

RESEARCH ARTICLE

Who is mentally healthy? Mental health profiles of Japanese social networking service users with a focus on LINE, Facebook, Twitter, and Instagram

Ryota Sakurai^{1*}, Yuta Nemoto¹, Hiroko Mastunaga², Yoshinori Fujiwara¹

1 Research Team for Social Participation and Community Health, Tokyo Metropolitan Institute of Gerontology, Tokyo, Japan, **2** Japan Support Center for Suicide Countermeasures, National Center of Neurology and Psychiatry, Kodaira, Tokyo, Japan

* r_sakurai@hotmail.co.jp**OPEN ACCESS**

Citation: Sakurai R, Nemoto Y, Mastunaga H, Fujiwara Y (2021) Who is mentally healthy? Mental health profiles of Japanese social networking service users with a focus on LINE, Facebook, Twitter, and Instagram. PLoS ONE 16(3): e0246090. <https://doi.org/10.1371/journal.pone.0246090>

Editor: Johan Bollen, Indiana University Bloomington, UNITED STATES

Received: May 1, 2020

Accepted: January 14, 2021

Published: March 3, 2021

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Data Availability Statement: The dataset used is owned by the local government and sharing the data is restricted. Further, our data contains sensitive participant information and cannot be released publicly due to ethicolegal restrictions imposed by the Ethics Committee at Tokyo Metropolitan Institute of Gerontology. Although the authors cannot make the study's data publicly available at the time of publication, all authors commit to make the data underlying the findings described in this study available to those who

Abstract

Background

Both negative and positive associations between social networking service (SNS) usage and mental health have been suggested by previous studies; however, their differences by type of SNS and age remain unclear. We addressed this issue based on the frequency of traditional communication such as face-to-face and non-face-to-face communication (e.g., phone, email, and letters).

Methods

In total, 8,576 individuals participated, including 2,543 aged 18–39, 3,048 aged 40–64, and 2,985 aged over 65 years. They were asked to indicate their frequency of SNS usage, both for posting and checking, of LINE (a popular message application in Japan), Facebook, Twitter, and Instagram, with frequent usage defined as posting or checking more than a few times a week. To determine mental health status, WHO-5 (i.e., well-being), K6 (i.e., distress symptoms), and feelings of loneliness were assessed. Multiple and logistic regression analyses were adjusted for the frequency of traditional communication. To avoid type 1 error, a Bonferroni correction of $p \leq 0.002$ was applied in the regression models ($p = 0.05/18$, a number of regression models).

Results

The most frequently used SNS across the three age groups was LINE; frequent usage (both posting and checking) among older adults was independently associated with better well-being. Frequent posting on Facebook was associated with better well-being in middle-aged adults. Young adults who frequently checked on Instagram showed a tendency toward better well-being and lower distress symptoms. On the contrary, frequent usage of Twitter was associated with distress symptoms or feelings of loneliness across all three age groups.

request the data, in compliance with the PLOS Data Availability policy. Please find contact information where you can direct data inquiries here: kenkyurinri@tmghig.jp (Tokyo Metropolitan Institute of Gerontology Ethics Board).

Funding: Dr. Sakurai was supported by the Grant-in-Aid for Challenging Exploratory Research from JSPS KAKENHI and Dr. Fujiwara was supported by the Grant from Japan Support Center for Suicide Countermeasures to conduct this research. These funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

Conclusions

We found generational and SNS-type-dependent negative and positive associations between SNS use and mental health, indicating the possible influences of SNS use and the importance of non-SNS communication.

Introduction

Social interactions and ties are fundamental components of human life and play an important role in maintaining health. A previous meta-analysis in fact showed that individuals who are more firmly embedded in their social surroundings are healthier than those with relatively thin social ties, an effect that may exceed the effects of other lifestyle factors such as smoking, drinking, and exercise habits [1]. This health impact is likely to be prominent in older adults who are predisposed to functional impairments with aging. Indeed, social isolation, which is an objective and quantifiable reflection of a reduced social network size and lack of social contact, among older adults increased the risk for subsequent all-cause mortality regardless of race [2–4], even among individuals without any physical dysfunction at the baseline [4]. These findings suggest that facilitating social interactions that reduce social isolation can be considered an important health measure, which can be applied globally.

A major current focus on preventing health issues due to poor social networks is whether online social interaction helps maintain mental health. A social networking service (SNS), denoting web-based services used to create social interactions, seems to be a useful tool to communicate and share one's emotions and thoughts with others. Some studies have found beneficial effects of SNS on social capital, social support, and relationship maintenance [5–7], which probably result in sound mental health. However, other studies cast doubt on this prospect; it has been indicated that SNS induced stressful experiences, with the users showing poor well-being [8, 9]. A recent meta-analysis also reported that the adolescents were found to show an association between greater time spent on SNS and higher levels of depression [10].

These conflicting results regarding SNS usage and mental health may be due to the failure to examine the respective frequencies of traditional face-to-face and non-face-to-face communications (e.g., telephone, e-mail, letters). If individuals who have decent social interactions with others use traditional communication channels, they may presumably not be influenced by the negative effect of SNS. Considering that the frequency of traditional communication such as face-to-face and non-face-to-face communication is strongly related to mental health, it is expected that traditional communication confounds (diminishes) the association between SNS usage and mental health.

Furthermore, the types of SNS and their usage (i.e., posting or checking) may also confound the positive and negative effects of SNS. A recent survey investigating the association between the usage of five types of SNS (i.e., YouTube, Twitter, Facebook, Snapchat, and Instagram) and mental health among young adults showed that Instagram was ranked the worst SNS for their young people's mental health [11]. However, extensive findings regarding the effects of SNS on mental health are limited to the findings mainly focusing on either total SNS usage or each SNS usage alone, particularly focusing on young adults [10, 12–14]; thus, the differences in the influence of the type of SNS remains an open research question.

Another pertinent question is the generational differences in SNS usage and its effects. Of special interest are the prevalence and characteristics of SNS usage among older adults. Some studies of older adults and SNS have focused on the usability analysis and case studies on online social networks [15–19]. Although a previous study suggested an association between higher frequency of technology usage for social connection (defined by the total usage of e-

mail, SNS [e.g., Facebook or Twitter], and online video or phone calls [e.g., Skype]) and better mental health [20], the influence of the type of SNS on mental health among older individuals and the confounding effect of traditional communication on such association have been poorly known. Indeed, the literature concerning the association of SNS usage with mental health has been mainly limited to adolescents [10, 12].

As outlined, there has been no consensus on the generational and SNS-type-dependent negative and positive associations between SNS use and mental health. In this study, we sought to extend the current findings by examining the mental characteristics of people who regularly use SNS. More specifically, we focused on the posting and checking on LINE (a popular message application in Japan), Facebook, Twitter, and Instagram for three generations (young, middle-aged, and older adults) to elucidate whether (1) the association between SNS usage and mental health varies by the type of service and generation, and (2) whether each association is independent of the frequency of traditional communication, such as face-to-face and non-face-to-face communication (e.g., phone, email, and letters), after taking into account the possession rate of communication devices for SNS purposes. The findings of the present study may contribute towards balancing the potential benefits and harms of social media use.

Materials and methods

Participants

Data were collected from the second wave of an ongoing prospective survey intended to assess the health policy of a municipality. From September to November 2019, we conducted a mail survey of residents aged 18 years and older in a town located in central Tokyo, Japan (with a working-age population ranging between 15 and 64 years constituting 168,925 people and an old-age population of 65 years and above constituting 56,378 people as of April 2019) based on the basic resident register. The sample of this survey was randomly selected, excluding people of foreign nationality, institutionalized older adults, and those who had been registered as needing above Care Level 4 of the national long-term care insurance system (i.e., considered dependent in the basic activities of daily living, such as toileting or feeding). We also sent a questionnaire to 3,842 individuals who responded in a baseline survey in 2016 that was conducted in the same manner as the present survey. In total, we sent a questionnaire to 21,300 individuals (3,842 previous respondents in the first wave and 17,458 newly selected sample) in the current survey.

The study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. Ethics approval was obtained from the Tokyo Metropolitan Institute of Gerontology. Informed consent was obtained at enrollment in accordance to the protocols approved by the local institutional review board.

Questionnaires

Possession of communication devices and SNS usage. First, the possession rates of communication devices, including a flip phone, smartphone, tablet, and computer were assessed, and having a device except the flip phone was used to define the holder of a communication device for SNS purposes. Participants were then asked about their frequency of usage of each SNS, including LINE, Facebook, Twitter, and Instagram, separately. The question on usage was divided into posting and checking. The responses were categorized as: (1) *every day*, (2) *a few times a week*, (3) *a few times a month*, and (4) *no use*. A frequent usage of each SNS was defined as usage of more than a few times a week (see [S1 Table](#)).

Mental health. In the present study, we defined mental health status using WHO-5, K6, and feelings of loneliness. WHO-5 is a short generic global rating scale measuring subjective

well-being. The scale has adequate validity as both a screening tool for depression and an outcome measure in clinical trials for Japanese samples [21]. The respondents were asked to rate how well each of the five statements applied to them within the last 14 days. Each of the five items is rated from 5 (*all of the time*) to 0 (*none of the time*). The scores for these subscales ranged from 0 to 25, with lower scores indicating lower well-being.

K6, which contains six items on depression and anxiety, is a previously validated questionnaire for measuring distress symptoms among Japanese sample, including overall worries and more somatic complaints [22, 23]. The respondents were asked to rate how well each of the six statements was applied within the last 30 days. Response categories included five categories from *all of the time* to *none of the time*, and the total score ranged from 0 to 24, with higher scores indicating greater distress and depressive symptoms.

Feelings of loneliness were measured using a single item, which is widely used [24]: “How often do you feel isolated from the community?” and the responses were categorized as (1) *very often*, (2) *quite often*, (3) *not very often*, and (4) *never*. Participants were then assigned to either the loneliness (*very often* and *quite often*) or non-loneliness (*not very often* and *never*) groups. It has been suggested that the lack of perception of being socially connected results in loneliness [25], which is a well-known risk factor for adverse health outcomes.

Covariates for the association between SNS usage and outcomes. Gender, age, level of education (low-level education ≤ 9), living arrangement (living alone or not), presence of chronic disease, subjective health, subjective financial status, frequency of going outdoors, and frequency of traditional communication with others were introduced as covariates. The level of instrumental activity of daily living (IADL), an indicator of the ability to live independently in a community, was assessed on only older adults as a covariate.

The presence of chronic disease was assessed, and those with at least one chronic disease (e.g., hypertension, heart disease, cerebrovascular disorder, and diabetes mellitus) were defined as having a chronic disease. Subjective health was assessed as *excellent*, *good*, *fair*, or *poor*; participants were then assigned to either the good (*excellent* or *good*) or poor (*fair* or *poor*) groups. Their subjective financial situation was determined based on a method used in a previous study [26]. Participants were asked to respond to a question regarding financial leeway with five choices, ranging from *I have much financial leeway* to *My finances are very tight*. Participants were then classed as having a moderate (*I have much financial leeway* to *Average*) or poor (*My finances are tight* to *My finances are very tight*) financial situation. For the frequency of going outdoors, high (*go out every day*) or low (*go out every few days or less*) frequency of going outdoors daily was assessed. IADL for older adults was evaluated using the IADL subscale of the Tokyo Metropolitan Institute of Gerontology Index of Competence [27], a questionnaire assessing the ability to (1) use public transportation independently, (2) shop for daily necessities, (3) prepare meals independently, (4) pay bills, and (5) manage banking independently.

For the frequency of traditional communication with others, the participants were asked about the frequency of both face-to-face and non-face-to-face (e.g., telephone, e-mail, letters) interactions with others, in addition to those practiced through SNS. The responses were then categorized as (1) *every day*, (2) *4–5 times a week*, (3) *2–3 times a week*, (4) *once a week*, (5) *2–3 times a month*, (6) *once a month*, (7) *less than once a month*, or (8) *no contact*. Based on previous studies, we defined poor traditional communication (i.e., social isolation) as having contact with anyone for less than once a week [4, 28–30].

Data analysis

We classified the possession rate of a communication device into the following three groups: having a communication device for SNS purposes, having a communication device for non-

SNS purposes, and having nothing. Similarly, the frequency of usage of each SNS (LINE, Facebook, Twitter, and Instagram) was summarized to confirm the rate of frequent usage of each SNS.

Multiple regression analyses of poor well-being (assessed by WHO-5) and distress symptoms (assessed by K6) and logistic regression analysis on the feelings of loneliness were run separately for three age groups (i.e., young adults aged 18–39, middle-aged adults aged 40–64, and older adults aged over 65 years) to assess the association with frequent usage of each SNS, separately for checking and posting. Each mental health variable was the dependent variable and each SNS usage was the independent variable; in total, we ran 18 models (three dependent variables by three age groups via two types of usage [posting and checking]). The percentage of participants for whom covariates were missing across each variable ranged from 0 to 3.9% for young adults, 0 to 2.6% for middle-aged adults, and 0 to 4.1% for older adults. The percentages of those with one or more missing measurements were 8.7% for young adults, 7.3% for middle-aged adults, and 14.5% for older adults. Missing values among covariates were imputed by multiple imputation, which allowed us to draw inferences for multivariate estimates from a dataset with missing values, with fully conditional specification. The imputation model consisted of the variables included in the regression analyses described above; 50 imputed datasets with missing values were created and regression analyses were then performed separately for each age group. Each model was adjusted for gender, age, level of education, living arrangement, comorbidity, subjective health, subjective financial status, frequency of going outdoors, IADL level (only in older adults), and poor traditional communication. In this case, participants who did not have any communication devices for SNS purposes were regarded as those who never used a given SNS. To avoid type 1 error, a Bonferroni correction of $p < 0.002$ was applied in the regression models ($p = 0.05/18$, a number of regression models). All statistical analyses were performed using PC-compatible IBM SPSS version 23.0 (SPSS Inc., Chicago, IL, USA).

Results

Respondents' characteristics, possession rate of communication device, and SNS usage

Of the 21,300 questionnaires mailed, 9,250 responded in the survey (response rate, 43.4%), of which 49 constituted unparseable data (e.g., the identification number was broken). We excluded 408 participants owing to incomplete data regarding the possession of a communication device. In total, 8,793 respondents were analyzed for the possession rate of a communication device. Furthermore, 217 of these were incomplete on SNS usage and main outcomes (i.e., WHO-5, K6, and feelings of loneliness), and thus 8,576 participants, consisting of 2,543 young, 3,048 middle-aged, and 2,985 older adults, were included in the analysis of the mental health profiles of SNS users (Fig 1).

Table 1 shows the demographic and lifestyle characteristics of respondents by age group. There was not much difference in the gender ratio among the three age groups, and the mean age of each age group was 29.7 for young adults, 51.9 for middle-aged adults, and 74.7 for older adults. Overall, our participants had a high education level. While the percentage of participants with each chronic disease tended to be higher in the senior group, the percentage of participants with poor mental health (i.e., poor well-being, distress symptoms, and feelings of loneliness) tended to be higher in the younger group.

Fig 2 shows the possession rate of a communication device that can use SNS by age group. More than 95% of young and middle-aged adults had a communication device for SNS purposes. Furthermore, even older adults showed a relatively high possession rate (62.3%), whereas the possession rate gradually decreased after age 70 (35% for those in their 80s; see S1 Fig).

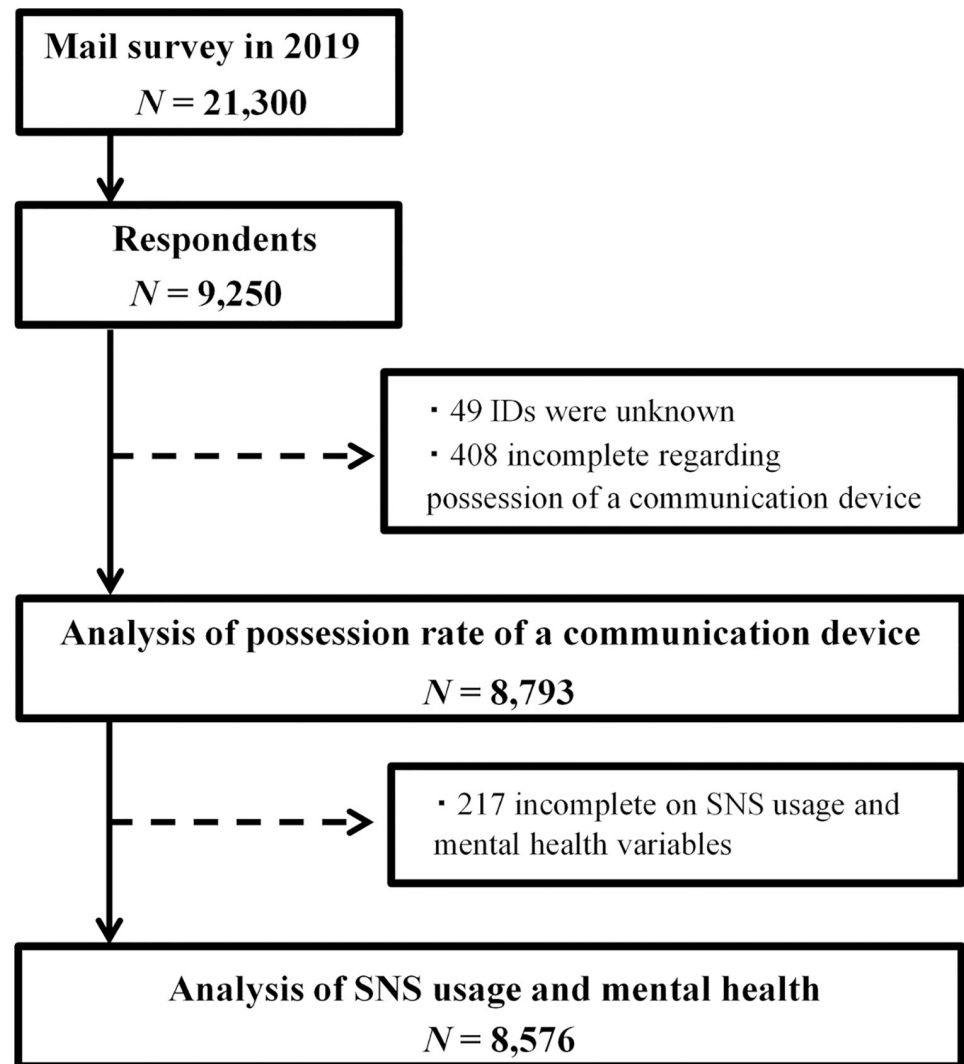


Fig 1. Schematic diagram of the selection of study participants.

<https://doi.org/10.1371/journal.pone.0246090.g001>

Fig 3 shows the prevalence of SNS usage. The most frequently used SNS was LINE, both in terms of posting and checking among all generations, followed by Twitter, Instagram, and Facebook. This is true for those of older age, and half of those in their 60s and one-third of those in their 70s used LINE (see S2 Fig). Only middle-aged adults showed higher Facebook usage than Twitter usage.

The association between SNS usage and well-being

Table 2 shows the results of the multiple regression model for the association between SNS usage and well-being status, which is assessed by WHO-5 for three age groups.

Frequent checking of Instagram among young adults was independently associated with higher well-being (B: 0.89; 95% confidence interval [CI]: 0.43, 1.36; $p < .001$). Middle-aged adults who frequently posted on Facebook showed higher well-being, which is independent of the frequency of traditional conversation (B: 1.00; 95% CI: 0.15, 1.84; $p = .002$). For older

Table 1. Characteristics of the analysis objects of SNS usage.

Variables	Young adults (aged 18–39 yr.)		Middle-aged adults (aged 40–64 yr.)		Older adults (aged 65–97 yr.)	
	<i>n</i>	Statistics	<i>n</i>	Statistics	<i>n</i>	Statistics
Female, <i>n</i> (%)	2543	1524 (59.9)	3048	1697 (55.7)	2985	1632 (54.7)
Age, mean (SD)	2543	29.7 (6.7)	3048	51.9 (7.1)	2985	74.7 (6.6)
Low-level education, ^a <i>n</i> (%)	2445	47 (1.9)	2969	58 (2.0)	2861	428 (15.0)
Living alone, <i>n</i> (%)	2543	312 (12.3)	3048	322 (10.6)	2985	567 (19.0)
Having chronic disease, <i>n</i> (%)	2464	327 (13.3)	2976	1052 (35.3)	2917	2132 (73.1)
Poor communication, ^b <i>n</i> (%)	2521	660 (26.2)	3011	973 (32.3)	2882	621 (21.5)
Subjective health, poor, <i>n</i> (%)	2523	252 (10.0)	3026	451 (14.9)	2877	693 (24.1)
Low frequency of going outdoors, ^c <i>n</i> (%)	2536	323 (12.7)	3035	400 (13.2)	2952	1133 (38.4)
Subjective financial status, poor, <i>n</i> (%)	2501	603 (24.1)	3009	746 (24.8)	2917	587 (20.1)
WHO-5 (/25), mean (SD)	2543	13.2 (5.4)	3048	12.9 (5.4)	2985	14.2 (5.6)
K6 (/24), mean (SD)	2543	5.3 (5.0)	3048	4.5 (4.3)	2985	4.1 (4.0)
Having feelings of loneliness, <i>n</i> (%)	2543	424 (20.0)	3048	468 (18.1)	2985	398 (15.4)

^a Years of education ≤ 9 .

^b Individuals who had contact less than once a week with others through traditional communication, such as face-to-face and non-face-to-face (e.g., telephone, e-mail, letters) communication.

^c Individuals who went out once every 2–3 days or less.

<https://doi.org/10.1371/journal.pone.0246090.t001>

adults, both frequent posting and checking on LINE were independently associated with better well-being (B: 0.85; 95% CI: 0.41, 1.29; $p < .001$ and β : 0.97; 95% CI: 0.51, 1.42; $p < .001$).

The association between SNS usage and distress symptoms

Table 3 shows the results of the multiple regression model for the association between SNS usage and distress symptoms assessed by K6 for three age groups. Frequent checking on

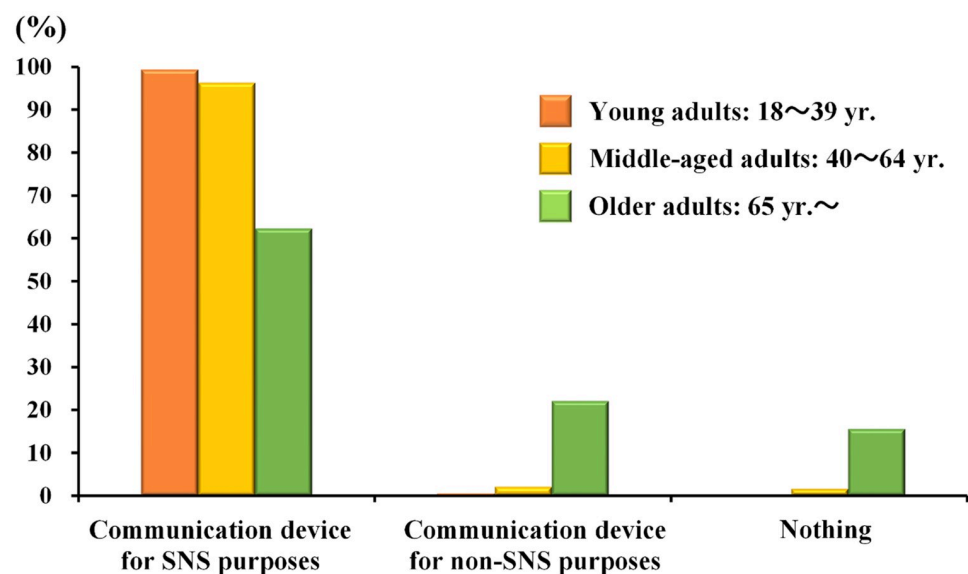


Fig 2. Possession rate of communication devices for SNS purposes across three generations. *Communication device for non-SNS purpose includes individuals who have only flip phones.

<https://doi.org/10.1371/journal.pone.0246090.g002>

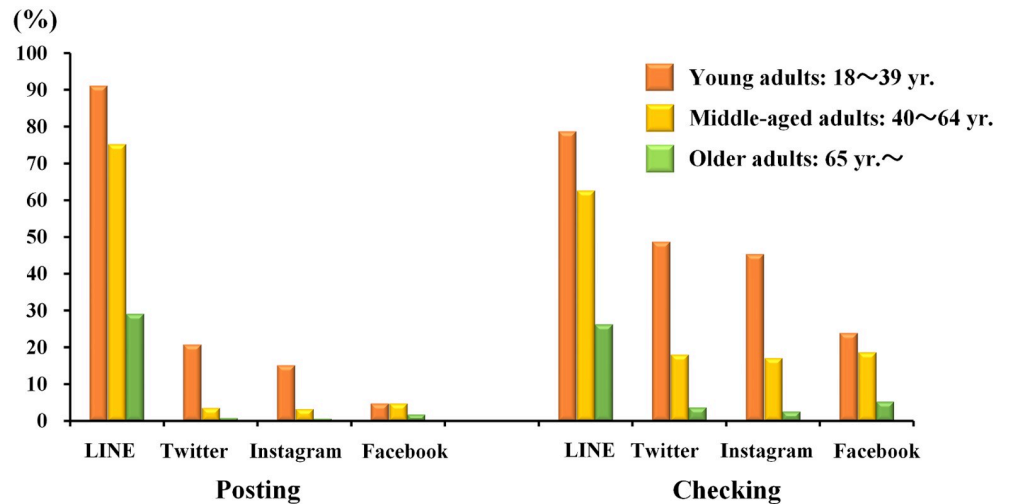


Fig 3. Prevalence of frequent SNS users for each SNS application across three generations. *Frequent usage of each SNS was defined as usage of more than a few times a week. Infrequent users include participants who did not have any communication devices for SNS purposes.

<https://doi.org/10.1371/journal.pone.0246090.g003>

Instagram was independently associated with lower distress symptoms (B: -0.88; 95% CI: -1.30, -0.45; $p < .001$), whereas both frequent posting and checking on Twitter were associated with greater distress symptoms among young adults (B: 0.83; 95% CI: 0.34, 1.32; $p = .001$ and B: 0.72; 95% CI: 0.33, 1.12; $p < .001$). Middle-aged adults who frequently posted on LINE

Table 2. Multiple regression analysis examining the association between SNS usage[†] and poor well-being detected by WHO-5.

Independent variables	Young adults (n = 2543)		Middle-aged adults (n = 3048)		Older adults (n = 2985)	
	B (95% CI)	p-value	B (95% CI)	p-value	B (95% CI)	p-value
Posting						
LINE	0.59 (-0.15, 1.33)	.118	0.54 (0.11, 0.97)	.015	0.85 (0.41, 1.29)	< .001
Facebook	1.45 (0.47, 2.43)	.004	1.00 (0.15, 1.84)	.002	2.14 (0.57, 3.70)	.007
Twitter	-0.52 (-1.05, 0.02)	.059	0.41 (-0.59, 1.41)	.423	0.35 (-2.14, 2.85)	.782
Instagram	0.89 (0.27, 1.51)	.005	0.78 (-0.31, 1.87)	.161	-0.85 (-3.75, 2.06)	.568
Poor communication ^{††}	-1.67 (-2.14, -1.19)	< .001	-1.71 (-2.11, -1.32)	< .001	-1.40 (-1.87, -0.92)	< .001
Checking						
LINE	0.51 (0.00, 1.02)	.050	0.25 (-0.13, 0.63)	.193	0.97 (0.51, 1.42)	< .001
Facebook	0.28 (-0.21, 0.78)	.263	0.54 (0.04, 1.05)	.035	1.00 (0.05, 1.95)	.039
Twitter	-0.21 (-0.65, 0.22)	.340	0.00 (-0.51, 0.50)	.990	0.26 (-0.85, 1.37)	.643
Instagram	0.89 (0.43, 1.36)	< .001	0.66 (0.10, 1.21)	.020	0.05 (-1.36, 1.46)	.941
Poor communication ^{††}	-1.63 (-2.10, -1.15)	< .001	-1.72 (-2.11, -1.32)	< .001	-1.40 (-1.87, -0.92)	< .001

B indicates unstandardized coefficient. Significant values after applying the Bonferroni correction are in bold.

[†] A value of 1 was given to frequent usage, 0 to infrequent usage.

^{††} Individuals who had contact less than once a week with others through traditional communication, such as face-to-face and non-face-to-face (e.g., telephone, e-mail, letters) communication. A value of 1 was given for poor communication, 0 for non-poor communication.

Each regression model, which was adjusted for covariates (i.e., gender, age, level of education, living arrangement, presence of chronic disease, subjective health, subjective financial status, frequency of going outdoors, frequency of traditional communication with others, and the level of instrumental activity of daily living [only for the group of older adults]), was performed separately for posting and checking on SNS for each age group. All SNS usages were introduced in the same model as the independent variables.

<https://doi.org/10.1371/journal.pone.0246090.t002>

Table 3. Multiple regression analysis examining the association between SNS usage[†] and distress symptoms detected by K6.

Independent variables	Young adults (n = 2543)		Middle-aged adults (n = 3048)		Older adults (n = 2985)	
	B (95% CI)	p-value	B (95% CI)	p-value	B (95% CI)	p-value
<i>Posting</i>						
LINE	-0.76 (-1.43, -0.09)	.026	-0.52 (-0.87, -0.16)	.001	-0.27 (-0.59, 0.06)	.106
Facebook	-0.22 (-1.11, 0.67)	.630	0.07 (-0.63, 0.76)	.854	-0.92 (-2.04, 0.21)	.109
Twitter	0.83 (0.34, 1.32)	.001	0.98 (0.15, 1.80)	.002	1.87 (0.04, 3.69)	.045
Instagram	-0.52 (-1.08, 0.04)	.070	0.66 (-0.23, 1.54)	.148	0.82 (-1.32, 2.95)	.455
Poor communication ^{††}	1.05 (0.61, 1.48)	< .001	0.72 (0.40, 1.04)	< .001	0.63 (0.28, 0.99)	< .001
<i>Checking</i>						
LINE	-0.39 (-0.85, 0.08)	.103	-0.19 (-0.50, 0.13)	.241	-0.31 (-0.65, 0.02)	.066
Facebook	-0.08 (-0.53, 0.37)	.723	0.03 (-0.38, 0.44)	.882	-0.29 (-0.98, 0.40)	.411
Twitter	0.72(0.33, 1.12)	< .001	0.75 (0.34, 1.17)	< .001	0.47 (-0.35, 1.28)	.259
Instagram	-0.88 (-1.30, -0.45)	< .001	-0.27 (-0.72, 0.18)	.235	0.17 (-0.85, 1.18)	.748
Poor communication ^{††}	1.02 (0.59, 1.44)	< .001	0.75 (0.43, 1.07)	< .001	0.62 (0.27, 0.98)	.001

B indicates unstandardized coefficient. Significant values after applying a Bonferroni correction are in bold.

[†] A value of 1 was given to frequent usage, 0 to infrequent usage.

^{††} Individuals who had contact less than once a week with others through traditional communication, such as face-to-face and non-face-to-face (e.g., telephone, e-mail, letters) communication. A value of 1 was given for poor communication, 0 for non-poor communication.

Each regression model, which was adjusted for covariates (i.e., gender, age, level of education, living arrangement, presence of chronic disease, subjective health, subjective financial status, frequency of going outdoors, frequency of traditional communication with others, and the level of instrumental activity of daily living [only for the group of older adults]), was performed separately for posting and checking on SNS for each age group. All SNS usages were introduced in the same model as the independent variables.

<https://doi.org/10.1371/journal.pone.0246090.t003>

showed a tendency toward lower distress symptoms (B: -0.52; 95% CI: -0.87, -0.16; $p = .001$). Significant associations between frequent posting or checking on Twitter and greater distress symptoms was observed, independent of the frequency of traditional conversation (B: 0.98; 95% CI: 0.15, 1.80; $p = .002$ and B: 0.75; 95% CI: 0.34, 1.17; $p < .001$), similar to the young adults. There were no significant associations between SNS usage and distress symptoms assessed by K6 for older adults.

The association between SNS usage and feelings of loneliness

Table 4 shows the results of the logistic regression model for the association between SNS usage and feelings of loneliness by age group. Compared to those with infrequent usage, frequent posting and checking of Twitter among middle-aged adults were both independently associated with higher odds of feelings of loneliness (odds ratio [OR]: 2.22; 95% CI: 1.35, 3.65; $p = .002$; OR: 1.70; 95% CI: 1.28, 2.25; $p < .001$). Similarly, the odds of loneliness tended to be higher in older adults who frequently posted on Twitter (OR: 14.3; 95% CI: 4.00, 51.2; $p < .001$). There were no significant associations between SNS usage and loneliness among young adults.

Poor traditional communication

Low frequency of traditional communication, that is, poor traditional communication, was associated with lower well-being (Table 2), greater distress symptoms (Table 3), and higher odds of feelings of loneliness (Table 4) across all three age groups; however, only the association between poor traditional communication and feelings of loneliness among young adults was not observed.

Table 4. Logistic regression analysis examining the association between SNS usage[†] and feelings of loneliness^{††}.

Independent variables	Young adults (n = 2543)		Middle-aged adults (n = 3048)		Older adults (n = 2985)	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Posting						
LINE	0.99 (0.67–1.46)	.956	1.21 (0.94–1.57)	.137	1.04 (0.78–1.39)	.788
Facebook	0.58 (0.32–1.07)	.081	0.87 (0.50–1.50)	.620	0.52 (0.15–1.85)	.317
Twitter	1.38 (1.04–1.84)	.026	2.22 (1.35–3.65)	.002	14.3 (4.00–51.2)	< .001
Instagram	1.37 (0.98–1.91)	.067	1.27 (0.70–2.31)	.433	0.63 (0.12–3.44)	.599
Poor communication [‡]	1.32 (1.02–1.70)	.033	1.73 (1.38–2.17)	< .001	1.57 (1.20–2.06)	.001
Checking						
LINE	0.95 (0.72–1.26)	.741	1.08 (0.87–1.36)	.481	0.99 (0.73–1.34)	.925
Facebook	1.04 (0.78–1.37)	.809	1.12 (0.83–1.51)	.464	1.13 (0.60–2.16)	.702
Twitter	1.31 (1.03–1.66)	.028	1.70 (1.28–2.25)	< .001	2.06 (1.07–3.96)	.033
Instagram	0.94 (0.73–1.22)	.646	0.78 (0.56–1.08)	.130	0.65 (0.25–1.74)	.397
Poor communication [‡]	1.28 (1.00–1.65)	.051	1.69 (1.35–2.12)	< .001	1.53 (1.17–2.00)	.002

Significant values after applying a Bonferroni correction are in bold.

[†] A value of 1 was given to frequent usage, 0 to infrequent usage.

^{††} A value of 1 was given for 'having a feeling of loneliness', 0 was given for 'not having a feeling of loneliness.'

[‡] Individuals who had contact less than once a week with others through traditional communication, such as face-to-face and non-face-to-face (e.g., telephone, e-mail, letters) communication. A value of 1 was given for poor communication, 0 for non-poor communication.

Each regression model, which was adjusted for covariates (i.e., gender, age, level of education, living arrangement, presence of chronic disease, subjective health, subjective financial status, frequency of going outdoors, frequency of traditional communication with others, and the level of instrumental activity of daily living [only for the group of older adults]), was performed separately for posting and checking on SNS for each age group. All SNS usage was introduced in the same model as the independent variables.

<https://doi.org/10.1371/journal.pone.0246090.t004>

Discussion

Summarizing the key findings

The present study demonstrated generational and SNS-type-dependent associations between SNS use and mental health. There was no common positive association between SNS usage and mental health, independent of the frequency of traditional communication across each generation. However, a negative association between frequent Twitter usage and greater distress symptoms or higher odds of feelings of loneliness was observed. This result might reflect the nature of Twitter, including its higher level of anonymity. Consistent with previous findings [1, 4, 26], the frequency of traditional communication was widely associated with mental health variables across generations, indicating the importance of traditional face-to-face and non-face-to-face (e.g., telephone, e-mail, letters) interactions. However, independent positive associations of better mental health with Instagram use for young adults, with LINE and Facebook use for middle-aged adults, and with LINE use in old adults were confirmed. The findings of the present study suggest that SNS usage may have both benefits and harms, and it is important to strike a balance between communication with and without SNS usage.

Prevalence of SNS usage

As far as we know, there have been few reports about the prevalence of each SNS usage in Asia and Western countries, which was obtained using a survey similar to the one used in the present study to define frequent usage among various generations using similar criteria. Since a number of studies have adopted online surveys and the definition of frequency of usage is vague, the prevalence is somewhat biased. For example, an earlier US online survey of

individuals aged 18 and older using the question, “Which of the following social media platforms do you use in your spare time?,” reported that 34% and 29% of US Internet users accessed Twitter and Instagram, respectively, and Facebook was ranked first with 78% usage rate [31]. An international survey report published in 2018 by the Japanese Ministry of Internal Affairs and Communications [32] reported that the active use of Facebook and Instagram in Japan was much lower than in other countries (the United States, Germany, and the United Kingdom, ranging from 25.9% to 47.7% for Facebook and from 10.2% to 21.0% for Instagram), whereas those of Twitter were comparable (from 8.0% to 16.3%). Further, the prevalence of LINE usage in Japan is reported to be much higher than that in other countries. Considering that each report implies lower usage of each SNS in Japan (except LINE), despite the differences in the methodologies used to demonstrate prevalence, caution should be exercised and the differences in prevalence should be considered when drawing conclusions from our results.

LINE

The association of message application use with mental health has been examined in various ways, however, the results are inconsistent due to the differences in the types of application and the methods used to define their usage [13]. We found that people who use LINE frequently had better mental health, corroborating a prior finding that active Facebook Messenger use may have a positive impact on mental health [33]. Although there was no significant association in young adults, those of middle-aged (association with distress symptoms) and older adults (association with well-being) were observed (Tables 2 and 3). This implies that even middle-aged and older adults who did not (could not) perform traditional forms of communication with others may maintain their mental health by communicating through a messaging application.

A possible explanation for the conflicting results that only young adults did not show an association between frequent usage of LINE and better mental health may be due to the differences in the prevalence of LINE usage across generations. More than three-fourths of young adults in the present study frequently post on LINE. This result indicates that LINE is an available and familiar SNS tool among young adults, and thus, its usage might be too simple to show an association with their mental health. Considering that poor traditional communication was associated with worse mental health in young adults, they might need traditional communication, including face-to-face conversation, in addition to messenger applications, to maintain social relationships, which can maintain good mental health.

Facebook

A significant association between frequent posting, but not checking, on Facebook and better well-being was observed only in middle-aged adults (Table 2). This indicates that middle-aged adults need active communication through Facebook, and passive communication is not enough to maintain that in a better way. This result extends prior findings that only active communicators on Facebook pages showed high levels of received social support [34] and maintenance of their mental health, whereas passive Facebook use led to decreased affective well-being [35].

On the contrary, young adults and older adults did not show an association between Facebook use and mental health, indicating that young and older adults use Facebook as a communication tool, but without showing an influence of maintaining their mental health, unlike the middle-aged adults. Previous studies showed both positive and negative effects of Facebook usage, particularly among young adults [7–9, 12]. These conflicting findings have been

considered to be a result of an inverted U-shaped curve relationship between the number of Facebook friends and perceived social support, which relates to mental health [36, 37]. If we had examined the number of Facebook friends, we might have obtained interesting results regarding Facebook usage and mental health in young and older adults as well as middle-aged adults.

Twitter

No positive effects of frequent usage of Twitter were observed among any of the generations in the present study. On the contrary, frequent usage of Twitter was associated with distress symptoms or feelings of loneliness across all three age groups (Tables 3 and 4). It has been suggested that Twitter is easily used in cyberbullying, ridiculing, and undeserved criticism, which are particularly problematic because of its potential for anonymity and the ease with which a number of others could join in the harassment of victims [38]. A previous survey demonstrated that 28% of Twitter users had experienced cyberbullying [39]. Naturally, not all frequent Twitter users engage in or had experienced cyberbullying, but our results might reflect the nature of Twitter, including its higher level of anonymity.

A previous study comparing the Twitter networks of people expressing loneliness or sadness and those expressing feeling loved and happy showed that people expressing negative emotions on Twitter had smaller networks and notably fewer followers [40]. Although some measure of social support through Twitter has been observed [41], evidence from information credibility perception experiments shows a definite tendency among people to view information shared on Twitter as less credible than the other sources [42]. Feelings of loneliness among frequent Twitter users may thus be attributed to small network size and uncredible information/support owing to its anonymity. This speculation is partly supported by the finding of the present study that a lower frequency of traditional communication was independently associated with feelings of loneliness, providing an indication that another style of social support (or social interaction), including face-to-face support, is needed to prevent loneliness.

Instagram

A recent report by the Royal Society for Public Health in the UK demonstrated that Instagram is the most detrimental SNS for mental health among young adults [11]. However, our study indicated that young adults who frequently check on Instagram showed fine well-being and low distress symptoms. This result is consistent with the previous findings, which suggest that image-based social media use, such as use of Instagram, decreases loneliness and increases happiness and life satisfaction [43]. The ability of Instagram to reduce and mitigate undesirable psychological states and induce positive ones observed in this and previous studies may be due to the ability of images to facilitate social presence [44], resulting in a feeling of connectedness and happiness, which could be similarly transmitted through image-based networks [43]. Although this interpretation seems plausible, it should be noted that only frequent checking was associated with sound mental health in the present study. It remains a challenge for future research to examine the differences posting and checking on image-based social media.

Limitations

Our results came from a large sample with multiple generations and provide an opportunity to balance the potential benefits and harms of social media use. However, there are limitations to be considered when interpreting the results. First, the cross-sectional study design precludes our ability to assess causality. Second, although frequent usage of SNS in the present study was

identified by the number of days of SNS use, for some types of SNS (e.g., Facebook and Instagram), its time usage might have been important to measure the association with mental health. Some previous studies have indicated the danger of SNS addiction, which arises with long usage times per day [45, 46]. If we had included usage time in measurements for some SNS, we might have found a similar impressive result for age-related differences in the association between SNS usage and mental health. Third, we assessed the feelings of loneliness by using a question on the Likert scale, which is limited to measuring the different levels of feelings of loneliness. The difference in culture could also affect the sensitivity of our questionnaire assessing loneliness because of the nature of the Likert scale. Fourth, similar to other mail surveys, comorbidity was assessed by self-report and not clinically assessed. Finally, caution should be exercised when generalizing our results, as the prevalence of each SNS usage may vary across countries and depend on their culture. The issue of whether our findings can be confirmed in other cohorts must be examined in future studies.

Conclusion

The present study demonstrated generational and SNS-type-dependent associations between SNS use and mental health. These associations indicate both benefits and harms, and it is important to balance communication with and without SNS usage. Based on the findings of the present study, people need to be equipped with the respective tools and knowledge to not only be able to navigate social media platforms in a positive way, but also in such a way as to promote good mental health. On the other hand, our results can also provide a window on the importance of traditional communication, such as face-to-face conversation. Since SNS usage is likely to change over time, the association between usage and health status should be investigated in future studies.

Supporting information

S1 Table. Questionnaires for SNS usage.

(DOCX)

S1 Fig. Possession rate of communication devices for SNS purposes across seven generations. *Communication device for non-SNS purpose includes individuals who have only flip phones.

(TIF)

S2 Fig. Prevalence of frequent SNS users for each SNS application across seven generations. *Frequent usage of each SNS was defined as usage of more than a few times a week.

(TIF)

Acknowledgments

Our gratitude goes to Dr. Kimi Estela Kobayashi-Cuya for her help in editing the final version of the manuscript. The authors also acknowledge the continued efforts in the management of survey by Fuchu Health Care Center.

Author Contributions

Conceptualization: Ryota Sakurai, Yoshinori Fujiwara.

Data curation: Ryota Sakurai, Yuta Nemoto, Hiroko Mastunaga.

Formal analysis: Ryota Sakurai.

Funding acquisition: Ryota Sakurai, Yoshinori Fujiwara.

Investigation: Ryota Sakurai, Yuta Nemoto.

Methodology: Ryota Sakurai, Yuta Nemoto, Hiroko Mastunaga, Yoshinori Fujiwara.

Project administration: Ryota Sakurai, Yoshinori Fujiwara.

Supervision: Ryota Sakurai, Yoshinori Fujiwara.

Writing – original draft: Ryota Sakurai.

Writing – review & editing: Ryota Sakurai, Yuta Nemoto, Yoshinori Fujiwara.

References

- Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review. *PLoS medicine*. 2010; 7(7):e1000316. Epub 2010/07/30. <https://doi.org/10.1371/journal.pmed.1000316> PMID: 20668659.
- Hanson BS, Isacson SO, Janzon L, Lindell SE. Social network and social support influence mortality in elderly men. The prospective population study of "Men born in 1914," Malmö, Sweden. *American journal of epidemiology*. 1989; 130(1):100–11. Epub 1989/07/01. <https://doi.org/10.1093/oxfordjournals.aje.a115301> PMID: 2787102.
- LaVeist TA, Sellers RM, Brown KA, Nickerson KJ. Extreme social isolation, use of community-based senior support services, and mortality among African American elderly women. *American journal of community psychology*. 1997; 25(5):721–32. Epub 1998/03/05. <https://doi.org/10.1023/a:1024643118894> PMID: 9485581.
- Sakurai R, Yasunaga M, Nishi M, Fukaya T, Hasebe M, Murayama Y, et al. Co-existence of social isolation and homebound status increase the risk of all-cause mortality. *International psychogeriatrics*. 2019; 31(5):703–11. Epub 2018/07/20. <https://doi.org/10.1017/S1041610218001047> PMID: 30022745.
- Ellison NB, Steinfield C, Lampe C. The Benefits of Facebook "Friends:" Social Capital and College Students' Use of Online Social Network Sites. *Journal of Computer-Mediated Communication*. 2007; 12(4):1143–68. <https://doi.org/10.1111/j.1083-6101.2007.00367.x>
- McEwan B. Sharing, Caring, and Surveilling: An Actor–Partner Interdependence Model Examination of Facebook Relational Maintenance Strategies. *Cyberpsychology, Behavior, and Social Networking*. 2013; 16(12):863–9. <https://doi.org/10.1089/cyber.2012.0717> PMID: 23962125.
- Nabi RL, Prestin A, So J. Facebook Friends with (Health) Benefits? Exploring Social Network Site Use and Perceptions of Social Support, Stress, and Well-Being. *Cyberpsychology, Behavior, and Social Networking*. 2013; 16(10):721–7. <https://doi.org/10.1089/cyber.2012.0521> PMID: 23790356.
- Fox J, Moreland JJ. The dark side of social networking sites: An exploration of the relational and psychological stressors associated with Facebook use and affordances. *Computers in Human Behavior*. 2015; 45:168–76. <https://doi.org/10.1016/j.chb.2014.11.083>.
- Kross E, Verduyn P, Demiralp E, Park J, Lee DS, Lin N, et al. Facebook use predicts declines in subjective well-being in young adults. *PloS one*. 2013; 8(8):e69841. Epub 2013/08/24. <https://doi.org/10.1371/journal.pone.0069841> PMID: 23967061.
- Vidal C, Lhaksampa T, Miller L, Platt R. Social media use and depression in adolescents: a scoping review. *International review of psychiatry (Abingdon, England)*. 2020;1–19. Epub 2020/02/18. <https://doi.org/10.1080/09540261.2020.1720623> PMID: 32065542.
- Cramer S, Inkster B. Social media and young peoples' mental health and wellbeing. 2017 [cited 2020 March 31]. <https://www.rsph.org.uk/uploads/assets/uploaded/d125b27c-0b62-41c5-a2c0155a8887cd01.pdf>
- Frost RL, Rickwood DJ. A systematic review of the mental health outcomes associated with Facebook use. *Computers in Human Behavior*. 2017; 76:576–600. <https://doi.org/10.1016/j.chb.2017.08.001>.
- Montag C, Becker B, Gan C. The Multipurpose Application WeChat: A Review on Recent Research. *Frontiers in Psychology*. 2018; 9(2247). <https://doi.org/10.3389/fpsyg.2018.02247> PMID: 30618894
- Lefebvre RC, Bornkessel AS. Digital Social Networks and Health. *Circulation*. 2013; 127(17):1829–36. <https://doi.org/10.1161/CIRCULATIONAHA.112.000897> PMID: 23630086
- Campos W, Martinez A, Sanchez W, Estrada H, Castro-Sánchez NA, Mujica D. A Systematic Review of Proposals for the Social Integration of Elderly People Using Ambient Intelligence and Social Networking Sites. *Cognitive Computation*. 2016; 8(3):529–42. <https://doi.org/10.1007/s12559-016-9382-z>

16. Tsai T-H, Chang H-T, Wong AM-K, Wu T-F, editors. *Connecting Communities: Designing a Social Media Platform for Older Adults Living in a Senior Village* 2011; Berlin, Heidelberg: Springer Berlin Heidelberg.
17. Garattini C, Wherton J, Prendergast D. Linking the lonely: an exploration of a communication technology designed to support social interaction among older adults. *Universal Access in the Information Society*. 2012; 11(2):211–22. <https://doi.org/10.1007/s10209-011-0235-y>
18. Kötteritzsch A, Weyers B. Assistive Technologies for Older Adults in Urban Areas: A Literature Review. *Cognitive Computation*. 2016; 8(2):299–317. <https://doi.org/10.1007/s12559-015-9355-7>
19. Chen Y-RR, Schulz PJ. The Effect of Information Communication Technology Interventions on Reducing Social Isolation in the Elderly: A Systematic Review. *J Med Internet Res*. 2016; 18(1):e18. <https://doi.org/10.2196/jmir.4596> PMID: 26822073
20. Chopik WJ. The Benefits of Social Technology Use Among Older Adults Are Mediated by Reduced Loneliness. *Cyberpsychology, behavior and social networking*. 2016; 19(9):551–6. Epub 2016/08/20. <https://doi.org/10.1089/cyber.2016.0151> PMID: 27541746.
21. Awata S, Bech P, Koizumi Y, Seki T, Kuriyama S, Hozawa A, et al. Validity and utility of the Japanese version of the WHO-Five Well-Being Index in the context of detecting suicidal ideation in elderly community residents. *International psychogeriatrics*. 2007; 19(1):77–88. Epub 2006/09/15. <https://doi.org/10.1017/S1041610206004212> PMID: 16970832.
22. Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand SL, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological medicine*. 2002; 32(6):959–76. Epub 2002/09/07. <https://doi.org/10.1017/s0033291702006074> PMID: 12214795.
23. Furukawa TA, Kawakami N, Saitoh M, Ono Y, Nakane Y, Nakamura Y, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *International journal of methods in psychiatric research*. 2008; 17(3):152–8. Epub 2008/09/04. <https://doi.org/10.1002/mpr.257> PMID: 18763695.
24. Luanaigh CO, Lawlor BA. Loneliness and the health of older people. *International journal of geriatric psychiatry*. 2008; 23(12):1213–21. Epub 2008/06/10. <https://doi.org/10.1002/gps.2054> PMID: 18537197.
25. Cacioppo JT, Patrick W. *Loneliness: Human nature and the need for social connection*. New York, NY, US: W W Norton & Co; 2008. xiv, 317–xiv, p.
26. Sakurai R, Kawai H, Suzuki H, Kim H, Watanabe Y, Hirano H, et al. Poor Social Network, Not Living Alone, Is Associated With Incidence of Adverse Health Outcomes in Older Adults. *Journal of the American Medical Directors Association*. 2019; 20(11):1438–43. Epub 2019/04/20. <https://doi.org/10.1016/j.jamda.2019.02.021> PMID: 31000349.
27. Koyano W, Shibata H, Nakazato K, Haga H, Suyama Y. Measurement of competence: reliability and validity of the TMIG Index of Competence. *Archives of gerontology and geriatrics*. 1991; 13(2):103–16. Epub 1991/09/01. [https://doi.org/10.1016/0167-4943\(91\)90053-s](https://doi.org/10.1016/0167-4943(91)90053-s) PMID: 15374421.
28. Fujiwara Y, Nishi M, Fukaya T, Hasebe M, Nonaka K, Koike T, et al. Synergistic or independent impacts of low frequency of going outside the home and social isolation on functional decline: A 4-year prospective study of urban Japanese older adults. *Geriatrics & gerontology international*. 2016. Epub 2016/01/23. <https://doi.org/10.1111/ggi.12731> PMID: 26799166.
29. Kobayashi E, Fujiwara Y, Fukaya T, Nishi M, Saito M, Shinkai S. Social support availability and psychological well-being among the socially isolated elderly. Differences by living arrangement and gender. [Nihon koshu eisei zasshi] *Japanese journal of public health*. 2011; 58(6):446–56. Epub 2011/10/06. PMID: 21970078.
30. Ejiri M, Kawai H, Fujiwara Y, Ihara K, Watanabe Y, Hirano H, et al. Social participation reduces isolation among Japanese older people in urban area: A 3-year longitudinal study. *PloS one*. 2019; 14(9):e0222887. Epub 2019/09/21. <https://doi.org/10.1371/journal.pone.0222887> PMID: 31539403.
31. Statista. Reach of selected social networks in the United States as of February 2017 2017 [cited 2020 April 12]. <https://www.statista.com/statistics/183682/us-social-media-website-ranking-by-number-of-users-logged-on/>.
32. Ministry of Internal Affairs and Communications. *The White Paper on Information and Communications in Japan*. 2018.
33. Frison E, Eggermont S. Exploring the Relationships Between Different Types of Facebook Use, Perceived Online Social Support, and Adolescents' Depressed Mood. *Social Science Computer Review*. 2016; 34(2):153–71. <https://doi.org/10.1177/0894439314567449>
34. Ballantine PW, Stephenson RJ. Help me, I'm fat! Social support in online weight loss networks. *Journal of Consumer Behaviour*. 2011; 10(6):332–7. <https://doi.org/10.1002/cb.374>

35. Verduyn P, Lee DS, Park J, Shablack H, Orvell A, Bayer J, et al. Passive Facebook usage undermines affective well-being: Experimental and longitudinal evidence. *Journal of experimental psychology General*. 2015; 144(2):480–8. Epub 2015/02/24. <https://doi.org/10.1037/xge0000057> PMID: 25706656.
36. Tong ST, Van Der Heide B, Langwell L, Walther JB. Too Much of a Good Thing? The Relationship between Number of Friends and Interpersonal Impressions on Facebook. *Journal of Computer-Mediated Communication*. 2008; 13(3):531–49. <https://doi.org/10.1111/j.1083-6101.2008.00409.x>
37. Kim J, Lee JE. The Facebook Paths to Happiness: Effects of the Number of Facebook Friends and Self-Presentation on Subjective Well-Being. *Cyberpsychology, Behavior, and Social Networking*. 2011; 14(6):359–64. <https://doi.org/10.1089/cyber.2010.0374> PMID: 21117983.
38. Glenn S, Diane F. The Social Networks of Cyberbullying on Twitter. *International Journal of Technoethics (IJT)*. 2017; 8(2):1–15. <https://doi.org/10.4018/IJT.2017070101>
39. Ditch the Label. The Annual Cyberbullying Survey 2013 [cited 2020 April 10]. <https://www.ditchthelabel.org/wp-content/uploads/2016/07/cyberbullying2013.pdf>.
40. Al-Saggaf Y, Utz S, Lin R, editors. Expressing feelings on Twitter and network size 2016.
41. Sophia A. Analysis of Tweets Related to Cyberbullying: Exploring Information Diffusion and Advice Available for Cyberbullying Victims. *International Journal of Cyber Behavior, Psychology and Learning (IJCBL)*. 2015; 5(4):31–52. <https://doi.org/10.4018/IJCBL.2015100103>
42. Schmierbach M, Oeldorf-Hirsch A. A Little Bird Told Me, So I Didn't Believe It: Twitter, Credibility, and Issue Perceptions. *Communication Quarterly*. 2012; 60(3):317–37. <https://doi.org/10.1080/01463373.2012.688723>
43. Pittman M, Reich B. Social media and loneliness: Why an Instagram picture may be worth more than a thousand Twitter words. *Computers in Human Behavior*. 2016; 62:155–67. <https://doi.org/10.1016/j.chb.2016.03.084>.
44. Sundar SS. The MAIN Model: A Heuristic Approach to Understanding Technology Effects on Credibility. In: Metzger MJ, Flanagin AJ, editors. *Digital media, youth, and credibility*. Cambridge, MA: The MIT Press; 2008.
45. Schou Andreassen C, Pallesen S. Social Network Site Addiction—An Overview. *Current Pharmaceutical Design*. 2014; 20(25):4053–61. <https://doi.org/10.2174/13816128113199990616> PMID: 24001298
46. Andreassen CS. Online Social Network Site Addiction: A Comprehensive Review. *Current Addiction Reports*. 2015; 2(2):175–84. <https://doi.org/10.1007/s40429-015-0056-9>