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Associations between smartphone use and mental health and well-being among young Swiss men

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ABSTRACT

Background and aims: Intense use of smartphones is associated with mental health problems and low well-being. However, little is known about the mental health and well-being of non- and low-level users. This study investigated the possibly non-linear associations between time spent using a smartphone, including non-users, and mental health and well-being among young adults.

Methods: Between 2016 and 2018, 5315 young Swiss men (M = 25.45 years old, SD = 1.25) completed a questionnaire assessing smartphone use, daily time spent using a smartphone, mental health and well-being (i.e. depression, social anxiety, attention deficit hyperactivity disorder, life satisfaction, stress) and potential confounding variables (social capital, personality, education). The associations of smartphone use and time spent using a smartphone (linear and quadratic associations) with mental health and well-being were tested using regression models.

Results: Non-users (4.3%) reported worse mental health and well-being than smartphone users on all outcomes. Time spent using a smartphone was linearly associated with higher rates of social anxiety, depression, attention deficit hyperactivity disorder and lower levels of life satisfaction. The association with stress was non-linear, with significant linear and quadratic coefficients of time spent using a smartphone. Associations were partially attributable to confounding variables (i.e. social capital, personality, and education).

Conclusions: Non-users and intense users of smartphones have lower levels of mental health and well-being than low-level users. Although society and mental health professionals are deeply concerned about the potentially negative consequences of the ever-increasing use of smartphones, the present study suggested that not using a smartphone may also indicate problems.

1. Introduction

Smartphone use has become wildly popular in the last years. The world's population owning a smartphone has increased from 49.4% in 2016 to 83.7% in 2022 (Turner, 2022). In Switzerland the rates of 18–75-year-olds owning a smartphone was 92% in 2018, with rates of 97% among 18–24-year-olds (Deloitte, 2019). Smartphones offer far more possibilities than simply calling and texting; they enable playing videogames, music and videos, geolocation, making payments, access to the internet, news and social media, and taking photos and videos almost anywhere. Thus, using smartphones is very appealing.

However, a large body of recent research shows that intense smartphone use is related to poorer mental health. For example, convergent evidence has shown its associations with greater anxiety, depression, stress and poorer sleep quality and well-being (Elhai et al., 2017; Thomée, 2018). Some studies have associated problematic smartphone use, i.e. an inability to regulate smartphone use (Billieux, 2012), with attention-deficit/hyperactivity disorder (ADHD) and social anxiety disorder (Dey et al., 2019; Fırat et al., 2018; Marmet et al., 2019; Panagiotidi and Overton, 2022). Furthermore, a recent meta-analysis

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showed that problematic smartphone use was associated with the *big-five* personality traits (Marengo et al., 2020), including a positive association with neuroticism and negative associations with conscientiousness, openness and agreeableness, with the strongest associations being for neuroticism and conscientiousness.

Although there is consistent evidence for higher rates of mental health problems in intense smartphone use, less is known about associations between different points along the continuum of smartphone use (i.e. from non-use to intense use) and mental health problems. Several studies investigating the associations of other addictive behaviours such as alcohol use (O'Donnell et al., 2006; Vanheusden et al., 2008) or screen time use, including television watching, computer/-internet use, and video gaming (Bélanger et al., 2011; Brailovskaia and Margraf, 2016; Liu et al., 2016), with mental health problems showed that associations were non-linear, with non- and intense users reporting more mental health problems than low-level users or with non-, low, and intense users reporting more mental health problems than moderate users. With regard to smartphone use specifically, to the best of our knowledge, no study to date has investigated potentially non-linear associations of smartphone use with mental health directly. Besides the above-mentioned studies showing higher rates of mental health problems in intense smartphone users, Pedrero-Pérez et al. (2019) showed, in a sample of Spanish smartphone users (aged 15–65) excluding non-users, that also those irregularly using their smartphone had a higher risk of poor mental health than those using it regularly. Non-regular users were also more likely to be male, older, from an unprivileged social class, to reside in a poorly developed district, to have only completed primary or lower education, to report lower levels of quality of life, experience feelings of loneliness, to report being overweight or have an obese body mass index, and to be less physically active. However, in adjusted analyses considering all these variables simultaneously, most of these associations were no longer significant. Only some sociodemographic variables (i.e. sex, social class, educational level, age), and feelings of loneliness remained significantly associated with not regularly using a smartphone, suggesting that associations with poorer mental health were driven at least partly by these individual characteristics. Other individual characteristics may also explain these associations, for example, those with low socioeconomic status may not have the financial resources to afford the subscription charge, those with poor social capital or high levels of neuroticism may be socially isolated. These variables are known to be related with poor mental health and well-being (Chen et al., 2018; Hamano et al., 2010; McDonald et al., 2017; Strickhouser et al., 2017). To our knowledge, there is no study investigating mental health and well-being of individuals not owning a smartphone. However, based on studies showing that non-users compared to low-levels or moderate users of internet, video games, or Facebook have poorer mental health (Bélanger et al., 2011; Brailovskaia and Margraf, 2016; Kim, 2012; Liu et al., 2016), similar associations can be expected for those not using a smartphone.

Taken together, results from previous studies suggests that people not using a smartphone, those using their smartphone very little (Pedrero-Pérez et al., 2019) and those using smartphones intensely (Billieux, 2012; Dey et al., 2019; Fırat et al., 2018; Marmet et al., 2019; Panagiotidi and Overton, 2022) may have a high risk of poor mental health. This suggests that the trend of mental health and well-being vary along the continuum of smartphone use (i.e. a non-linear association from non-use to intense use). The present study's first aim, therefore, was to investigate the shape of the associations between smartphone use and the mental health and well-being of a large sample of young Swiss men from the Cohort Study on Substance Use Risk Factors (C-SURF). In line with results of studies showing non-linear associations of alcohol and other reinforcing behaviours with mental health (Bélanger et al., 2011; Brailovskaia and Margraf, 2016; Liu et al., 2016; O'Donnell et al., 2006; Vanheusden et al., 2008), we hypothesize that non-users, those using their smartphone very little and intense users will report more mental health problems and lower well-being than moderate users.

The second aim was to estimate how much of the associations between smartphone use and mental health problems and well-being was attributable to differences in a series of personal characteristics available in the C-SURF study dataset, i.e. personality traits, social capital and sociodemographic variables. Since smartphone use, mental health and well-being are all related to personality (Marengo et al., 2020; Steel et al., 2008; Strickhouser et al., 2017), social capital (Chen et al., 2018; Cho, 2015; Hamano et al., 2010) and sociodemographic status (McDonald et al., 2017; Meyer et al., 2014), these variables may constitute potential confounding variables that may be helpful to better understand the mechanisms underlying associations between smartphone use and mental health and well-being. We hypothesize that associations between smartphone use and mental health and well-being will be partly attributable to personality traits, social capital and sociodemographic variables.

2. Methods

2.1. Study design and participants

We used data from the third-wave questionnaire of the Cohort Study on Substance-Use Risk Factors (C-SURF; research protocol number 15/07, approved by Lausanne University Medical School's Ethics Committee for Clinical Research). Participants were enrolled in three of Switzerland's six military recruitment centres when their eligibility for military service was assessed. Since this assessment is mandatory for all Swiss men at the age of about 19 years old, recruitment offers a unique opportunity to enrol a non-selective sample of the country's population of young men. Between August 2010 and November 2011, 7556 young men reporting to the recruitment centres in Lausanne (French-speaking), Windisch and Mels (German-speaking) gave their written consent to participate in the study. Participants completed the questionnaires outside of the military environment, however. More general information on the study and enrolment procedures have been reported previously (Gmel et al., 2015; Studer et al., 2013a, 2013b). Questionnaires were completed between August 2010 and March 2012 (baseline questionnaire), March 2012 and January 2014 (second-wave questionnaire) and April 2016 and March 2018 (third-wave questionnaire). In the present study only data from the third-wave questionnaire were used because not all variables of interest were available in the two first questionnaires. A total of 5516 men (73.0% response rate) filled out the third-wave questionnaire. With 201 (3.6% of respondents) excluded due to missing values for at least one variable of interest, the final sample for analysis included 5315 participants (96.4% of third-wave respondents).

2.2. Measurements

2.2.1. Exposure variable

Smartphone use was measured by asking participants whether they owned a smartphone and, if yes, what their average daily smartphone use had been (hours and minutes) over the previous 12 months.

2.2.2. Criterion variables

Social anxiety disorder was measured using the Clinically Useful Social Anxiety Disorder Outcome Scale (CUSADOS; Dalrymple et al., 2013). CUSADOS includes 12 statements assessing the symptoms of social anxiety disorder, and respondents are asked to indicate how well these statements describe them during the past week, including the test day, on a 5-point scale ranging from 0 ("almost never true") to 4 ("almost always true"). A sum score ranging from 0 to 48 was computed, and a cut-off score of 16 was used to identify participants with and without social anxiety disorder, as proposed by the authors.

Symptoms of major depression in the previous two weeks was measured using the Major Depression Inventory (Bech et al., 2001), which comprises 12 statements covering the ten symptoms of depression as per the ICD-10 (World Health Organization, 1992). Two of the

symptoms are measured using two statements each, but only the highest score for each symptom was retained for computing the total score. Each statement was evaluated on a 6-point scale ranging from 0 ("never") to 5 ("always"). A sum score ranging from 0 to 50 was computed for the ten symptoms, and a cut-off score of 21 was used to reflect mild or more severe depression, as proposed by the authors.

ADHD symptoms were measured using the screener for the Adult ADHD Self-Report Scale (ASRS-v1.1; Kessler et al., 2007), a 6-item scale based on DSM-IV diagnostic criteria (American Psychiatric Association, 2000). Participants evaluated how often they had experienced ADHD symptoms, over the previous 12 months, using a 5-point scale ranging from 0 ("never") to 4 ("very often"). A sum score ranging from 0 to 24 was computed for the 6 items, and a cut-off score of 14 was used to define the presence of ADHD, as proposed by the authors.

Life Satisfaction was measured using the Satisfaction with Life Scale (Diener et al., 1985), which consists of five statements rated on a 7-point scale, ranging from 1 ("strongly disagree") to 7 ("strongly agree"). A sum score ranging from 5 to 35 was computed.

Perceived stress was measured using the Perceived Stress Scale (Cohen and Williamson, 1988). Participants were asked to evaluate how often they experienced 10 feelings and thoughts related to stress over the previous month. Responses were given on a 5-point scale ranging from 0 ("never") to 4 ("very often"), and a sum score ranging from 0 to 40 was computed.

2.2.3. Potential confounding variables

Two aspects of perceived social capital were measured. Perceived bridging refers to loose connections between individuals who may provide useful information but do not provide emotional support. Perceived bonding refers to bonds between individuals who are in emotionally close relationships (Chang and Zhu, 2012; Putnam, 2000). Statements initially developed to measure bridging and bonding on social networking sites were taken from Chang and Zhu (2012) and adapted by replacing references to those sites with references to the participant's community. We selected the five (out of 10) most heavily weighted items in the "perceived bridging social capital" scale and used all five items in the "perceived bonding social capital" scale. Participants were asked to indicate the extent to which they agreed with the statements on a 5-point scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Mean scores were computed for each aspect.

The cross-cultural, shortened form of the Zuckerman–Kuhlman Personality Questionnaire (Aluja et al., 2006) was used to assess neuroticism–anxiety, aggression–hostility and sociability personality traits. Each trait was measured using ten true or false statements, with the possible score of endorsed statements ranging from 0 to 10. The eight-item Brief Sensation-Seeking Scale (Hoyle et al., 2002) was used to measure sensation seeking. Participants answered each item on a 5-point scale (from "strongly disagree" to "strongly agree"). Scores ranging from 1 to 5 were computed by averaging responses to the eight items.

We also measured age, linguistic region (French- or German-speaking) and highest educational level achieved (primary schooling, vocational training, post-secondary schooling).

2.3. Statistical analyses

Descriptive statistics were used to characterise the sample. Logistic (for dichotomous outcomes) and linear (for continuous outcomes) regression models were used to test the unadjusted associations of smartphone use and time spent using a smartphone as exposure variables with mental health, well-being, and with potential confounding variables as outcome variables (models 1). Models 1 (unadjusted associations) included use of smartphone (coded 0 for non-users and 1 for users), time spent using a smartphone (in hours), and the square of time spent using a smartphone as exposure variables. For adjusted associations with mental health and well-being as outcomes, models 2 included the same exposure variables as in models 1 plus all potential confounding variables.

Estimations of how much of the unadjusted significant associations in model 1 were attributable to potential confounding variables (aim 2) required decomposing the total effect (i.e. the unadjusted association in model 1) into direct (i.e. adjusted associations net of confounding) and confounded (unadjusted associations minus adjusted associations net of confounding) effects. In linear regressions, this can be done by directly comparing the unadjusted and adjusted (for confounding) coefficients. However, in logistic regression models, these coefficients cannot be directly compared because they are not on the same scale: the magnitude of the coefficient depends on the model's error variance, which in turn depends on the covariates included in that model (Karlson et al., 2012). The Karlson, Holm and Breen (Karlson et al., 2012; Kohler et al., 2011) method addresses this issue by estimating all the effects at the same scale so that the coefficients are not affected by rescaling problems. Thus, this method enables an estimation of the percentage of the total effect (i.e. unadjusted association) that is attributable to confounding effects by comparing the total, direct and confounding effects net of rescaling.

3. Results

Participants were 25.45 years old on average. About 57% were French-speaking and 43% German-speaking. Descriptive characteristics for the total sample and as a function of time spent using a smartphone are reported in Table 1.

Results from regression models investigating associations between smartphone use and the potential confounding variables are reported in Table 2. Compared to non-users, smartphone users were significantly less likely to report primary and vocational education, they reported significantly higher levels of bridging, bonding and sensation seeking, and lower levels of aggression-hostility and anxiety-neuroticism. Significant positive linear associations were found between time spent using a smartphone and primary and vocational education, age, bridging, aggression-hostility, sociability, anxiety-neuroticism and sensation seeking, whereas a significant negative linear association was found with bonding. Significant negative associations were found between squared time spent using a smartphone and bridging, aggression-hostility, sociability, anxiety-neuroticism, and sensation seeking.

3.1. Unadjusted associations between smartphone use and mental health and well-being (model 1)

Results from the regression models testing the associations between smartphone use and the outcomes of mental health and well-being are reported in Table 3. Correlations between time spent using a smartphone and the outcomes of mental health and well-being among those reporting using a smartphone are reported in Supplementary Material Table 1. In model 1 (i.e. no adjustment for potential confounding variables), smartphone users (vs. non-users) were significantly less likely to report social anxiety, depression, ADHD. They also reported significantly higher levels of life satisfaction and lower levels of stress.

Significant positive linear associations were found between time spent using a smartphone and social anxiety, depression, ADHD, and stress, whereas a significant negative linear association was found with life satisfaction. Associations of squared time spent using a smartphone with outcomes were not significant, except for the significant negative association with stress. The shape of the association was monotone: stress levels increased with increasing time spent using a smartphone, but the increase flattened at higher levels of time spent using a smartphone (see Supplementary Material Fig. 1).

3.2. Adjusted associations between smartphone use and mental health and well-being (model 2)

Associations adjusted for potential confounding variables are

Table 1
Sample's descriptive characteristics.

	Linguistic region				Education						Social anxiety		Depression		ADHD	
	French		German		Primary		Vocational		Post-secondary							
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Total (N = 5315)	3038	57.2%	2277	42.8%	178	3.3%	2135	40.2%	3002	56.5%	894	16.8%	418	7.9%	300	5.6%
Time spent using a smartphone																
Non-users (n = 227, 4.3%)	141	62.1%	86	37.9%	17	7.5%	96	42.3%	114	50.2%	55	24.2%	36	15.9%	20	8.8%
>0 h–0.5 h (n = 340, 6.4%)	200	58.8%	140	41.2%	10	2.9%	129	37.9%	201	59.1%	60	17.6%	23	6.8%	15	4.4%
>0.5 h–1 h (n = 1064, 20.0%)	601	56.5%	463	43.5%	25	2.3%	386	36.3%	653	61.4%	149	14.0%	64	6.0%	45	4.2%
>1 h–1.5 h (n = 350, 6.6%)	198	56.6%	152	43.4%	8	2.3%	137	39.1%	205	58.6%	49	14.0%	14	4.0%	21	6.0%
>1.5 h–2 h (n = 1094, 20.6%)	585	53.5%	509	46.5%	18	1.6%	408	37.3%	668	61.1%	175	16.0%	76	6.9%	56	5.1%
>2 h–2.5 h (n = 150, 2.8%)	93	62.0%	57	38.0%	4	2.7%	72	48.0%	74	49.3%	18	12.0%	8	5.3%	4	2.7%
>2.5 h–3 h (n = 731, 13.8%)	432	59.1%	299	40.9%	24	3.3%	285	39.0%	422	57.7%	112	15.3%	44	6.0%	46	6.3%
>3 h–3.5 h (n = 73, 1.4%)	46	63.0%	27	37.0%	9	12.3%	29	39.7%	35	47.9%	13	17.8%	6	8.2%	3	4.1%
>3.5 h–4.5 h (n = 473, 8.9%)	268	56.7%	205	43.3%	15	3.2%	205	43.3%	253	53.5%	87	18.4%	41	8.7%	31	6.6%
>4.5 h–5.5 h (n = 321, 6.0%)	186	57.9%	135	42.1%	15	4.7%	139	43.3%	167	52.0%	70	21.8%	31	9.7%	24	7.5%
>5.5 h to higher (n = 492, 9.3%)	288	58.5%	204	41.5%	33	6.7%	249	50.6%	210	42.7%	106	21.5%	75	15.2%	35	7.1%

	Age		Social capital				Personality								Life satisfaction		Stress	
			Bridging		Bonding		Aggression - hostility		Sociability		Anxiety - Neuroticism		Sensation-seeking					
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Total (N = 5315)	25.45	1.25	3.62	0.69	4.10	0.73	3.78	2.15	4.95	2.24	2.19	2.16	2.99	0.81	25.94	6.22	13.31	5.97
Time spent using a smartphone																		
Non-users (n = 227, 4.3%)	25.43	1.10	3.40	0.81	3.79	0.84	3.69	2.08	4.55	2.29	2.36	2.24	2.74	0.98	23.84	7.99	14.95	6.20
>0 h–0.5 h (n = 340, 6.4%)	25.37	1.14	3.52	0.78	4.10	0.75	3.22	2.18	4.24	2.39	2.00	2.04	2.82	0.84	26.87	5.75	11.64	6.05
>0.5 h–1 h (n = 1064, 20.0%)	25.41	1.23	3.62	0.68	4.16	0.72	3.48	2.08	4.76	2.30	1.98	2.06	2.94	0.80	26.38	5.92	12.56	5.79
>1 h–1.5 h (n = 350, 6.6%)	25.32	1.32	3.66	0.59	4.20	0.65	3.59	2.13	5.01	2.20	2.08	2.00	3.06	0.75	26.90	5.63	12.50	5.81
>1.5 h–2 h (n = 1094, 20.6%)	25.40	1.22	3.63	0.68	4.13	0.74	3.69	2.10	5.00	2.23	2.19	2.18	3.05	0.76	26.42	5.85	12.93	5.74
>2 h–2.5 h (n = 150, 2.8%)	25.46	1.06	3.62	0.70	4.04	0.72	3.85	1.84	5.16	2.18	2.11	2.27	2.87	0.77	26.13	5.54	12.41	6.28
>2.5 h–3 h (n = 731, 13.8%)	25.56	1.34	3.62	0.69	4.12	0.71	3.92	2.19	5.12	2.21	2.14	2.16	3.00	0.82	26.01	5.91	13.45	5.57
>3 h–3.5 h (n = 73, 1.4%)	25.48	1.02	3.71	0.56	4.06	0.73	4.03	2.17	5.29	2.44	2.10	2.08	2.96	0.93	25.23	6.64	15.14	5.41
>3.5 h–4.5 h (n = 473, 8.9%)	25.42	1.32	3.68	0.71	4.11	0.69	3.99	2.18	5.03	2.16	2.35	2.24	3.09	0.79	25.63	6.52	13.77	6.29
>4.5 h–5.5 h (n = 321, 6.0%)	25.61	1.28	3.62	0.69	4.02	0.74	4.32	2.15	4.92	2.19	2.36	2.08	3.05	0.83	24.98	6.60	14.74	5.78
>5.5 h to higher (n = 492, 9.3%)	25.58	1.30	3.68	0.69	4.00	0.75	4.32	2.25	5.46	1.97	2.63	2.40	3.06	0.84	24.43	6.88	15.16	6.26

Note. ADHD = attention deficit hyperactivity disorder; M = mean; SD = standard deviation.

reported in Table 3 (model 2). After adjustment for confounding, the coefficients of users (vs. non-users) were lower (in absolute terms, i.e. closer to the Null) but remained significant. After adjustment, the linear associations of time spent using a smartphone with life satisfaction and stress were lower (in absolute terms, i.e. closer to the Null) but remained significant, whereas the associations with social anxiety, depression and ADHD were no longer significant. The non-linear association between squared time spent using a smartphone and stress did not reach significance when adjusting for confounding.

The percentage of total association (unadjusted, model 1) attributable to confounding variables is reported in Table 3. The percentages reported in the rows of smartphone use, time spent using a smartphone, and time spent using a smartphone (squared) in model 2 reports the percentage of the significant unadjusted associations in model 1 accounted for when all the confounding variables were tested simultaneously in the model 2. The percentages reported in the confounding variable rows in model 2 report the percentages of the significant unadjusted associations of smartphone use in model 1 accounted for by each confounding variable tested separately (i.e. not adjusted for other confounding variables).

For the difference between users and non-users, adjustment for all confounding variables accounted for a significant percentage of the unadjusted associations with social anxiety (37.1%), depression (27.4%), life satisfaction (47.2%) and stress (36.6%). When looking at individual confounding variables, bonding, aggression-hostility and anxiety-neuroticism accounted for a significant percentage of the unadjusted associations with all outcomes in model 1. Bridging accounted for a significant percentage of the associations with all outcomes in model 1 except ADHD, whereas education accounted for a significant percentage of the associations with depression, life satisfaction and stress in model 1. Sensation seeking had a significant negative confounding effect on the association with stress, i.e. adjustment for sensation seeking increased the association by 2.4%.

For the linear association of time spent using a smartphone, adjustment for all confounding variables accounted for a significant percentage of the association with social anxiety (53.9%), depression (52.6%), ADHD (43.4%), life satisfaction (55.0%) and stress (49.2%). When looking at individual confounding variables, aggression-hostility and anxiety-neuroticism accounted for a significant percentage of the associations with all outcomes in model 1. Bonding accounted for a significant percentage of the associations with life satisfaction and stress in model 1. Sensation seeking accounted for a significant percentage of the

Table 2
Associations between smartphone use and potential confounding variables.

	Smartphone					
	Use		Time spent		Time spent squared	
	B	95% CI	B	95% CI	b	95% CI
Linguistic region[a]	0.25	−0.04, 0.54	−0.01	−0.07, 0.04	>0.00	<0.00, >0.00
Education (ref. post-secondary)[b]						
Primary	−1.64	−2.27, −1.01	0.23	0.07, 0.38	<0.00	−0.01, 0.01
Vocational	−0.43	−0.73, −0.13	0.09	0.03, 0.15	<0.00	−0.01, >0.00
Age[c]	−0.08	−0.26, 0.10	0.04	>0.00, 0.08	<0.00	<0.00, >0.00
Social capital						
Bridging[c]	0.18	0.08, 0.28	0.03	0.01, 0.05	<0.00	<0.00, <0.00
Bonding[c]	0.38	0.27, 0.48	−0.02	−0.04, <0.00	>0.00	<0.00, >0.00
Personality						
Aggression - hostility[c]	−0.46	−0.77, −0.15	0.26	0.19, 0.32	−0.01	−0.02, −0.01
Sociability[c]	0.04	−0.28, 0.36	0.17	0.11, 0.24	−0.01	−0.01, <0.00
Anxiety - Neuroticism[c]	−0.46	−0.77, −0.15	0.13	0.06, 0.19	−0.01	−0.01, <0.00
Sensation-seeking[c]	0.17	0.05, 0.29	0.05	0.02, 0.07	<0.00	<0.00, <0.00

Note. b = coefficient of association from regression; CI = confidence interval; b < 0.00 = >-0.01 and <0.00; b > 0.00 = >0.00 and < 0.01.
[a] Logistic regression model.
[b] Multinomial logistic regression model.
[c] Linear regression model.

associations with ADHD and stress, age for a significant percentage of the association with life satisfaction, whereas education accounted for a significant percentage of the associations with life satisfaction and stress. Education had also a significant negative confounding effect on the associations with ADHD. Negative confounding effects were also found for the associations of sociability and bridging with all outcomes (not significant for the association with ADHD).

For the association of squared time spent using a smartphone with stress, adjustment for all confounding variables accounted for a significant 57.6% of the unadjusted association in model 1. When looking at individual confounding variables, aggression-hostility and anxiety-neuroticism and sensation seeking accounted for a significant percentage of the association in model 1. Bridging and sociability had a significant negative confounding effect.

4. Discussion

The present study investigated associations between smartphone use and the mental health and well-being outcomes of a sample of young Swiss men. Results showed that compared to smartphone users, non-users had worse mental health and well-being and that among users, increasing time spent using a smartphone was associated with worse mental health and well-being. This is in line with our hypothesis that non- and intense users have worse mental health than moderate users. However, the results did not support the hypothesis that low-levels users have worse mental health than moderate users. For all outcomes except stress, quadratic associations of time spent using a smartphone were not significant, only the linear associations were significant. For stress, a non-linear association was found (both linear and quadratic associations were significant): the shape of the association was monotone, i.e. stress levels increased with increasing time spent using a smartphone but increase was larger at lower than at higher levels of time spent using a smartphone.

The worse mental health of intense users is in line with the association between problematic smartphone use and mental health problems that has often been reported previously (Dey et al., 2019; Elhai et al., 2017; Fırat et al., 2018; Marmet et al., 2019; Panagiotidi and Overton, 2022; Thomée, 2018). By contrast, the difference between non-users and users has, to the best of our knowledge, never been investigated for smartphone use specifically. Although the existing literature warns against potentially higher rates of mental health problems among problematic smartphone users, the present study's results suggest that not using a smartphone may also indicate problems.

Coefficients of association were reduced after adjusting for confounding variables. The worse mental health and lower levels of well-being of non-users of smartphones were at least partially attributable to social capital: in both bonding and bridging (not significant for ADHD). This suggests that non-users of smartphones have lower levels of mental health and well-being because they lack emotionally close relationships (low levels of bonding) and of relationships with more distant individuals and the community (low levels of bridging). The lower levels of life satisfaction and higher levels of stress of intense users were also partially attributable to deficit in bonding. Interestingly, higher levels of time spent using a smartphone was positively associated with levels of bridging and bridging had a negative confounding effect on the association between time spent using a smartphone and all outcomes (except ADHD). This suggests that if intense users had levels of bridging similar to low levels users, their mental health would be even worse. These findings are in line with studies showing the protective effect of social capital on mental health (Chen et al., 2018; Hamano et al., 2010; Kim and Shin, 2021).

Lower levels of mental health and well-being among non-users and intense users of smartphones were also partially attributable to their higher levels of aggression–hostility and anxiety–neuroticism. These two personality traits are part of a larger construct, namely negative emotionality (Zuckerman, 2002), which predisposes individuals to negative mood and stress and to loneliness (Buecker et al., 2020). Thus, in line with studies on the associations between coping motives and positive metacognitions with regards to emotional and cognitive regulation through problematic smartphone use (Casale et al., 2020; Chen et al., 2017), intense users may spend a lot of time using their smartphone for mood management purposes. Alternative explanations are also possible. Intense smartphone use may also cause negative mood and stress (La Torre et al., 2019), which in turn may increase the traits of aggression–hostility and anxiety–neuroticism even though personality is generally relatively stable (McCrae and Costa, 1994). Third variables that has not been accounted for, such as unemployment, issues with impulse control, poor coping strategies may also have caused both intense use of smartphone and high levels of aggression–hostility and anxiety–neuroticism. For non-users, their worse mental health may be related to loneliness associated with high levels of aggression–hostility and anxiety–neuroticism. Higher levels of ADHD and, to a lesser extent, of stress among intense users were attributable to their higher levels of sensation seeking. This finding is in line with studies showing associations between ADHD and sensation seeking and with the hypothesis that individuals with ADHD and high levels of sensation seeking seek

Table 3
Associations between smartphone use and time spent using a smartphone and mental health and well-being.

	Social anxiety[a]				Depression[a]			
	b (95%CI)	% of association smartphone use	% of association TSUS	% of association TSUS (squared)	b (95%CI)	% of association smartphone use	% of association TSUS	% of association TSUS (squared)
Model 1 (unadjusted)								
Smartphone use (vs. no use)	**−0.70(-1.04, -0.35)**	–	–	–	**−1.27(-1.70, -0.84)**	–	–	–
Time spent using a smartphone	**0.08(0.01, 0.16)**	–	–	–	**0.14(0.04, 0.24)**	–	–	–
Time spent using a smartphone (squared)	<0.00(-0.01, >0.00)	–	–	–	<0.00(-0.01, 0.01)	–	–	–
Model 2 (adjusted)								
Smartphone use (vs. no use)	**−0.55(-0.95, -0.15)**	**37.1**[c]	–	–	**−1.04(-1.52, -0.55)**	**27.4**[c]	–	–
Time spent using a smartphone	0.05(-0.04, 0.13)	**-**	**53.9**[c]		0.07(-0.04, 0.18)	–	**52.6**[c]	–
Time spent using a smartphone (squared)	<0.00(-0.01,0.01)	–	–	–	>0.00(-0.01, 0.01)	–	–	–
Bonding	**−0.29(-0.41, -0.16)**	**25.4**	11.7	–	**−0.41(-0.56, -0.26)**	**18.4**	9.3	–
Bridging	**0.17(0.03, 0.31)**	**6.4**	**−8.2**	–	−0.06(-0.24, 0.12)	**5.7**	**−7.8**	–
Aggression/Hostility	−0.01(-0.05, 0.03)	**6.8**	**31.2**	–	0.02(-0.03, 0.07)	**5.2**	**26.1**	–
Sociability	**−0.11(-0.15, -0.07)**	1.4	**−45.0**	–	−0.03(-0.08, 0.03)	0.6	**−22.8**	–
Anxiety/Neuroticism	**0.50(0.46, 0.54)**	**28.7**	**75.8**	–	**0.42(0.38, 0.47)**	**14.6**	**41.4**	–
Sensation seeking	−0.05(-0.16, 0.06)	1.3	−3.1	–	**0.16(0.02, 0.30)**	−1.5	3.7	–
Linguistic region (ref. French-speaking)								
German-speaking	−0.17(-0.35, 0.01)	1.9	0.8	–	−0.04(-0.28, 0.19)	1.2	0.6	–
Education (ref. post-secondary)								
Primary	−0.32(-0.78, 0.15)	−0.1	−0.1	–	**0.57(0.10, 1.04)**	**3.7**	2.3	–
Vocational	0.25(-0.11, 0.03)	1.8	4.1	–	0.02(-0.21, 0.26)	0.2	0.4	–
Age	−0.36(-2.25, 1.53)	0.1	0.6	–	**0.14(0.06, 0.23)**	0.9	4.4	–
	ADHD[a]				Life satisfaction[b]			
	b (95%CI)	% of association smartphone use	% of association TSUS	% of association TSUS (squared)	b (95%CI)	% of association smartphone use	% of association TSUS	% of association TSUS (squared)
Model 1 (unadjusted)								
Smartphone use (vs. no use)	**−0.83(-1.36, -0.29)**	–	–	–	**3.14(2.26, 4.03)**	–	–	–
Time spent using a smartphone	**0.14(0.02, 0.27)**				**−0.37(-0.55, -0.19)**			
Time spent using a smartphone (squared)	−0.01(-0.02, >0.00)	–	–	–	0.01(-0.01, 0.02)	–	–	–
Model 2 (adjusted)								
Smartphone use (vs. no use)	**−0.75(-1.33, -0.17)**	12.6[c]	–	–	**1.66(0.88, 2.44)**	**47.2**[c]	–	–
Time spent using a smartphone	0.10(-0.04, 0.23)	**-**	**43.4**[c]	–	**−0.16(-0.32, -0.01)**	–	**55.0**[c]	–
Time spent using a smartphone (squared)	−0.01(-0.02, >0.00)	–	–	–	>0.00(-0.01, 0.01)	–	–	–
Bonding	−0.09(-0.27, 0.09)	**12.6**	4.1	–	**1.50(1.27, 1.73)**	**30.1**	**14.5**	–
Bridging	>0.00(-0.19, 0.20)	2.9	−2.6	–	**0.68(0.43, 0.93)**	**10.7**	**−14.2**	–
Aggression/Hostility	0.05(<0.00, 0.11)	**9.4**	**30.4**	–	**−0.10(-0.17, -0.03)**	**6.0**	**28.5**	–
Sociability	−0.05(-0.11, 0.01)	0.7	**−16.8**	–	**0.13(0.06, 0.20)**	0.7	**−25.3**	–
Anxiety/Neuroticism	**0.36(0.31, 0.41)**	**20.9**	**34.4**	–	**−0.91(-0.99, -0.84)**	**15.9**	**37.8**	–
Sensation seeking	**0.65(0.48, 0.82)**	−12.5	**18.9**	–	**−0.22, (-0.40, -0.03)**	0.5	−1.2	–
Linguistic region (ref. French-speaking)								
German-speaking	**−0.60(-0.88, -0.32)**	4.3	1.3	–	−0.22(-0.53, 0.09)	1.1	0.5	–
Education (ref. post-secondary)								
Primary	−0.14(-0.74, 0.46)	3.0	1.2	–	**−4.19(-5.01, -3.36)**	**8.7**	5.2	–
Vocational	**−0.47(-0.75, -0.20)**	−4.2	**−6.7**	–	**−1.44(-1.74, -1.13)**	**3.5**	**8.3**	–
Age	0.01(-0.09, 0.11)	0.5	1.41	–	**−0.30(-0.42, -0.18)**	1.1	**5.3**	–

(*continued on next page*)

Table 3 (*continued*)

	Stress[b]			
	b (95%CI)	% of association smartphone use	% of association TSUS	% of association TSUS (squared)
Model 1 (unadjusted)				
Smartphone use (vs. no use)	−3.13(-3.98, -2.29)	–	–	–
Time spent using a smartphone	0.60(0.43, 0.77)	–	–	–
Time spent using a smartphone (squared)	−0.02(-0.03, -0.01)	–	–	–
Model 2 (adjusted)				
Smartphone use (vs. no use)	−1.99(-2.69, -1.28)	36.6[c]	–	–
Time spent using a smartphone	0.30(0.16, 0.45)	-	49.2[c]	–
Time spent using a smartphone (squared)	−0.01(-0.02, >0.00)	-	-	57.6[c]
Bonding	−1.10(-1.30, -0.89)	20.6	6.1	1.6
Bridging	−0.01(-0.23, 0.21)	4.8	−3.9	−7.4
Aggression/Hostility	0.23(0.16, 0.29)	8.3	24.1	36.0
Sociability	>0.00(-0.06, 0.07)	0.6	−12.2	−16.8
Anxiety/Neuroticism	1.35(1.28, 1.41)	21.3	30.9	38.8
Sensation seeking	0.39(0.22, 0.56)	−2.4	3.6	6.1
Linguistic region (ref. French-speaking)				
German-speaking	1.20(0.92, 1.48)	−1.1	−0.3	−0.2
Education (ref. post-secondary)				
Primary	1.53(0.79, 2.28)	4.0	1.5	−1.9
Vocational	0.50(0.22, 0.77)	1.7	2.5	1.6
Age	0.21(0.10, 0.32)	0.5	1.5	1.2

Note. B coefficients and percentages of associations in bold are significant at $p < .05$; CI = confidence interval; TSUS = Time spent using a smartphone; ADHD = attention deficit hyperactivity disorder.

[a] Logistic regression model.

[b] Linear regression model.

[c] Percentage of association attributable by all confounders tested simultaneously.

external stimulation (White, 1999). Smartphone use may constitute a source of stimulation.

Non-users were more likely, whereas intense users were less likely to report lower levels of education. Lower levels of education were generally associated with worse mental health and well-being (except ADHD): higher depression (not significant for vocational vs. post-secondary education) and stress, and lower life satisfaction. However, only a small percentage of the lower levels of mental health and well-being among non-users and intense users of smartphones was attributable to their educational achievements. Moreover, the pattern of significance of the contribution of educational achievements in accounting for the associations of smartphone use was not consistent across outcomes (e.g. for social anxiety: not significant; for stress: only significant for vocational education).

Although a broad spectrum of confounding variables was tested, i.e. personality, social capital and sociodemographic characteristics, a large part of the associations between smartphone use and mental health and well-being remained unexplained. For intense users of smartphones, their increased likelihood of problematic smartphone use—which is known to co-occur with other mental health problems (Marmet et al., 2019)—may also account for this difference. However, the reasons behind non-users' lower levels of mental health are less straightforward, and this result should be interpreted with caution. It is unlikely that not using a smartphone *per se* increases the risk of mental health problems. It is more likely that some other factors—only partly described in this study—account for this difference. For example, low socio-economic status (SES) is associated with mental health problems (McDonald et al., 2017; Meyer et al., 2014) and not using a smartphone (Ma et al., 2020). The present study found that a small percentage of the higher rates of mental health problems of non-users was attributable to participants' educational achievements (one aspect of SES), but we were unable to adjust for financial income, one aspect of SES that is probably more closely related to access to smartphones. Non-users may not have the financial resources to afford a smartphone and the associated mobile plan. However, in the last years, smartphones and mobile plans became more affordable in Switzerland. The prevalence of young adults not owning a smartphone has decreased since data collection (Bernath et al., 2020). Another explanation may be that some people with mental health problems may avoid using smartphones because they are afraid of making their problems worse, e.g. repeated exposition to bad news may increase sadness and perceived stress.

4.1. Limitations

The present study had some limitations. Its cross-sectional design did not allow us to draw any causal conclusions, which would require longitudinal studies. The analyses did not account for other potential confounding factors, such as Internet addiction, that are related to both smartphone addiction and mental health problems (Ho et al., 2014; Marmet et al., 2019). Since the sample only included young men, the findings should not be generalised to women or other age groups. Results might also vary across borders depending on the penetration of smartphone use. Finally, using self-reported measures and the sensitive nature of questions about mental health may introduce biases, such as social desirability bias.

5. Conclusions

The present study showed that intense users of smartphones and non-users of smartphones had worse mental health, higher stress levels and lower satisfaction with life than low-level users of smartphones. Although society and mental health professionals are deeply concerned about the potentially negative consequences of the ever-increasing use of smartphones, the present study suggested that not using a smartphone may also indicate problems. This may in part be explained by lower levels of social capital and higher levels of anxiety–neuroticism and

aggression–hostility among non-users. Thus, healthcare professionals should also be vigilant with young people not using smartphones.

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Authors' contributions

Studer Joseph: Conceptualization, Formal analysis, Methodology, Data Curation, Writing - Original Draft; Marmet Simon: Conceptualization, Writing - Review & Editing, Methodology; Wicki Matthias: Conceptualization, Writing - Review & Editing, Methodology; Khazaal Yasser: Conceptualization, Writing - Review & Editing; Gmel Gerhard: Conceptualization, Writing - Review & Editing, Funding acquisition.

Ethics

C-SURF was approved by Lausanne University Medical School's Clinical Research Ethics Committee (research protocol number 15/07).

Declaration of competing interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2022.10.036.

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