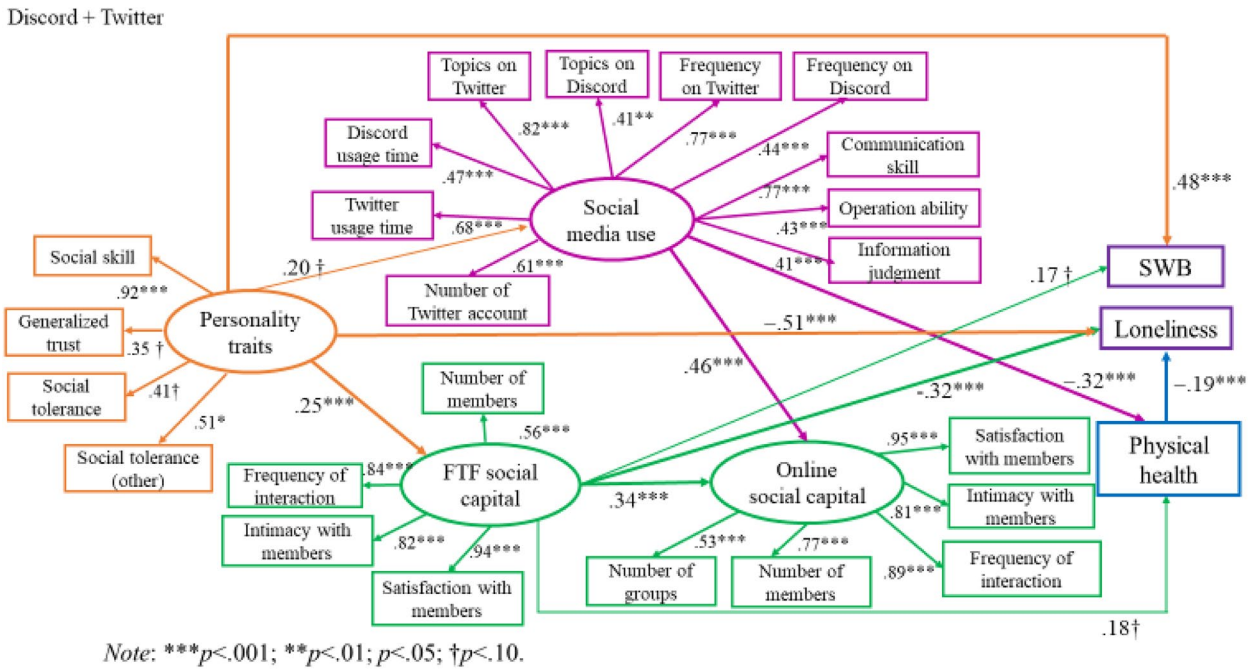

Fig. 6 Results for Discord + Twitter Pattern

social capital did not relate to perceived physical or mental health. Conversely, social media use decreased users' perceived physical health. This was most evident in the Discord + Twitter pattern. The social skills factor of personality traits had the most substantial effect, followed by generalized trust. Regarding social media use, Twitter usage time, topics of content posted on Twitter, and posting frequency affected the five patterns. Additionally, all three Internet literacy factors had positive effects. FTF and online social capital configurations were similar, but the number of groups joined did not affect the Discord + Twitter pattern.

Some relationships were limited to specific patterns. First, the effects of personality traits on perceived physical health were found only for the Instagram + Twitter pattern. Second, the effects of FTF social capital on improving perceived physical health were significant in the overall case, Twitter only and LINE + Twitter patterns, but became marginally significant in the Discord + Twitter pattern, and no effects in the Instagram + Twitter pattern. Moreover, the marginally significant effects of physical health on SWB were only observed in the Twitter only pattern. Finally, social tolerance (all and others) did not affect the Twitter only pattern.

Discussion

This study aimed to clarify how university students' social media use relates to their mental and perceived physical health by considering the effects of personality traits and social capital formed through FTF and online communication. We examined and compared different patterns formed by combinations of the four most popular social media platforms for communication among university students in Japan (Twitter, LINE, Instagram, and Discord). Four hypotheses were investigated, and their respective results are discussed below.

Before discussing our findings, it is essential to note that our data collection took place in the late summer of 2022, two years after the COVID-19 pandemic. Our participants had spent much of their academic lives online. As shown in Table 7, only 10.2% of our participants had FTF classes in Spring 2020, while 88.9% of them had recorded online classes. Even in Spring 2022, immediately before data collection, 75.3% of students were still enrolled in recorded online classes, its percentage was higher than those students who took FTF classes (62.6%) in the same semester. Participants may have needed to generate social capital from both online and FTF environments.

Personality traits and health

Personality traits have strong direct effects on improving SWB and decreasing loneliness but only affect perceived physical health in the Instagram + Twitter pattern. Hence, the relationship between personality traits and mental health may differ from the relationship between personality traits and perceived physical health. Social skills have the largest effects on personality traits, followed by

Table 6 Summary of all results

Constructs (Cronbach's a)	Overall ($n = 409$)	Twitter Only ($n = 354$)	LINE + Twitter ($n = 316$)	Instagram + Twitter ($n = 270$)	Discord + Twitter ($n = 101$)
Paths and Adjusted R^2(bold on the first line)					
Perceived physical health (PPH):	**.02**	**.05**	**.04**	**.04**	**.11**
Social capital → PPH	.14 **	.16 **	.14 *		.18 †
Social media use → PPH	-.10 †	-.17 **	-.16 *	-.17 *	-.32 ***
Personality traits → PPH				.15 *	
SWB:	**.30**	**.32**	**.31**	**.26**	**.29**
Personality traits → SWB	.49 ***	.50 ***	.51 ***	.45 ***	.48 ***
Social capital → SWB	.12 **	.10 †	.12 *	.15 *	.17 †
PPH à SWB		.10 †			
Loneliness:	**.44**	**.43**	**.42**	**.42**	**.49**
Personality traits → Loneliness	-.50 ***	-.48 ***	-.50 ***	-.46 ***	-.51 ***
PPH → Loneliness	-.16 ***	-.18 ***	-.15 ***	-.17 ***	-.19 **
Social capital → Loneliness	-.25 ***	-.25 ***	-.24 ***	-.27 ***	-.32 ***
Social capital (SC):	**.11**	**.12**	**.09**	**.10**	**.05**
Personality traits → SC	.33 ***	.35 ***	.31 ***	.33 ***	.25 *
Online social capital (OSC):	**.34**	**.34**	**.32**	**.34**	**.33**
Social capital → OSC	.16 ***	.19 ***	.18 ***	.18 ***	.34 ***
Social media usage → OSC	.55 ***	.55 ***	.53 ***	.56 ***	.46 ***
Social media use (SMU):			**.01**		**.03**
Personality traits → SMU			.11 †		.20 †
Factor Loadings					
Social media usage:					
Discord usage time	.56 ***				.47 ***
Instagram usage time	.12 †				
LINE usage time	.22 **		.19 †		
Twitter usage time	.72 ***	.66 ***	.65 ***	.62 ***	.68 ***
Discord post topics	.52 ***				.41 ***
Instagram post topics	.23 **			.29 ***	
LINE post topics	.30 ***		.32 ***		
Twitter post topics	.77 ***	.78 ***	.77 ***	.77 ***	.73 ***
Discord posting frequency	.51 ***				.44 **
Instagram posting frequency	.26 ***			.31 ***	
LINE posting frequency	.26 ***		.26 ***		
Twitter posting frequency	.77 ***	.76 ***	.74 ***	.77 ***	.82 ***
Number of Twitter accounts	.69 ***	.71 ***	.67 ***	.70 ***	.61 ***
Communication skills	.71 ***	.75 ***	.74 ***	.73 ***	.77 ***
Operational ability	.43 ***	.42 ***	.46 ***	.46 ***	.43 **
Information judgment	.39 ***	.38 ***	.42 ***	.42 ***	.41 **
Social capital:					
Number of groups joined	.29 *	.27 *	.38 *	.21 †	
Total number of members	.54 ***	.55 ***	.56 ***	.49 ***	.56 ***
Frequencies of interactions	.84 ***	.83 ***	.82 ***	.81 ***	.84 ***
Intimacy with members	.79 ***	.79 ***	.78 ***	.80 ***	.82 ***
Satisfaction with members	.94 ***	.94 ***	.93 ***	.94 ***	.94 ***
Online social capital:					
Number of groups joined	.62 ***	.61 ***	.61 ***	.58 ***	.53 ***
Total number of members	.77 ***	.77 ***	.78 ***	.77 ***	.77 ***
Frequencies of interactions	.90 ***	.90 ***	.90 ***	.90 ***	.89 ***

Table 6 (continued)

Constructs (Cronbach's a)	Overall ($n = 409$)	Twitter Only ($n = 354$)	LINE + Twitter ($n = 316$)	Instagram + Twitter ($n = 270$)	Discord + Twitter ($n = 101$)
Intimacy with members	.85 ***	.85 ***	.84 ***	.86 ***	.81 ***
Satisfaction with members	.95 ***	.95 ***	.95 ***	.95 ***	.95 ***
Personality traits					
Generalized trust	.61 ***	.61 ***	.56 ***	.60 ***	.35 †
Social skills	.92 ***	.93 ***	.93 ***	.89 ***	.92 ***
Social tolerance (entire)	.22 †		.23 †	.31 *	.41 †
Social tolerance (others)	.25 *		.27 *	.32 *	.51 **

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$

Table 7 Distribution of class format between Spring 2020 and Spring 2022

Class Format	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022
Recorded online	88.9%	87.2%	87.7%	85.8%	75.3%
Live online	62.0%	64.6%	62.9%	62.3%	49.4%
Face-to-face	10.2%	44.7%	56.8%	59.7%	62.6%

(1) Participants who took at least one class in a respective format were counted towards the total. (2) Record online classes are pre-recorded and can be viewed on demand; Live online classes require students to join the classes online at specific class times; and face-to-face classes are held in person. As Japan did not lock down during COVID-19, universities could offer FTF classes, but the number of classes was significantly reduced. (3) Percentages only consider the time when the participants were university students, i.e., first-year students in 2022 were not included in 2020 and 2021 calculations

generalized trust and social tolerance. Therefore, improving these factors in young adults will help improve their mental health. This study focused on two types of social tolerance: social tolerance toward others and overall social tolerance (which includes tolerance toward family, friends, and older adults). However, only social tolerance toward others had a significant effect on mental health. With increased social tolerance toward others, young adults would be able to accept other people's opinions and avoid unnecessary conflicts. In addition, since perceived physical health only decreases loneliness but does not improve SWB, positive self-perceptions of physical health might decrease the effects of the negative aspects of mental health (i.e., loneliness). However, it might not relate to positive aspects, such as SWB. Therefore, H1 was fully supported in terms of mental health but partly supported for perceived physical health, owing to differences in social media use patterns. These results demonstrate that different aspects of mental health should be considered when examining the relationship between mental and perceived physical health.

For the Instagram + Twitter pattern, personality trait effects on perceived physical health differed from other patterns. This was the third-largest pattern in this study. Instagram is known as a social media platform that can cause addiction owing to people's recognition and social needs [56]. Faelens et al. [57] conducted a meta-analysis of 93 articles on Instagram use and mental health, self-esteem, body image, and disordered eating. They identified four categories to examine their relationships: Instagram membership, use intensity, use type, content, and profile characteristics. They demonstrated the relationships between Instagram use and social comparisons, body image, and disordered eating outcomes, but the findings were inconclusive for other variables. As Table 4 shows, social skills and generalized trust scores in the Instagram + Twitter pattern were the second highest. This pattern's scores for social tolerance (both overall and toward others) were the highest among all patterns. As Table 2 shows, university students use Instagram to post photos and videos, showcase their personal and social lives, share interests, and maintain everyday friendships. This suggests that users with higher levels of social skills, generalized trust, and social tolerance might be more able to receive information about physical health from those they trust, and they may be more tolerant of different perspectives on health issues. This implication is important when examining the relationship between Instagram use and physical and mental health.

Personality traits, social capital, and social media use

Personality traits had positive relationships to social capital formation through FTF communication, which had significant effects on decreasing loneliness but weaker

effects on improving SWB. Furthermore, the effect of social capital on perceived physical health became marginally significant in the Discord + Twitter pattern but was not observed for the Instagram + Twitter pattern. This suggests that, similar to personality traits, forming fruitful social capital via FTF communication can help decrease the negative effects on mental health. However, the effects of social capital on improving positive aspects such as SWB and perceived physical health may differ between patterns. In particular, the effects of FTF social capital on SWB were only marginally significant in the Twitter only and Discord + Twitter patterns. These patterns had the highest levels of visual anonymity and were most frequently used to share common interests, although they were also used to communicate with friends. Even if users have fruitful FTF social capital, the effects on positive mental health aspects, such as SWB, might decrease if they use social media with higher levels of visual anonymity, such as Twitter and Discord. Our results provide further evidence that FTF social capital positively relates to physical health [58].

Additionally, social capital was not related to social media use. The effects of personality traits on social media use were marginally significant in the LINE + Twitter and Discord + Twitter patterns. These results indicate that, unlike middle-aged or older adults, these three social media platforms have become their daily communication tools with their friends (Table 2). This echoes previous research findings that personality traits might have no relationship with using social media platforms, echoing the implications of previous research (e.g., [59]).

FTF social capital and social media use helped users to form more online social capital, which was not related to mental or perceived physical health. However, social media use was negatively related to perceived physical health. These effects were stronger for the Twitter only and Discord + Twitter patterns. Posting frequency on Twitter was the most impactful social media use factor, followed by the number of topics and usage time. Three factors of Internet literacy also had significant effects on social media use, but the effects of information judgment were much weaker than Twitter use. Among the four social media platforms, Twitter has the highest level of visual anonymity and is used to share interests and post photos and videos. This suggests that, even with high levels of online communication skills, operational abilities, and the ability to judge information critically, they are not strong enough to decrease the negative effects of Twitter overuse. Additionally, as social media use was not directly related to SWB or loneliness and considering that young adults' overuse of Twitter stems from their low levels of SWB [60], low SWB among young adults in Japan may affect their Twitter use. This could, in turn, have mediating effects on decreasing perceived physical health. Thus, the negative effects of social media use are not directly related to mental health but are mediated by perceived physical health. Therefore, improving younger generations' SWB will help prevent their overuse of Twitter, which will decrease its negative effects on perceived physical health. As a result, improving SWB will decrease their levels of loneliness.

Furthermore, finding a way to share relevant health information with young adults is essential to follow health advice and to prevent Twitter overuse. However, previous research suggests that people may have difficulty understanding health information because they lack domain knowledge [61]. There are other reasons for these results. For example, as Table 7 shows, the percentage of participants taking online (especially recorded) classes was still higher than FTF immediately before this survey. It is possible that our participants did not get enough physical activity, which may also have led to poor physical health conditions. Future research should explore whether shifting to online work and studying will increase the risk of deteriorating our physical health.

Based on these findings, we conclude that H2 and H3 are partially supported. Regarding H4, our findings also showed a slight difference in the Discord + Twitter pattern compared to other patterns. In particular, this group showed a more significant relationship between FTF and online social capital. This may be because of the characteristics of Discord use in Japan, as young people use Discord to communicate with friends (instead of as a tool for communicating with online gaming friends). This may serve as an extension of their social ties in real life. This strengthens the link between FTF and online social capital.

Finally, compared to the other patterns, the LINE + Twitter pattern had unique characteristics. LINE is a unique platform that is popular in Japan but not in other parts of the world (except Taiwan). It is typically used to connect with family members, close friends, and classmates and is expected to promote SWB and decrease loneliness. However, usage time and post topics were the lowest in the LINE + Twitter pattern compared to the other patterns, while posting frequency was the highest. This may be because of its use in daily communication with family members and close friends. Hence, users need to reply to the messages immediately and frequently, as "read without reply" may lead to LINE bullying. Additionally, research has shown that the more "friends" and "groups" registered on LINE, the more likely it is that negative emotions will easily occur [62]. People who wait for replies to read messages are more likely to have negative emotions than those who wait for replies to unread messages. The second behavior is more

pronounced in highly dependent individuals [63]. LINE has a function to "block" or "delete" friends; however, this might be extremely difficult if communication partners are family members, friends, acquaintances, and classmates involved in users' daily lives. Therefore, users cannot mute or block others as easily as on Twitter or other platforms. Furthermore, the scores for online communication skills and operational abilities for the LINE + Twitter pattern were the lowest among the four patterns. Therefore, their low levels of Internet literacy may make LINE users unable to determine which messages should be prioritized. Therefore, LINE fatigue may occur easily, decreasing its positive effects on mental and physical health.

Research implications

Social skills, generalized trust, and social tolerance toward others need to be improved for young people to form fruitful FTF social capital that can help maintain good mental health. Second, social media use, especially on Twitter, may decrease users' perceived physical health and increase their loneliness. Therefore, reducing Twitter overuse could be one of the solutions to help maintain good perceived physical health and indirectly reduce loneliness. However, as the overuse of Twitter by younger Japanese people stems from their lower levels of SWB, as shown in previous research [60], improving their SWB is another critical consideration.

Limitations and future research directions

This study was limited by the small sample size. Our analysis could only explore four patterns (Twitter only, Twitter + LINE, Instagram + Twitter, and Discord + Twitter). As LINE is unique to Japan, Twitter is less widely used than in other countries. Japanese youth use Discord quite differently from other countries. Hence, the study's implications may not apply to other countries with cultural differences. Longitudinal and experimental studies are necessary to improve the robustness of our findings. Further research should analyze more social media platforms, including those widely used worldwide. A larger sample size is necessary, and the research should be expanded to multiple countries to compare participants from various cultural and ethnic backgrounds. Considering TikTok in future analyses is necessary, as prior research has reported its addiction risk and probable impact on both mental and physical health [44].

The directions described in the structural equation model were based on results from previous studies. It is possible that these directions may differ between the variables as this is a cross-sectional study. While the analysis considered the effects of social media use on perceived physical health, there might be other factors contributing to perceived physical health, such as regular exercise, diet, and extracurricular activities. However, as this study was conducted during the COVID-19 pandemic, we could not examine these factors. Therefore, future research should investigate these factors further.

Furthermore, the physical health assessment was based on the participants' self-reported perceptions. Although perceived physical health may be a proxy for physical health, future research should use physical health data (e.g., data obtained from annual medical examinations) to explore the relationships predicted by our model. Finally, more diverse age groups and social backgrounds should be considered. Information literacy skills may differ by age and social background, and these insights can support better public health policies to improve people's physical and mental health.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40359-024-02278-4.

Supplementary Material 1.

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Institutional review board statement
In accordance with the Declaration of Helsinki, the survey was conducted with the approval of the Research Ethics Review Committee at the Faculty of Library, Information, and Media Science, University of Tsukuba, Japan (No. 22–47, approved on July 26, 2022).

Informed consent statement
Informed consent was obtained from all participants involved in the study.

Authors' contributions
SY and KH were responsible for conceptualization, software, validation, writing and editing, and visualization. SY was responsible for investigation, resources, data curation, supervision, and project administration. KH was responsible for formal analysis. All authors have read and agreed to the final version of the manuscript.

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Data availability
The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Consent for publication
No consent is required for publication.

Competing interests
The authors declare no competing interests.

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