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## Original Contribution

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# Association of Facebook Use With Compromised Well-Being: A Longitudinal Study

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**Holly B. Shakya\*** and **Nicholas A. Christakis**

\* Correspondence to Dr. Holly B. Shakya, Division of Global Public Health, School of Medicine, University of California San Diego, 9500 Gilman Drive, #0507, La Jolla, CA 92093-0507 (e-mail: hshakya@ucsd.edu).

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Face-to-face social interactions enhance well-being. With the ubiquity of social media, important questions have arisen about the impact of online social interactions. In the present study, we assessed the associations of both online and offline social networks with several subjective measures of well-being. We used 3 waves (2013, 2014, and 2015) of data from 5,208 subjects in the nationally representative Gallup Panel Social Network Study survey, including social network measures, in combination with objective measures of Facebook use. We investigated the associations of Facebook activity and real-world social network activity with self-reported physical health, self-reported mental health, self-reported life satisfaction, and body mass index. Our results showed that overall, the use of Facebook was negatively associated with well-being. For example, a 1-standard-deviation increase in “likes clicked” (clicking “like” on someone else’s content), “links clicked” (clicking a link to another site or article), or “status updates” (updating one’s own Facebook status) was associated with a decrease of 5%–8% of a standard deviation in self-reported mental health. These associations were robust to multivariate cross-sectional analyses, as well as to 2-wave prospective analyses. The negative associations of Facebook use were comparable to or greater in magnitude than the positive impact of offline interactions, which suggests a possible tradeoff between offline and online relationships.

body mass index; mental health; social interaction; social media; social networks; social support

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Abbreviation: BMI, body mass index.

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There is a considerable body of research that has demonstrated the importance of social interactions for human well-being. There have been thousands of studies in which researchers have investigated social support and its related constructs, and for the most part, the results have shown that human beings thrive when they have strong positive relationships with other human beings (1–3). The benefits of strong social ties include lower risks of mental illnesses, such as depression (1, 4); a higher likelihood of positive health behaviors (5, 6); a lower likelihood of negative health behaviors, such as excessive alcohol use (7); and overall lower risk of morbidity and mortality from a wide range of causes (8–11). These benefits arise not only as a result of having a sufficient number of relationships but also from having relationships that are close and within well-integrated groups of people (1, 8).

Most of the work on social interaction has been conducted using real-world, face-to-face social networks rather than

online relationships, which are increasingly common. With the ubiquity of online social network sites and the substantial amount of time being spent on them, important questions have arisen regarding the effect of online social interactions on well-being.

Results from some studies have suggested that social media use might increase the risk of mental health problems (12–15) and might compromise well-being more generally (12, 16–19). Use of social media may detract from face-to-face relationships (20), reduce investment in meaningful activities (20), increase sedentary behavior by encouraging more screen time (20), lead to Internet addiction (21, 22), and erode self-esteem through unfavorable social comparisons (23). Although Internet addiction and detracting from meaningful activities can be associated with any Internet activity, unfavorable social comparison is particularly relevant to social media use (24). Because people tend to display

the most positive aspects of their lives on social media (25), it is possible for an individual to believe that his or her own life compares negatively to the carefully constructed positive lives of friends displayed on social media (26, 27). It has been hypothesized that this can lead to lower self-esteem and to depression.

Some investigators, however, have found no relationship between social media use and depression (28), and others suggested that social media use has a positive impact on well-being through increased social support and reinforcement of real-world relationships (29–32). Nabi et al. (33) showed that having a higher number of friends on Facebook (Menlo Park, California) significantly predicted higher perceived social support, reduced stress, and increased overall well-being, although the interpretation of their results is limited by the cross-sectional nature of the study. Other investigators have also concluded that it may be the quality of social media use that is associated with mental health outcomes rather than the quantity of time spent on social media sites, such that when social media is being used to leverage social resources, its overall impact may be positive (23, 34).

Given the conflicting findings from these various studies, more rigorous research is needed to untangle the relationship between social media use and well-being. In the present study, we assessed the potential effects of both online and real-world social networks using data from a national survey in which several measures of subjective well-being were assessed. Many studies in which social media use has been assessed were cross-sectional and relied on self-report of social media use. We had access to respondents' direct Facebook data in 3 consecutive survey waves, as well as to self-reported data on real-world social networks, all of which were measured longitudinally. This allowed us to directly compare the longitudinal associations of real-world network associations and Facebook use associations with 4 domains of well-being: self-reported physical health, self-reported mental health, self-reported life satisfaction, and body mass index (BMI).

## METHODS

### Data

We collected data from 3 survey waves over 3 consecutive years. We developed and included a social network survey instrument for deployment within Gallup's ongoing, longitudinal, probability-based panel of American households (Gallup, Princeton, New Jersey); it was based on the social network instrument used previously in the General Social Survey (35–37) and the National Health and Social Life Survey (38). The survey included measures of respondent characteristics, nominated social contacts (we refer to them as "friends") and their characteristics, and respondent-friend relationships.

The Gallup Panel is a nationally representative, multi-mode panel recruited and refreshed using random digit dialing. Only members of the Web-based portion of the Panel were eligible for participation in this study. Randomly selected Web-based members were e-mailed an invitation (wave 1,  $n = 35,256$ ; wave 2,  $n = 49,363$ ; and wave 3,

$n = 43,145$ ) in which they were asked to respond to an online survey about "the various people that you spend your free time with and have important conversations with." In wave 1, data were from 20,373 respondents; in wave 2, data were collected from 27,879 respondents; and in wave 3, data were collected from 24,087 respondents. A total of 10,680 respondents completed the survey in all 3 waves. All respondents were asked whether they would share data from their Facebook account, and those who assented were asked to click a link to an application that would access that respondent's Facebook information. A smaller subset of respondents in each wave agreed to give us access to their Facebook data (wave 1,  $n = 1,900$ ; wave 2,  $n = 3,091$ ; and wave 3,  $n = 3,195$ ). Data from this smaller set of respondents were used in these analyses, and their differences from the overall sample are described below. Web Table 1 (available at <http://aje.oxfordjournals.org/>) shows the total number of respondents in each wave.

### Measures

**Outcome measures: health and well-being.** We analyzed 4 separate outcome measures: self-reported physical health, self-reported mental health, self-reported life satisfaction, and BMI. Respondents rated their physical health and mental health on a standard scale, with 1 indicating poor, 2 indicating fair, 3 indicating good, and 4 indicating excellent. Respondents rated their life satisfaction in answer to a question in which they were asked to evaluate their life currently and to rate it on a scale of 0–10, with 0 being the worst and 10 being the best (for details on exact question wordings, see the Web Appendix). Respondents were also asked to provide their weight and height, from which we calculated a continuous measure of BMI (39). We used  $z$ -score standardization on all outcome measures to increase ease of interpretation.

**Real-world social network measures.** In each wave, respondents were asked to name up to 4 friends with whom they discuss important matters and up to 4 friends with whom they spend their free time, so that each participant could name up to a total of 8 unique individuals (although the same people could be identified in response to both name generators, respondents were later asked to remove duplicate nominations) (40). We calculated social network measures for each wave in which the respondent was a participant. The total number of friends named is called "degree," and it indicates how connected the respondent is to the rest of the network. For each friend named, respondents were asked to rate on a scale of 1–10 how close they are with that person ("closeness"), with 1 being not at all and 10 being very close. We created an average closeness measure for each participant across friends. We also asked each respondent to estimate the frequency of in-person, face-to-face interactions they had with each nominated friend over the past year, with 5 being every day (the most frequent) and 1 being never. We treated that measure as continuous and calculated a mean interaction frequency measure for each respondent across all nominated friends ("interaction").

**Facebook measures.** In each wave, we collected information from all respondents about multiple Facebook-related

measures. These included the number of Facebook friends they had (“friend count”), the number of times in their history of Facebook use that they had clicked “like” on someone else’s content (“lifetime like count”), the number of links they had clicked in the past 30 days (“30-day link count”), and the number of times they had updated their status in the past 30 days (“status count”).

*Control variables.* We included sociodemographic control variables in all of our multivariate models. These variables included income, educational level, age, sex, marital status, race, and Hispanic ethnicity (see the Web Appendix for details).

### Statistical analyses

We first conducted 2 sets of separate cross-sectional linear regression analyses for each of our 4 well-being outcomes (physical health, mental health, life satisfaction, and BMI) with each of our primary social network predictors, to which we applied  $z$ -score standardization to increase the comparability of the results across predictors (lifetime like count, 30-day link count, status count, friend count, degree, closeness, and interaction). The first set was bivariate; the second set included all demographic control variables. These first 2 sets of models included all observations for each of the 3 waves of the study stacked into 1 data set, excluding those with missing data, so that respondents who participated in more than 1 wave would be included more than once in the data set ( $n = 6,730$ ). Of all respondents in the data set, 75% responded to 1 survey wave and therefore had only 1 observation in the data set, 20% responded to 2 survey waves and therefore had 2 observations in the data set, and 5% responded to 3 survey waves and therefore had 3 observations in the data set (see Web Table 1). We accounted for multiple observations of single individuals by using a general estimating equation to adjust the standard errors that resulted from that potential clustering. All models controlled for wave-level fixed effects.

Finally, we conducted prospective multivariate analyses in which we explored the relationship of each social network predictor with each well-being outcome, including demographic control variables. Our final data set included a set of stacked observations: wave 1 to wave 2 observations and wave 2 to wave 3 observations ( $n = 1,398$ ), which included wave 1 ( $X_{i,t}$ ) social network measures predicting wave 2 ( $Y_{i,t+1}$ ) outcomes ( $n = 457$ ) and wave 2 ( $X_{i,t}$ ) social network measures predicting wave 3 ( $Y_{i,t+1}$ ) outcomes ( $n = 941$ ). Each set of models controlled for well-being measures from the previous wave ( $Y_{i,t}$ ), as well as later-wave demographic control variables ( $Z_{i,t+1}$ ) and wave-level fixed effects ( $\alpha_{t+1}$ ), as follows:

$$Y_{i,t+1} = \alpha_{t+1} + X_{i,t} + Y_{i,t} + Z_{i,t+1} + \epsilon_{i,t+1}.$$

By stacking the observations in 1 data set, we were able to maximize the sample while maintaining a consistent analysis of the impact of the previous-wave predictors on the subsequent-wave outcomes over a 1-year period.

## RESULTS

In Web Table 2, we compared the characteristics of the sample we used in our analyses (individuals who gave permission for us to access their Facebook data) with the characteristics of those individuals in the full Gallup survey who did not give us permission to use their Facebook data. There are some clear differences. People who gave us permission to use their Facebook data were on average younger (48 years vs. 57 years), more educated, more likely to be female (58% vs. 50%), and more likely to be unmarried (66% vs. 71%), with slightly lower scores on mental health and life satisfaction, significantly more self-reported friends (4.5 vs. 4.0), and less time spent interacting in person with real-world friends.

Table 1 shows the summary statistics for our sample population across all 3 waves. In keeping with past work (36, 40), the average degree per individual was approximately 4 (range, 0–8), whereas the average closeness per individual across friends was a little higher than 8. The mean level of in-person, face-to-face interaction (which does not include telephone, texting, or email interaction) across friends was 3.75 (range, 1.5–5), which equates to a little less than once per week across all nominated friends. The number of Facebook friends on average increased each year from 292 in year 1 to 341 in year 3. The mean lifetime like count also increased each year from 124 in year 1 to 221 in year 3, whereas the mean number of status updates per month was a little more than 4.

### Multivariate regression analyses

We next ran multivariate regression analyses of both physical and mental health. Table 2 shows the results of our statistical analyses.

*Physical health.* In our cross-sectional multivariate analyses, we found that for each 1-standard-deviation increase in lifetime Facebook likes, a person’s self-reported physical health status decreased by 8% of a standard deviation. In the prospective model, most of these associations lost significance, with the exception of lifetime like count and 30-day link count, both of which were still significantly associated with diminished self-reported physical health. Each 1-standard-deviation increase in lifetime like count in wave  $t$  was associated with a decrease of 5% of a standard deviation in self-reported physical health in wave  $t + 1$ , and each 1-standard-deviation increase in 30-day link count in wave  $t$  predicted a decrease of 4% of a standard deviation in self-reported physical health in wave  $t + 1$  after we controlled for physical health in wave  $t$  and all demographic control variables.

*Mental health.* The results of our analyses on mental health were similar to those of our analyses on physical health, albeit with slightly stronger associations and significance across a greater array of predictors. Figure 1 illustrates the cross-sectional associations of Facebook use with mental health. Although having more Facebook friends was associated with better mental health, using Facebook in any of the 3 ways we measured it was associated with worse mental health. On the other hand, nominating more

**Table 1.** Nonweighted Summary Statistics for Respondents, Gallup Panel Social Networks Survey, 2013–2015

Characteristic	Wave 1		Wave 2		Wave 3	
	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%
Self-reported physical health <sup>a</sup>	2.98 (0.68)		2.95 (0.70)		2.93 (0.71)	
Self-reported mental health <sup>a</sup>	3.22 (0.73)		3.20 (0.74)		3.17 (0.75)	
Self-reported life satisfaction <sup>b</sup>	7.05 (1.57)		7.05 (1.60)		7.11 (1.65)	
Body mass index <sup>c</sup>	28.20 (6.50)		28.70 (6.76)		28.70 (6.74)	
Total degree	4.54 (1.53)		4.50 (1.52)		4.39 (1.64)	
Mean closeness across friends	8.24 (0.96)		8.24 (0.97)		8.19 (1.06)	
Mean interaction across friends	3.76 (0.65)		3.78 (0.65)		3.76 (0.67)	
Facebook friend count	292.00 (391.00)		320.00 (370.00)		341.00 (366.00)	
Facebook lifetime like count (lifetime)	124.00 (226.00)		186.00 (371.00)		221.00 (388.00)	
Facebook 30-day status update count	4.39 (8.78)		4.37 (7.59)		4.38 (7.34)	
Facebook 30-day link click count	12.30 (48.30)		16.20 (43.70)		13.70 (44.60)	
Female sex		58		56		54
Age, years	48.40 (14.70)		48.60 (13.90)		48.70 (14.80)	
Educational level <sup>d</sup>	4.84 (1.32)		4.87 (1.28)		4.81 (1.31)	
Mean income <sup>e</sup>	4.73 (1.88)		4.76 (2.04)		4.72 (2.05)	
Marital status						
Married		66		66		64
Separated		1		1		2
Divorced		9		10		9
Widowed		3		3		3
Single		14		14		16
Living with partner		7		6		6
Race						
White		87		89		88
Asian		1		1		1
Black		4		3		3
Other		2		1		1
Mixed		6		6		7
Hispanic ethnicity		8		6		5

Abbreviation: SD, standard deviation.

<sup>a</sup> Rated on a scale of 1–4, as follows: 1, poor; 2, fair; 3, good; and 4, excellent.

<sup>b</sup> Rated on a scale from 0–10, with 0 being the worst and 10 being the best.

<sup>c</sup> Weight in pounds  $\times$  703 divided by height in inches squared.

<sup>d</sup> Educational level was divided into 6 categories: less than high school, high school graduate, vocational school, some college, college graduate, and postgraduate degree.

<sup>e</sup> Annual income was divided into 9 categories: <\$15,000, \$15,000–\$24,999, \$25,000–\$34,999, \$35,000–\$49,999, \$50,000–\$74,999, \$75,000–\$99,999, \$100,000–\$149,999, \$150,000–\$199,999, and  $\geq$ \$200,000.

real-world friends, feeling close to those friends, and interacting with them more frequently were associated with better mental health. In the final prospective models, Facebook use in wave  $t$  was still significantly associated with poorer mental health outcomes in wave  $t + 1$  after we controlled for self-reported mental health in wave  $t$ . Mental health status decreased by 7% of a standard deviation for each 1-standard-deviation increase in lifetime like count, 8% of a standard deviation for each 1-standard-deviation increase in 30-day link count, and 5% of a standard deviation for each 1-standard-deviation increase in

status updates. Although real-world degree and interaction dropped from significance, closeness to friends remained statistically significant. For each 1-standard-deviation increase in average closeness to friends in wave  $t$ , self-reported mental health in wave  $t + 1$  increased by 6% of a standard deviation.

*Life satisfaction.* The results for predictors of life satisfaction were again consistent with what we found with physical health and mental health. We found that using Facebook was associated with lower life satisfaction, whereas having real-life friends and interacting with them was associated

**Table 2.** Facebook Usage and Real-World Social Networks as Predictors of Self-Reported Health and Well-Being Outcomes in the Gallup Panel Social Networks Survey<sup>a</sup>, 2013–2015

Predictors of Well-Being Outcomes	Bivariate Cross-Sectional: 3 Waves		Multivariate Cross-Sectional: 3 Waves		Multivariate Prospective		Multivariate Prospective With Degree	
	$\beta$ (SE)	P Value	$\beta$ (SE)	P Value	$\beta$ (SE)	P Value	$\beta$ (SE)	P Value
<b>Physical health</b>								
Facebook lifetime like count	-0.11 (0.01)	0.00	-0.08 (0.01)	0.00	-0.05 (0.02)	0.03	-0.05 (0.02)	0.03
Facebook 30-day link click count	-0.09 (0.02)	0.00	-0.05 (0.02)	0.00	-0.04 (0.02)	0.05	-0.04 (0.02)	0.04
Facebook status updates	-0.06 (0.01)	0.00	-0.05 (0.01)	0.00	-0.03 (0.02)	0.17	— <sup>b</sup>	
Facebook friend count	0.03 (0.01)	0.03	0.04 (0.01)	0.01	0.01 (0.02)	0.45	— <sup>b</sup>	
Friends nominated	0.04 (0.01)	0.00	0.03 (0.01)	0.01	0.03 (0.02)	0.19	— <sup>b</sup>	
Closeness to friends	0.05 (0.01)	0.00	0.04 (0.01)	0.00	0.02 (0.02)	0.24	— <sup>b</sup>	
Interaction with friends	0.01 (0.01)	0.39	— <sup>b</sup>		-0.01 (0.02)	0.62	— <sup>b</sup>	
<b>Mental health</b>								
Facebook lifetime like count	-0.09 (0.02)	0.00	-0.05 (0.01)	0.00	-0.07 (0.03)	0.02	-0.07 (0.03)	0.02
Facebook 30-day link click count	-0.05 (0.01)	0.00	-0.03 (0.01)	0.01	-0.08 (0.03)	0.00	-0.08 (0.03)	0.00
Facebook status updates	-0.07 (0.01)	0.00	-0.04 (0.01)	0.01	-0.05 (0.02)	0.04	-0.05 (0.02)	0.03
Facebook friend count	0.04 (0.01)	0.00	0.09 (0.01)	0.00	0.03 (0.02)	0.08	0.03 (0.02)	0.09
Friends nominated	0.03 (0.01)	0.01	0.05 (0.01)	0.00	0.03 (0.02)	0.15	— <sup>b</sup>	
Closeness to friends	0.15 (0.01)	0.00	0.13 (0.01)	0.00	0.06 (0.02)	0.01	0.07 (0.02)	0.00
Interaction with friends	0.06 (0.01)	0.00	0.04 (0.01)	0.00	-0.01 (0.02)	0.53	— <sup>b</sup>	
<b>Life satisfaction</b>								
Facebook lifetime like count	-0.15 (0.02)	0.00	-0.08 (0.01)	0.00	-0.06 (0.02)	0.00	-0.06 (0.02)	0.00
Facebook 30-day link click count	-0.09 (0.01)	0.00	-0.06 (0.01)	0.00	-0.06 (0.02)	0.00	-0.06 (0.02)	0.00
Facebook status updates	-0.07 (0.01)	0.00	-0.04 (0.01)	0.00	-0.02 (0.02)	0.34	— <sup>b</sup>	
Facebook friend count	0.01 (0.01)	0.51	— <sup>b</sup>		0.02 (0.02)	0.38	— <sup>b</sup>	
Friends nominated	0.02 (0.01)	0.20	0.02 (0.01)	0.09	0.05 (0.02)	0.01	— <sup>b</sup>	
Closeness to friends	0.17 (0.01)	0.00	0.14 (0.01)	0.00	0.03 (0.02)	0.18	— <sup>b</sup>	
Interaction with friends	0.07 (0.01)	0.00	0.05 (0.01)	0.00	0.01 (0.02)	0.60	— <sup>b</sup>	
<b>Body mass index<sup>c</sup></b>								
Facebook lifetime like count	0.71 (0.12)	0.00	0.59 (0.12)	0.00	0.03 (0.14)	0.83	— <sup>b</sup>	
Facebook 30-day link click count	0.58 (0.14)	0.00	0.40 (0.13)	0.00	0.06 (0.11)	0.59	— <sup>b</sup>	
Facebook status updates	0.56 (0.10)	0.00	0.60 (0.10)	0.00	0.08 (0.08)	0.33	— <sup>b</sup>	
Facebook friend count	-0.10 (0.10)	0.33	— <sup>b</sup>		-0.06 (0.06)	0.35	— <sup>b</sup>	
Friends nominated	-0.28 (0.10)	0.00	-0.22 (0.08)	0.00	0.07 (0.05)	0.21	— <sup>b</sup>	
Closeness to friends	0.07 (0.10)	0.49	— <sup>b</sup>		-0.19 (0.07)	0.00	-0.18 (0.07)	0.01
Interaction with friends	0.25 (0.09)	0.01	0.28 (0.09)	0.00	-0.08 (0.06)	0.22	— <sup>b</sup>	

Abbreviation: SE, standard error.

<sup>a</sup>  $\beta$  coefficients reflect percent standard-deviation change in the outcome as a function of a 1-standard-deviation change in the predictor.

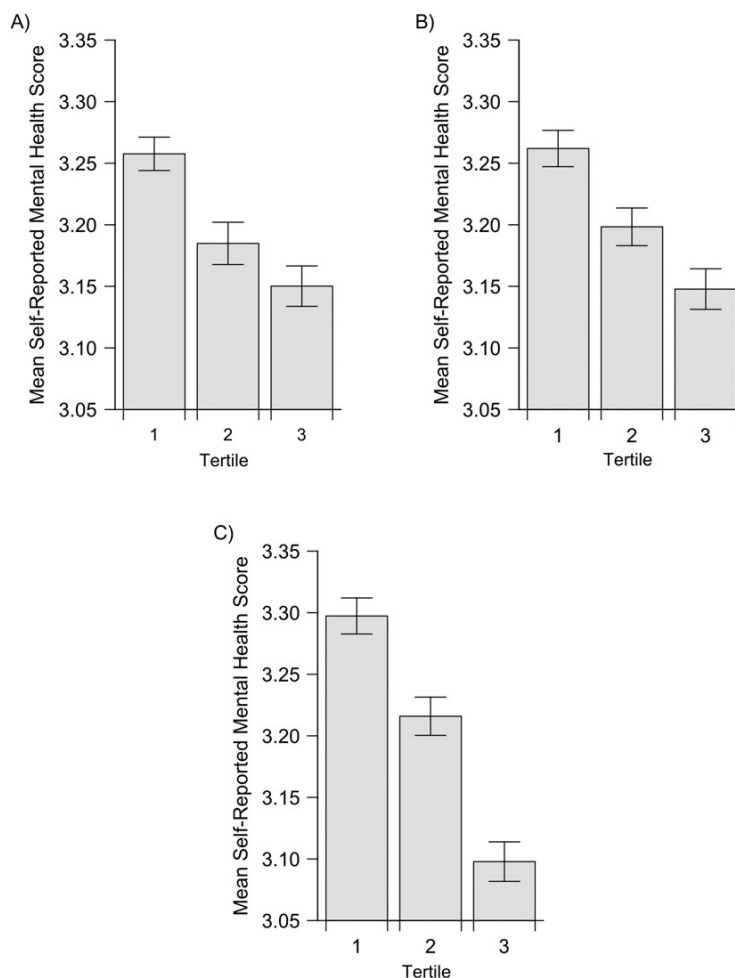
<sup>b</sup> Variables were insignificant in the previous model and therefore were not carried forward to the subsequent model.

<sup>c</sup> Weight in pounds  $\times$  703 divided by height in inches squared.

with higher life satisfaction. In the prospective models, we found that more Facebook likes and link clicks in wave  $t$  were associated with decreased life satisfaction in wave  $t + 1$  after we controlled for life satisfaction in wave  $t$ . Among the real-world relationship measures, the number of friends nominated in wave  $t$  predicted life satisfaction in wave  $t + 1$  after we controlled for life satisfaction in wave  $t$ .

**Body mass index.** Finally, with BMI, the results were consistent across the first 2 sets of models. Using Facebook

was associated with having a higher BMI. In contrast to our previous outcomes in which the associations between the outcome and Facebook use and between the outcome and real-world friend interactions were in opposite directions, frequency of interaction with friends was also positively associated with higher BMI. Having a larger number of nominated friends, on the other hand, was associated with lower BMI. In the prospective models, only closeness to friends was significant.



**Figure 1.** Mean self-reported mental health scores across tertiles of A) Facebook status count, B) Facebook link count, and C) Facebook like count, using cross-sectional data from all 3 waves of the Gallup Panel Social Networks Study, 2013–2015. As Facebook use increases, mean self-reported mental health decreases for each measure.

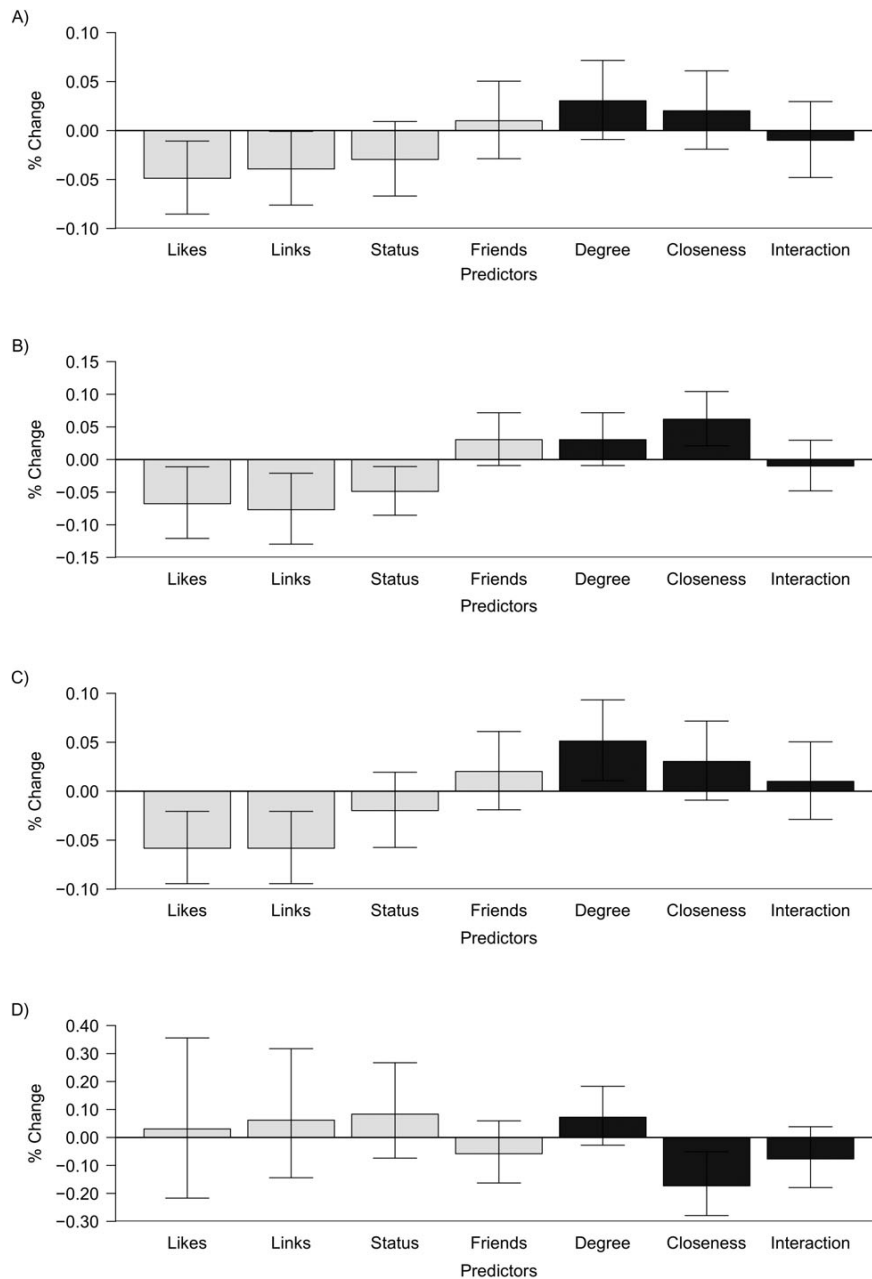
*Models controlling for degree and closeness.* The results for our Facebook use predictors could potentially be the result of confounding. It is possible that those who were initially socially isolated in the real world tended to use Facebook more often. Our final set of models therefore included degree, or the number of nominated real-world friends, to account for that possibility. The inclusion of degree did not change any of our results. Finally, in Web Table 3, we added average closeness with friends to our models. Again, our results are not changed.

## DISCUSSION

Our analyses here are very unusual in that we used 3 waves of nationally representative survey data, including real-world social network measures, in combination with

objective measures of Facebook use that were determined from each respondent's Facebook account. Using this rich source of data, we were able to investigate the associations of Facebook use and of real-world social network activity with self-reported physical health, self-reported mental health, self-reported life satisfaction, and BMI. Although there were some variations in the significance of the different measures across outcomes, a clear pattern emerged. Our results showed that although real-world social networks were positively associated with overall well-being, the use of Facebook was negatively associated with overall well-being. These associations were robust to multivariate cross-sectional analyses, as well as to 2-wave prospective analyses.

Although the positive effects of social support have been well-established, in our longitudinal analyses, the positive associations with real-world networks were less robust than were the negative associations with Facebook use. Figure 2,



**Figure 2.** Percent change in A) self-reported physical health, B) self-reported mental health, C) self-reported life satisfaction, and D) body mass index as a result of a 1-standard-deviation increase in social network predictors using data from the Gallup Panel Social Networks Study, 2013–2015. The Figure illustrates the consistent negative impact of Facebook use across all outcomes and the fact that the effect sizes for Facebook use are comparable to or greater than those of real-world networks. Online social network Facebook use is represented by the 4 left bars and real-world network interaction is represented by the 3 right bars (with horizontal shading). Relationships significant at the  $P < 0.05$  level are shown with confidence interval bars that do not cross the rule at 0.00. Likes indicates the total number of times the respondent clicked “like” on someone else’s content; links indicates the number of times the respondent clicked a link to another site or article in the past 30 days; status indicates the number of times the respondent updated her or his Facebook status in the past 30 days; friends indicates the total number of Facebook friends; degree indicates the total number of real-world friends named; closeness indicates an average rating on a scale of 1–10 across real-world friends; and interaction is an average measure of the frequency of in-person, face-to-face interaction with real-world friends.

which is an illustration of the analyses in Table 2, demonstrates that across all outcomes and all social network predictors, the effect sizes of Facebook use variables are comparable to or greater than the effect sizes of real-world social network variables and also much more likely to be significant across all outcomes. These effect sizes are small, but that is to be expected; they are similar in magnitude to those found in other studies (12, 31) and reveal an important pattern regarding the nature of real-world social interaction compared with online interaction. Liking others' content and clicking links posted by friends were consistently related to compromised well-being, whereas the number of status updates was related to reports of diminished mental health. Although having a greater number of Facebook friends showed a positive correlation with well-being in the cross-sectional models, it did not retain significance in the longitudinal models, which suggests that prior work (33) might have been confounded by other factors.

The associations between Facebook use and compromised well-being may stem from the simple fact that those with compromised well-being may be more likely to seek solace or attempt to alleviate loneliness by excessively using Facebook in the first place. However, the longitudinal models accounted for well-being measures in wave  $t$  when including Facebook use to predict the well-being outcomes in wave  $t + 1$ . Also, in our final models, we included degree (or real-world friendship counts) to adjust for this possibility, and the results remained intact. This provides some evidence that the association between Facebook use and compromised well-being is a dynamic process. Although those with compromised well-being may be more likely to use Facebook, even after accounting for a person's initial well-being, we found that using Facebook was associated with a likelihood of diminished future well-being. The exception to this is the case of BMI. Our cross-sectional models showed a strong correlation between Facebook use and higher BMI. All 3 of these associations dropped out in our prospective models, however, which suggests that those with higher BMI may be more frequent Facebook users, though it is unlikely that Facebook use itself is the cause of higher BMI.

Of the total sample of Gallup survey respondents, a small proportion allowed use of their Facebook data. Those respondents were different from those who did not. They were younger and had more real-world friendships. In addition, there were proportionally more women. These are characteristics that are consistent with Facebook users in general (41). This group is also potentially less concerned with online privacy, as indicated by their allowing access to their Facebook data. How much our results may have changed as a result of these characteristics is hard to say. Although we controlled for age and sex in our analyses, we did not control for privacy concerns, so we cannot assess whether this unmeasured characteristic may have confounded our results. However, because participants in this sample had more friends overall, it may have led to an underestimation of our associations, because the positive association of more real-world friendships may have ameliorated the associations of Facebook usage.

There are other limitations of the present study. First, well-being was established through self-report measures,

which are subject to various types of response biases. Our survey did not assess clinical depression or other potential health conditions that could have increased the likelihood of an individual spending more time on Facebook. Despite this limitation, the fact that the same individuals responded to the same questions across waves suggests that our longitudinal models are illustrative of a dynamic process. Second, although we did have longitudinal data, because of the small number of individuals who gave permission to use their Facebook data, sample size limitations may have decreased the likelihood of finding some significant associations. Although the direction and magnitude of some associations were consistent between the cross-sectional and the longitudinal models, many of the results we found in the cross-sectional models lost significance in the final models. Finally, our models cannot identify the mechanisms by which Facebook use may lead to reduced well-being. Although "liking" other people's content could be reflective of attention to other's positive posts, which could lead to negative self-comparison, updating one's own status and clicking links would seem to suggest that the relationships we found are simply a matter of quantity of use. If this is the case, our results are in contrast to those from previous research asserting that the quantity of social media interaction is irrelevant and that only the quality of those interactions matter. Large quantities of social media interaction may indeed detract from more meaningful real life experiences.

There has been a lack of consensus on the impact of online social network use and well-being, no doubt because of the complexity of these associations but also because of the difficulties inherent in measuring social media use and assessing impact using observational studies such as ours. We overcame some of the weaknesses of prior research by using objective measures of Facebook use and 3 waves of data. Our results are consistent across 3 distinct outcomes, which suggests that overall, Facebook use does not promote well-being and that individual social media users might do well to curtail their use of social media and focus instead on real-world relationships.

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Author affiliations: Division of Global Public Health, School of Medicine, University of California, San Diego, La Jolla, California (Holly B. Shakya); and Yale Institute of Network Science, Department of Sociology, Yale University, New Haven, Connecticut (Nicholas A. Christakis).

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