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Physical activity mediates the association between daily stress and Facebook Addiction Disorder (FAD) – A longitudinal approach among German students

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ABSTRACT

Physical activity has regularly been demonstrated to be a protective factor against stressful experiences. The present study investigated whether physical activity buffers the association between daily stress and Facebook Addiction Disorder (FAD) over a period of one year (first measurement time point, T1: October 2016; second measurement time point, T2: October 2017). In a sample of 122 German Facebook users (82.8% women; age at T1: $M = 21.70$, $SD = 3.67$, range: 17–38), physical activity at T1 mediated the significant positive relationship between chronic daily stress at T1 and FAD at T2 (total effect: $p = .036$; direct effect: $p = .164$). Furthermore, at T2, FAD was significantly negatively associated with positive mental health (i.e., high level of emotional, social, and psychological well-being). The current study provides first longitudinal results of possible risk associated with and potential protective factors of FAD. These results demonstrated that this addictive behavior is positively related to chronic daily stress and negatively related to physical activity. Practical applications for future studies and limitations of the present results are discussed.

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1. Introduction

For many people, use of the social networking site Facebook has become indispensable for their everyday life. Some Facebook members may lose control over their use and exhibit a psychological need to stay online, to update their Facebook page, and to comment updates of other members (e.g., Ryan, Chester, Reece, & Xenos, 2014). Often, if these people do not intensively interact online, they are afraid to be socially excluded and to lose popularity; a phenomenon called “Fear of Missing out (FoMo)” (Beyens, Frison, & Eggermont, 2016; Przybylski, Murayama, DeHaan, & Gladwell, 2013). All these characteristics of problematic Facebook use taken together have caught the attention of researchers (Brailovskaia & Margraf, 2017; Casale & Fioravanti, 2018; Koc & Gulyagci, 2013), with a focus on the so-called Facebook Addiction Disorder (FAD) (Fenichel, 2009). Andreassen, Torsheim, Brunborg, and Pallesen (2012) defined FAD to be a subtype of behavioral

addictions. Earlier studies described salience (e.g., permanent thinking of Facebook), tolerance (e.g., increasing of Facebook usage time to achieve previous positive effect), mood modification (e.g., mood improvement by Facebook use), relapse (reverting to earlier use pattern after ineffective attempts of Facebook use reduction), withdrawal symptoms (e.g., growing nervousness without Facebook use), and conflict (e.g., interpersonal problems caused by intensive Facebook use) to belong to the main characteristics of FAD. Younger age and male gender were found to be its positive predictors (Andreassen et al., 2013; Andreassen et al., 2012; Wilson, Fornasier, & White, 2010). FAD was demonstrated to be positively related to the personality traits narcissism, neuroticism and extraversion. Its association with the traits agreeableness, conscientiousness and openness was negative (e.g., Andreassen, et al., 2013; Brailovskaia & Margraf, 2017). Furthermore, some studies described FAD to be positively associated with insomnia, depression and anxiety symptoms (e.g., Hong, Huang, Lin, & Chiu, 2014; Koc & Gulyagci, 2013).

Certain individuals often resort to Facebook use to find relief and to escape from negative mood caused by daily stress (Ryan et al., 2014). University students, because they are heavy users of social media, represent a group which may interact on Facebook as a

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means of escapism (Brailovskaia & Margraf, 2018; German Federal Statistical Office, 2016; Rehbock, 2017). They frequently experience a high level of academic stress due to grade competition and high pressure to perform (Misra & McKean, 2000; Wunsch, Kasten, & Fuchs, 2017) and tend to excessively use Facebook for mood modification after such stressful experiences (Brailovskaia & Margraf, 2017).

Considering that some cross-sectional studies demonstrated a positive association between Facebook use and well-being, this coping strategy could be helpful at short-term. For example, Brailovskaia and Margraf (2016) demonstrated Facebook users to have higher values of life satisfaction and subjective happiness than Facebook non-users. Social interaction on Facebook (e.g., number of Facebook friends, frequency of posting behavior) was positively related to happiness and anticipated social support (e.g., Lin & Utz, 2015; Liu & Yu, 2013; Manago, Taylor, & Greenfield, 2012). However, considering the few available longitudinal investigations on the use of Facebook, this coping strategy can also negatively impact mental health in the long term and enhance the risk to develop FAD (Brailovskaia & Margraf, 2017). In the longer term, Facebook activity was found to contribute to the decrease of life satisfaction and physical health (Kross et al., 2013; Shakya & Christakis, 2017). Members who did not use Facebook over a one-week period had increased values of positive mood and life satisfaction (Tromholt, 2016). Furthermore, Facebook activity was demonstrated to be negatively associated with academic performance, inter alia because Facebook is often used while studying, which interrupts the learning process (Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013; Kirschner & Karpinski, 2010). In this context, some earlier studies investigating general cell phone use, which also can imply use of Facebook, found it to be negatively related to academic performance (Lepp, Barkley, & Karpinski, 2014), physical activity (Lepp, Barkley, Sanders, Rebold, & Gates, 2013), and positively to poor sleep quality (Li, Lepp, & Barkley, 2015). Moreover, excessive cell phone use was negatively related to parent and peer attachment in a group of college students (Lepp, Li, & Barkley, 2016). To sum up, it can be assumed that excessive long-term Facebook use – similar to excessive cell phone use – often displaces activities that contribute to mental and physical health, academic performance, and maintenance of social relationships, and thus, instead of reducing stress experiences contributes to the enhance of the level of daily stress.

While some earlier studies described acute stress to have a positive impact on health (e.g., improve of immune function) (e.g., Dhabhar & Mcewen, 1997), chronic daily stress experienced across different aspects of life (e.g., family, study, job, and finances) has been demonstrated to have negative impact on mental health by for example enhancing symptoms of depression and anxiety and by decreasing positive well-being (D'Angelo & Wierzbicki, 2003; Edwards & Rothbard, 1999; Parrish, Cohen, & Laurenceau, 2011; Schönfeld, Brailovskaia, Bieda, Zhang, & Margraf, 2016). These do not only cause individual suffering, but also economic burden to the community due to substantial therapy costs and productivity loss (Brailovskaia et al., 2017; Hoffman, Dukes, & Wittchen, 2008). Considering these negative implications, studies have focused on potential resources and strategies to regulate the impact of chronic daily stress on individual health. According to the stress-buffering hypothesis (see Lazarus & Folkman, 1984), physical activity, for example jogging or cycling, can buffer against the negative effects of daily stress and therefore may contribute to the protection of mental health (Gerber & Pühse, 2009; Kindermann, Javor, & Reuter, 2016; Klaperski, Seelig, & Fuchs, 2012; Wunsch et al., 2017).

Even though problematic Facebook use is a subject of international discussion and FAD has been found to be related to personality and mental health (Andreassen et al., 2013; Hong et al., 2014;

Koc & Gulyagci, 2013), only little research exists on FAD, on the reasons for its development and maintenance. Most of the studies utilize a cross-sectional design (Kraemer et al., 1997). Similar to problematic Internet use (Reed et al., 2017), the lack of empirical evidence impedes the recognition of this addictive behavior as a formal disorder in the Diagnostic and Statistical Manual of Mental Disorders (5th ed., DSM-5) (American Psychiatric Association, 2013).

Therefore, the main aim of the present study – which included two measurement time points (T1 and T2) with a time interval of one year – was to investigate whether, on the one hand, chronic daily stress is associated with FAD and, on the other hand, whether physical activity can mediate this relationship in a sample of German university students. This population was chosen as prior research has indicated university students are prone to large amounts of daily stress (Wunsch et al., 2017) and are at risk of developing FAD (Brailovskaia & Margraf, 2017). The results of this longitudinal study may contribute to the exploration of possible mechanisms that could increase the probability to develop FAD and to finding possibilities to prevent such development. Considering earlier findings, we expected chronic daily stress to be positively related to FAD (Hypothesis 1) and negatively to physical activity (Hypothesis 2). Further, we hypothesized physical activity to be negatively associated with FAD (Hypothesis 3). Additionally, we assumed that physical activity at T1 can serve as a mediator between daily stress at T1 and FAD at T2 (Hypothesis 4).

Earlier studies described a positive association between FAD and variables of negative mental health, such as depression symptoms (e.g., Ryan, et al., 2014). However, the association between FAD and positive mental health, that is, high levels of emotional, social and psychological well-being (Lukat, Margraf, Lutz, van der Veld, & Becker, 2016), has not been considered. According to the dual-factor model of mental health, general mental health consists of positive and negative mental health. Both are interrelated but separate unipolar dimensions of mental health (Keyes, 2005; Suldo & Shaffer, 2008). Therefore, we included positive mental health in our present investigation: FAD was expected to be negatively related to positive mental health (Hypothesis 5).

2. Materials and methods

2.1. Procedure and participants

The present study is part of the ongoing BOOM (Bochum Optimism and Mental Health) research program that investigates risk and protective factors of mental health (e.g., Bieda, et al., 2016; Schönfeld et al., 2016). In October 2016, a randomly collected sample of 200 students of a large German university received a collective e-mail invitation to the first online survey (T1) including measures of chronic daily stress and physical activity. The requirement for participation was a current Facebook membership. Additionally, to exclude extreme levels of physical activity, participants were not to be competitive athletes. Those 28 participants who at the beginning of the survey indicated not to meet the requirements, were automatically excluded from further questions of the survey. In October 2017, an e-mail invitation to the second online survey (T2) including measures of chronic daily stress, physical activity, FAD and positive mental health, was sent to these who had completed the first survey ($N = 148$). Participation was voluntary and participating students could be compensated with course credits. In whole, 122 persons (82.8% women; age (years) at T1: $M = 21.70$, $SD = 3.67$, range: 17–38) completed both surveys. While at T1, all participants were students, at T2, 18% of them had finished their studies and were working. The responsible Ethics Committee approved the implementation of the present study.

Participants were properly instructed and gave online their informed consent to participate. A priori conducted power analyses (G*Power program, version 3.1) revealed that the sample size was sufficient for valid results (power > .80, $\alpha = 0.05$, effect size $f^2 = 0.15$; see Cohen, 1988) (cf., Mayr, Erdfelder, Buchner, & Faul, 2007).

2.2. Measures

Daily Stress. The Brief Daily Stressor Screening (BDSS) (Scholten, Lavalée, Velten, Zhang, & Margraf, 2014) was used to measure chronic daily stressful experiences over the last 12 months. The nine items rated on a 5-point Likert scale (0 = *not at all*, 4 = *very much*) assess inconveniences or difficulties in daily life (e.g., family, health, finances, study or job). Earlier, the Brief Daily Stressor Screening has been found to have an internal scale reliability of Cronbach's $\alpha = 0.82$ (Schönfeld et al., 2016). Current reliability: $\alpha_{T1} = 0.75$, $\alpha_{T2} = 0.74$.

Physical activity frequency. Frequency of physical activity was measured by the item "How regularly did you engage in physical exercise in the last 12 months?" rated on a 5-point Likert scale (0 = *never*, 4 = *four times a week or more*) which has been earlier demonstrated to be a reliable and valid instrument to assess physical activity (Milton, Bull, & Bauman, 2011; Velten et al., 2014).

Positive Mental Health. To measure positive mental health, the unidimensional Positive Mental Health Scale (PMH-Scale) (Lukat et al., 2016) was included, consisting nine items (e.g., "I am a calm, balanced human being.") rated on a 4-point Likert scale (0 = *do not agree*, 3 = *agree*). Its internal reliability has been found to be $\alpha = 0.93$. Current reliability: $\alpha_{T2} = 0.92$.

Facebook Addiction Disorder (FAD). To assess FAD over a time-frame of the last year, the brief version of the Bergen Facebook Addiction Scale (BFAS) (Andreassen et al., 2012) was used. This instrument consists of six items (e.g., "Felt an urge to use Facebook more and more?") according to the six core addiction features (i.e., salience, tolerance, mood modification, relapse, withdrawal, conflict). Items are rated on a 5-point Likert scale (1 = *very rarely*, 5 = *very often*). The brief version of the Bergen Facebook Addiction Scale has been demonstrated to have similar good psychometric properties as the long 18-item version. Its internal scale consistency has been reported to be $\alpha = 0.83$ – 0.86 (Andreassen et al., 2013; Andreassen et al., 2012; Pontes, Andreassen, & Griffiths, 2016). Current reliability: $\alpha_{T2} = 0.82$.

2.3. Statistical analyses

Statistical analyses were conducted with the Statistical Package for the Social Sciences (SPSS) 24 and the macro Process version 2.16.1 (www.processmacro.org/index.html). After descriptive analyses of the investigated variables, their associations were assessed by zero-order bivariate correlations and a mediation analysis which included chronic daily stress at T1 (predictor, X), physical activity at T1 (mediator, M), and FAD at T2 (outcome, Y), controlling for age and gender (covariates). In the mediation model, *c* (the total effect) denoted the basic relationship between daily stress and FAD. The path of daily stress to physical activity was denoted by *a*, the path of physical activity to FAD was denoted by *b*. The combined effect of path *a* and path *b* represented the indirect effect. The direct effect of daily stress to FAD after the inclusion of physical activity in the model was denoted by *c'*. The bootstrapping procedure (10,000 samples) which provides accelerated confidence intervals (95% CI) assessed the mediation effect. P_M (the ration of indirect effect to total effect), which has been reported to overcome the shortcomings of the commonly used effect size kappa-squared (κ^2), was included as the mediation effect measure (Wen & Fan, 2015).

Furthermore, a multiple linear regression analysis was calculated that included FAD at T2 as independent variable, and positive mental health at T2 as dependent variable, controlling for age and gender.

3. Results

Table 1 summarizes descriptive values of the investigated variables.

Daily stress and physical activity were (significantly) negatively correlated (T1: $r = -0.310$, $p < .01$; T2: $r = -0.124$, $p > .05$). FAD at T2 was significantly positively related to daily stress at T1 ($r = 0.202$, $p < .05$) and at T2 ($r = 0.427$, $p < .01$), and (significantly) negatively to physical activity at T1 ($r = -0.282$, $p < .01$) and at T2 ($r = -0.176$, $p = .05$), as well as to positive mental health at T1 ($r = -0.066$, $p > .05$) and at T2 ($r = -0.270$, $p < .01$).

Fig. 1 presents the results of the bootstrapped mediation analysis. Physical activity mediated the relationship between daily stress and FAD (total effect, c : $p = .036$; direct effect, c' : $p = .164$). The indirect effect (ab) became significant, $b = 0.036$, $SE = 0.021$, 95% CI [0.006, .092]; P_M : $b = 0.323$, $SE = 1.943$, 95% CI [0.034; 1.269].

The regression model explained 7.9% of the variance, $F(3,118) = 3.379$, $p = .021$. While age ($\beta = -0.080$, n.s.) and gender ($\beta = 0.006$, n.s.) did not show significant results, FAD served as a significant negative predictor ($\beta = -0.259$, $p = .004$, 95% CI [-0.708; -0.134]) of positive mental health.

4. Discussion

In recent years, a number of mostly cross-sectional studies have focused on problematic Facebook use (Hong et al., 2014). However, studies investigating FAD are rare, especially in Germany. The present work belongs to the first studies with a longitudinal design to investigate potential reasons for the development and maintenance of FAD. We found significant associations that contribute to a better understanding of FAD and potential ways to decrease its level.

Chronic daily stress was positively associated with FAD in the present sample of German students (confirming Hypothesis 1). Students often use Facebook to escape from daily experienced (academic) stress. On Facebook, they engage in different positive activities, such as communication and self-promotion regardless of geographical distance, exchange interesting information, or playing online games (Brailovskaia & Bierhoff, 2016). Earlier studies even assumed Facebook use to promote life satisfaction and happiness (Brailovskaia & Margraf, 2016; Kim & Lee, 2011). However, it can be hypothesized that if excessive Facebook activity becomes the only source of joy and relief for a person, the risk to develop FAD may increase (Brailovskaia & Margraf, 2017).

In line with previous studies (e.g., Gerber & Pühse, 2009), we found daily stress to be negatively associated with physical activity (confirming Hypothesis 2). Moreover, physical activity was negatively related to FAD (confirming Hypothesis 3). And, physical activity at T1 mediated the relationship between daily stress at T1 and FAD at T2 (confirming Hypothesis 4). Earlier research has demonstrated that physical activity may buffer the negative impact of stressful experiences on different mental health variables. People with high levels of experienced stress engaging in sport-related activities, such as walking, were more resistant to negative mental health (Klapperski et al., 2012). However, for the first time, the present longitudinal study found that physical activity mediated the relationship between daily stress and FAD. This finding complements previous results by highlighting the potential protective influence of physical activity. But, it is also important to consider that due to the non-experimental design of the current

Table 1
Descriptive statistics of investigated variables at T1 and T2.

	T1		T2	
	M (SD)	Min–Max	M (SD)	Min–Max
Brief Daily Stress Scale	13.11 (6.40)	1–30	13.92 (6.37)	0–32
Physical Activity	3.20 (1.07)	1–5	3.07 (1.07)	1–5
Bergen Facebook Addiction Scale			8.98 (3.64)	6–24
Positive Mental Health-Scale			18.07 (5.91)	2–27
Frequency of Physical Activity	N (%)		N (%)	
(0) "never"	9 (7.4)		13 (10.7)	
(1) "once a month"	22 (18)		21 (17.2)	
(2) "2 to 4 times a month"	36 (29.5)		37 (30.7)	
(3) "2 to 3 times a week"	45 (36.9)		46 (37.7)	
(4) "4 times a week or more"	10 (8.2)		5 (4.1)	

Notes. N = 122; M = Mean; SD = Standard Deviation; Min = Minimum; Max = Maximum; due to rounding, the sum of listed figures at T2 is higher than 100%.

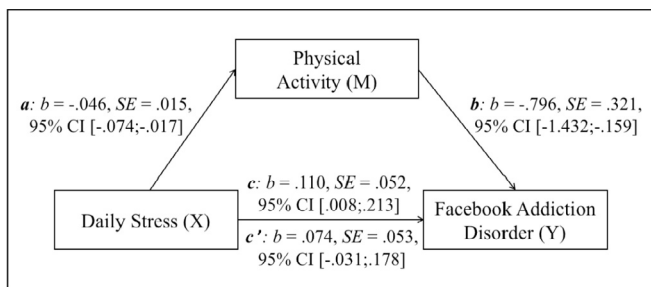


Fig. 1. Mediation model with daily stress at T1 (predictor, X), physical activity at T1 (mediator, M), and FAD at T2 (outcome, Y). c = total effect, c' = direct effect; b = standardized regression coefficient, SE = standard error, CI = confidence interval.

study, causal inference cannot be drawn. Further experimental studies are necessary to examine the hypothetically assumed causal impact of physical activity on FAD.

Currently, Facebook has over 2.1 billion members and is one of the most popular social networking sites (Roth, 2017). Users are often unaware of the possible negative consequences of Facebook activity on their mental health, inter alia, because these are still not sufficiently investigated. Nevertheless, considering the results of recent studies (e.g., Brailovskaia & Margraf, 2017; Casale & Fioravanti, 2018), we expect FAD to gain significance in the coming decades, especially for younger generations. Thus, to reduce the probability of the development of FAD today, it is important that students who experience daily (academic) stress and utilize social media, are aware of the negative consequences of excessive Facebook use as well as of the potential protective influence of physical activity. This seems to be of particular importance considering that, as demonstrated by current results, FAD is not only positively related to negative mental health, but is also negatively associated with positive mental health (confirming Hypothesis 5). Consequently, it can be hypothesized that FAD may impact both dimensions of general mental health described by the dual-factor model (Keyes, 2005). Further investigations on FAD are necessary to help to understand this impact in more detail.

4.1. Limitations and further research

The most important limitation that reduces the generalizability of present results is the mostly female and young composition of our sample. To partly tackle this limitation, we controlled the variables age and gender in our calculations. Nonetheless, to draw more generalizable conclusions, future studies are strongly recommended to replicate current results within a larger, more gender and age representative sample.

Furthermore, data were collected by online self-report surveys known to be prone to socially desirable responding and perception mistakes, especially when investigating addictive symptoms that concerned persons often are unaware of. Additionally, physical activity was assessed with only one item, which – even though earlier found to have sufficient validity and reliability (e.g., Velten, et al., 2014) – makes this measure especially prone to social desirability and memory biases. In future studies, these problems could partly be tackled, on the one hand, by the inclusion of an instrument measuring the tendency of social desirability (e.g., the Balanced Inventory of Desirable Responding, BIDR; Musch, Brockhaus, & Bröder, 2002). On the other hand, objective measures and physiological markers, such as blood pressure, heart rate, and skin conductance, which earlier studies have shown to be connected to problematic Internet use and stress reactions (Reed et al., 2017; Romano et al., 2017) could be considered. Additionally, physical activity should be investigated in more detail by measuring its extent and nature (e.g., team or endurance sport). Moreover, FAD was measured only at T2. Therefore, we cannot determine potential changes of FAD between both measurement time points and make conclusions about its occurrence.

A further limitation of our study design is that even though our longitudinal investigation reveals possible mechanisms behind the development and maintenance of FAD, we cannot draw conclusions on causality from our results. In order to make real causal statements, our work has to be extended by experimental studies that include a manipulation of the independent variables.

Additionally, it is important to mention that while all participants were students at T1, at T2, 18% of the sample had finished their studies and were working. Thus, it cannot be excluded that due to the transition from studying to the working world these 18% of the participants have experienced significant changes of their everyday life and of their life conditions which could influence their response style in our investigation. However, calculations conducted separately in both subsamples (students at T1 and at T2: $N = 100$; students only at T1: $N = 22$) revealed same result pattern. Nevertheless, we advise further longitudinal studies to consider the potential effect of changes of life conditions on the development and maintenance of FAD and its associations.

Considering that 82.8% of our participants were young women, it is important to mention that earlier research demonstrated women with ovulatory menstrual cycles to have a circadian rhythm superimposed on the menstrual-associated rhythm, and menstrual events influence circadian rhythm (Baker & Driver, 2007). Given that these rhythms can impact stress responses and physical activity (Constantini, Dubnov, & Lebrun, 2005; Nepomnaschy, Welch, McConnell, Strassmann, & England, 2004), we advise further studies to control for differences in ovulatory menstrual cycles of female participants and circadian rhythm.

Nevertheless, the current longitudinal findings present significant associations between FAD, daily stress and physical activity. They emphasize that physical activity may buffer the positive relationship between daily stress and FAD and thus may be a protective factor against FAD. Additionally, the current study belongs to the first longitudinal investigations of risk factors that can contribute to the development and maintenance of FAD in German university students. Considering that only little attention has been paid to this research area, the present results demonstrate that further investigations examining FAD are warranted.

Conflicts of interest

None.

Declaration of interest

None.

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