



# The longitudinal interaction of adolescents' interest in physical education, school burnout, and disturbed sleep related to social media and phone use

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## Abstract

This study attempted to explain the relationship of disturbed sleep related to social media and phone use, interest in physical education, and school burnout. A longitudinal survey of two waves was conducted among 2304 eighth- and ninth-grade Taiwanese adolescents of an average age of 13.89 years ( $SD = .76$ ) at Time 1. Cross-lagged modelling revealed that school burnout at Time 1 was positively associated with disturbed sleep related to social media at Time 2; however, the reverse association was not substantial. Moreover, students' interest in physical education at Time 1 did not significantly predict either school burnout or disturbed sleep at Time 2. In contrast, adolescents who had elevated school burnout tended to report lower interest in physical education later, with a very small effect size for practical significance. Physical activities may not easily break the bond of the negative factors of burnout and disturbed sleep unless special programmes are designed.

**Keywords** Burnout · Physical education · Secondary school · Sleep · Social media

## Introduction

Adolescents in developed nations are increasingly applying the Internet and smartphones to manage their day-to-day activities (Haug et al., 2015). The technology also raises challenges such as compulsive Internet use, disturbed sleep, and fear of missing out (Franchina et al., 2018; Salmela-Aro et al., 2017). These problems may be particularly troublesome for early adolescents because they are in a stage of having more autonomy over the use of the Internet and smartphones, developing self-control, and eagerly building up social groups. Moreover, the study load

in secondary schools is heavier than in primary schools. When students experience some level of school burnout, the Internet could be conducive to escape (Walburg et al., 2016). Furthermore, adequate sleep is as vital as a healthy diet and regular exercise. However, mobile phones interfere with adolescents' sleep (Mei et al., 2019), and the use of social media (SM) (e.g., Facebook) keeps adolescents awake while in bed, which reduces their sleep time (Chen & Gau, 2016). SM, disturbed sleep, and school burnout seem to be intercorrelated.

Studies have shown that engaging in physical activities improves sleep quality (Mendelson et al., 2016; Semplonius & Willoughby, 2018). When asleep, the anabolic process which builds and repairs organs and tissues is at its peak. The anabolic process is critical for one to experience restorative sleep (Adam & Oswald, 1977). Inadequate sleep may create a debt burden for the anabolic process, whereas physical activities may enhance the anabolic process and restorative sleep.

Apart from restorative sleep, adolescents can make friends and release their stress when they engage in physical activities. The friends they make can double up as socially accountable group partners. When an adolescent suffers burnout, one way to counter it may be to head to the gym with a companion to play basketball or any other game to refresh themselves (Karpov et al., 2015). Physical activities and social support offer potential alternatives for reducing school burnout and the urge to indulge in the Internet or SM.

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This study investigated the role of physical education in the well-being of adolescents. Our previous study found that students' interest in physical education (IPE) is more important for moderating their compulsive Internet use than real participation in physical activities (Ting et al., 2019). Physical education is part of the mandatory curriculum. Nevertheless, not all students have a high level of interest in physical education. Physical education accompanied by intrinsic interest has a practical impact on students' Internet use. Therefore, this study chose to explore the relation between IPE and other factors. Longitudinal, rather than cross-sectional, data were utilised to better understand how disturbed sleep related to social media and phone use (DSSM), IPE, and school burnout interact, as well as the direction of their relations to one another. Based on the investigation, researchers, students, educators and parents could make informed decisions for helping adolescents overcome the challenges of school burnout and DSSM.

### Disturbed Sleep Related to Social Media and School Burnout

SM has considerably shaped social interactions. Once a recipient reads a message, there is pressure to reply, while at the same time the sender feels ignored if the message receives no response (Tateno et al., 2019). A person with poor sleep hygiene has the habit of using a phone just before bed time or waking up to check messages due to fear of missing out (Franchina et al., 2018). When a person is woken up to attend to SM, it interrupts the metabolic process and hinders the restorative function of sleep (Adam & Oswald, 1977). Moreover, the mistimed light exposure may interfere with melatonin (sleep hormone) secretion, thereby keeping the phone users awake for longer and altering their circadian rhythm. A disrupted circadian rhythm further changes the sleep structure (Chen & Gau, 2016) and reduces sleep time (Mortazavi et al., 2018).

Some empirical studies have reported a positive association between disturbed sleep and frequent use of social media. For example, Levenson et al. (2017) revealed that young adults who often checked SM before bedtime experienced higher sleep disturbance, compared with those who rarely checked SM before bedtime. Tavernier and Willoughby's (2014) longitudinal study with university students also found that problematic sleep is a predictor of longer media and technology use. In particular, adolescents may use media as a sleeping aid (Eggermont & Van den Bulck, 2006). It should be noted that the above-mentioned research, as well as Orben and Przybylski's (2019, 2020) analyses of both retrospective self-report and time-use diary data, has shown significant yet small associations between adolescents' digital engagement and sleep ( $r < .20$ ). Nevertheless, the prolonged accumulated effect due to the interaction of technology use and sleep

deserves more research. It is possible that, given the pervasive and interactive nature of SM, adolescents indulge in SM to relax and pass the time. Disturbed sleep and SM use may become a vicious cycle. The present study combined two notions (i.e., SM use and disturbed sleep) and focused on disturbed sleep specifically linked to the use of SM (i.e., DSSM).

Although scant research has directly examined the relation between DSSM and school burnout, disturbed sleep, SM use, and Internet use have been found separately to be associated with burnout (Evers et al., 2020; Walburg et al., 2016). Hublin et al. (2001) pointed out that insufficient sleep results in daytime sleepiness. Daytime sleepiness and exhaustion (a component of burnout) have a reciprocal relationship (Pagnin et al., 2014). Lehto et al. (2019) confirmed that insufficient sleep and subsequent daytime sleepiness are risk factors for burnout. Regarding the link of SM and Internet use to burnout, according to the self-escape theory (Baumeister, 1989), people may try to escape from themselves if they recognise the disparity between the real self and the ideal self. This discrepancy may be catalysed by pressure for good school performance from relatives, teachers, and the student's own standards (Kiuru et al., 2008). Burnout creates a negative effect, which gives rise to a desire to escape from the self, leading to pathological SM use (Walburg et al., 2016). Additionally, a longitudinal Finnish study by Salmela-Aro et al. (2017) found a reciprocal cross-lagged relationship between school burnout and excessive use of the Internet among adolescents. Similar to the previous findings regarding digital participation and sleep, the correlation coefficients between Internet use and burnout are generally small. Nonetheless, the negative influence could add up to a problem for the young generation. Accordingly, we hypothesized a positive reciprocal relationship between school burnout and DSSM among adolescents (H1), that is, school burnout would positively predict later DSSM, and vice versa.

### School Burnout and Exercise

Burnout is a state of physical, emotional, and mental fatigue which induces exhaustion, depersonalization, and a feeling of a low level of accomplishment in one's work (Maslach & Jackson, 1981). School burnout can be a particular problem in cultures where education is highly valued (Tan & Yates, 2011). Adolescents study hard to attain high academic achievement so as to pass examinations and enter into a prestigious university. Attending a prestigious university is often associated with a good job and high social status. Pressure to attain high academic achievement may create burnout as well as sacrifice sleep and exercise. As a result, a hypothesis in the current study was: adolescents who reported higher burnout would be more likely to report lower IPE later (H2).

The involvement of adolescents and young adults in sports could promote physical and psychological health (Swann

et al., 2018), social skills, cognitive development, academic achievement (Herting & Chu, 2017), self-esteem (Liu et al., 2015), leadership, teamwork, positive thinking, and problem-solving skills (Hellison et al., 2008). In 2015, Gerber et al. conducted a study in Switzerland among vocational students, and revealed that students who performed moderate-to-vigorous physical activity had considerably fewer symptoms of burnout. In addition, other studies have suggested that physical activities can preserve and enhance cognitive vitality (Prakash et al., 2015) and concentration (Brand et al., 2010b), which might reduce school burnout (Ali et al., 2020). Similar findings by Banno et al. (2018) and Brand et al. (2017) also revealed that physical activities improve sleep quality and reduce burnout.

However, a review by Ochentel et al. (2018) warned that among a large number of publications using physical activities as therapy for patients with job burnout, only a handful employed randomized controlled interventions. The effectiveness of physical activities in terms of burnout was not statistically confirmed by the limited high-quality studies available. Further research is needed to settle the issue. Since the current study was set in the context of school, IPE, rather than other physical activities, was examined. The current study contributes to our knowledge of the efficacy of physical education in relation to adolescents' school burnout. It was hypothesized that elevated IPE would predict lower school burnout at a later time among adolescents (H3).

### Sleep and Exercise

Previous research has found that sleep quality positively correlates with exercise (Banno et al., 2018). For example, Brand et al., (2010a) compared physiological patterns between exercisers and non-exercisers. Exercisers showed less rapid eye movement during sleep, took a shorter time to fall asleep, awoke less after the onset of sleep, and generally had greater sleep efficiency compared to non-exercisers. These findings are in agreement with the result of a review article on the association between sleep and exercise, which showed that exercise increases sleep duration and slow-wave sleep (Driver & Taylor, 2000). Slow-wave sleep was found to exist among individuals engaged in vigorous and prolonged exercise (>1 h) (Dworak et al., 2008). Moreover, Kalak et al. (2012) conducted a study among adolescents by engaging them in morning exercise for 3 weeks. The study revealed that with mild exercise, participants exhibited improvement in objective sleep (i.e., increase in slow-wave sleep and decrease in sleep onset latency). Overall, not only prolonged vigorous exercises but even mild exercises had positive impacts on sleep. Furthermore, Wang and Boros' (2021) meta-analysis of the relation between sleep quality and intensity of physical activities concluded that moderate exercise yields a better effect on sleep quality than vigorous exercise. Additionally,

exercisers also exhibit better concentration and less sleepiness during the day (Brand, Gerber, et al., 2010).

Contrarily, Mitchell et al. (2016) claimed no relation between physical activities and sleep. Data measuring sleep, sedentary behaviours, and different levels of physical activities were collected from adult women for seven days using accelerometers. Their study concluded that, in the short term, a daily increase in physical activities may not necessarily translate to improvement of sleep. Differences in the findings of Mitchell et al. (2016), Brand et al. (2010a), and Kalak et al. (2012) may be attributed to variations in sample characteristics. For example, Mitchell et al. (2016) conducted their study among working women ( $M_{age} = 55$  years), whereas the other studies comprised younger samples between 12 and 18 years old. Exercise may be more effective for the young population. Moreover, intervention may be needed to observe any effect.

Additionally, the longitudinal study by Semplonius and Willoughby (2018) examined the relationship between sleep quality, emotion regulation, and physical activities. An autoregressive cross-lagged path analysis disclosed that good sleep quality improves one's ability to better regulate emotion, which in turn improves physical activity over time. The reverse was also verified, whereby a moderate level of involvement in physical activities improves one's ability to have better emotion regulation, which in turn improves sleep quality. That is, sleep quality and physical education have a bidirectional relation through emotion regulation. The results imply that mediators and moderators may be taken into account to explain the relation between the two. Overall, physical activities and sleep quality correlate positively or not at all, but not negatively. Therefore, the current study hypothesized that adolescents reporting higher IPE would report lower DSSM later (H4).

### Demands-Resources Model of Conceptualizing the Relations of School Burnout, DSSM, and IPE

This study utilized the job demands-resources model (Salmela-Aro & Upadyaya, 2014; Schaufeli & Bakker, 2004) to conceptualize the relations of the variables. The model explains positive and negative outcomes of well-being as a result of balancing demands and resources. Demands and resources can be psychological, physical, social, or organizational. Based on the above-mentioned literature review, in the education setting and the adolescent developmental stage, IPE is expected to act as a resource to balance the demands of study load, social support, and disturbed sleep, whereas decreased school burnout and DSSM are the outcomes. For the latter, increased school burnout might demand more SM use to self-escape and gain social support, and elevated DSSM might contribute to more burnout due to daytime sleepiness.

Thus, burnout and DSSM form a vicious cycle and bond as causes and consequences.

In summary, other studies have discussed ways to reduce burnout and problematic sleep. However, no longitudinal study has closely examined how the two problems (i.e., school burnout and DSSM) which seem to have a reciprocal relationship, could be minimized concurrently by factors related to physical activities or physical education among adolescents. Therefore, in this study we examined how interest in physical education, school burnout, and DSSM interact longitudinally.

## Research Questions

The literature has shown that involvement in sports and physical activities improves sleep quality and reduces burnout. Since social media use is an emerging issue for adolescents, the current investigation focused on DSSM, rather than disturbed sleep in general. Furthermore, considering that physical education is mandatory in schools and universities, the investigation would be more meaningful if it incorporated IPE and extracurricular exercises. Based on Ting et al. (2019) and a pilot study, IPE demonstrated stronger correlation than extracurricular exercises to compulsive Internet use and academic performance. Accordingly, IPE was selected for this study. The main research question was: How are the levels of school burnout, DSSM, and IPE related to one another over time? Additionally, the students' overall levels of burnout, DSSM, and IPE as well as the correlations were examined.

## Methods

To answer the research question, longitudinal research was conducted. Data were collected from the same group of participants at two time points. The analyses examined how the adolescents' burnout, DSSM, and IPE at Time 1 (T1) predicted one another at Time 2 (T2).

## Participants

Eighth- and ninth-grade adolescents were recruited in the present longitudinal study from seven schools in the Taipei metropolitan area. The seven schools were selected from a pool stratified according to small/large, public/private, type, and low/high socio-economic districts. Among the seven schools, four were small size, six were public, two were Grade 7–12 comprehensive schools, five were Grade 7–9 middle schools, and three were from socio-economic districts above the average. This sampling technique helped the researchers select a representative sample of different school characteristics.

The participation was voluntary and the responses were confidential. At T1 (December in the fall semester), 2304 students (53.52% male,  $M_{age} = 13.89$  years,  $SD = .76$ ) filled in the questionnaires. The second wave survey took place in May in the spring semester. Participants who did not answer questions of a whole scale at either time ( $n = 152$ ) were removed. Thereafter, data of 2152 students (52.46% males; 1150 eighth graders and 1002 ninth graders) were used in the final analysis. Missing values of partially filled questionnaires were imputed using full information maximum likelihood. There was an attrition rate of 6.60% from T1 to T2. The ninth graders had a slightly higher attrition rate due to graduation activities and absence. An independent sample  $t$  test on the T1 data was used to test if the 152 students who participated only once differed from those who completed both times. There was an insignificant difference in scores in school burnout,  $t(2302) = 1.81$ ,  $p = .07$ , and in IPE,  $t(2302) = .02$ ,  $p = .99$ . However, a statistical significance was realized in DSSM  $t(2302) = 3.00$ ,  $p = .003$ . A chi-square test for gender also revealed a statistical significance  $\chi^2(1, N = 2304) = 14.53$ ,  $p < .001$ . Hence there existed an attrition bias for DSSM and gender, but not for IPE and school burnout. Higher DSSM students and males were more likely not to participate.

## Procedures

The study was conducted using a two-wave panel design with a time lag of 6 months. The questionnaires were distributed to the participants during class, lunch break, or after school, according to their preference. They were asked to complete demographic information along with three scales: DSSM, school burnout, and IPE.

## Instruments

The internal consistency, represented by Cronbach's alpha, and construct validity, tested by confirmatory factor analysis (CFA), were evaluated for all instruments. Model fit indices root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR)  $< .06$ , and comparative fit index (CFI) and Tucker-Lewis Index (TLI)  $> .95$  were considered as good.

## School Burnout Inventory (SBI)

Salmela-Aro et al.'s (2009) School Burnout Inventory (SBI) was used to assess participants' school burnout. The inventory was translated into traditional Chinese and back translated to ensure the same meaning. SBI has nine items and uses a 6-point Likert scale (1 = *Completely disagree* and 6 = *Completely agree*), where a higher score means a higher level of school burnout. School burnout was defined as exhaustion,

cynicism, and feelings of inadequacy regarding schoolwork. Sample items include, ‘I feel overwhelmed by my schoolwork’, ‘I feel a lack of motivation in my schoolwork and often think of giving up’, and ‘I often have feelings of inadequacy in my schoolwork’. The Maximum likelihood estimator was used for CFA with the T1 data. The measurement model had a good model fit: RMSEA = .062, CFI = .981, TLI = .968, and SRMR = .023. Five pairs of the nine items were correlated in their variances. The scale yielded Cronbach’s  $\alpha$  reliability of .89 for Time 1 and .91 for Time 2.

**Disturbed Sleep Related to Social Media**

The DSSM scale has 12 items asking participants about their routine phone practices at bedtime with regard to social media. The questions were framed in relation to LINE messenger and Facebook since they are the most popular social media networks used by the target population. DSSM applied a 5-point Likert scale (1 = *Never* and 5 = *Always*), where a higher score indicates higher DSSM.

Exploratory factor analysis using the T1 data was conducted to investigate the construct validity of the scale. Parallel analysis revealed three factors that explained 60% of the variance: (1) Sleep disturbance by light or vibration from the phone (2 items, e.g., How often is your sleep disturbed due to phone vibration?), (2) Sleep disturbance due to Facebook use (6 items, e.g., How often do you wake up in the night to check Facebook notifications?), and (3) Sleep disturbance due to LINE use (4 items, e.g., How often is your sleep duration reduced due to LINE use before sleeping?). T2 data were used to conduct CFA to confirm the proposed factor structure. Indices of the model showed good fit, RMSEA = .075, CFI = .979, TLI = .971, and SRMR = .026. The DSSM scale had two items which correlated in their variances. The scale yielded a good Cronbach’s  $\alpha$  reliability of .89 and .91 for T1 and T2, respectively.

**Interest in Physical Education (IPE)**

IPE is a subscale of the Sports Interest Questionnaire (Chien & Chen, 2015). IPE has eight items and uses a 5-point Likert scale (1 = *Strongly disagree* and 5 = *Strongly agree*) asking about their feelings about and interest in physical education. Examples of items are: ‘During physical education class, I exercise as little as possible’ as a negative item and ‘I am looking forward to physical education class’ as a positive item. The six negative items were reversely coded. The model fit indices were good: RMSEA = .079, CFI = .985, TLI = .978, and SRMR = .014. The scale yielded an excellent Cronbach’s  $\alpha$  reliability of .94 at both T1 and T2.

**Data Analysis**

For each scale, the composite scores, which were calculated by averaging the scores of the items, were used for descriptive and inferential statistics. Descriptive statistics and correlation analysis were first performed for all the study variables to understand the overall burnout, DSSM, and IPE levels as well as their association. Thereafter, the cross-lagged panel model using Mplus was conducted to test the longitudinal relationship among the variables. Gender and age were controlled as covariates in both waves.

**Results**

**Adolescents’ DSSM, School Burnout, and IPE and their Correlations**

Descriptive Statistics and Pearson correlations among the variables at T1 and T2 are shown in Table 1. The mean scores for school burnout were 3.09 (*SD* = 1.00) at T1 and 3.05 (*SD* = 1.06) at T2, depicting a medium level of burnout. The

**Table 1** Descriptive Statistics (Mean, SD) and Pearson Correlations of the Measures at Time 1 and Time 2

Variable	Mean	SD	1	2	3	4	5	6
1 Burnout T1	3.09	1.00	1.00					
2 Burnout T2	3.05	1.06	.64**	1.00				
3 DSSM T1	1.55	0.69	.23**	.20**	1.00			
4 DSSM T2	1.61	0.75	.22**	.24**	.51**	1.00		
5 IPE T1	3.97	0.90	-.16**	-.13**	-.18**	-.09**	1.00	
6 IPE T2	3.88	0.91	-.13**	-.17**	-.09**	-.24**	.66**	1.00

*Note.* T1 = Time 1; T2 = Time 2; Burnout = school burnout; DSSM = disturbed sleep related to social media; IPE = interest in physical education

\*\**p* < .01

participants' response to IPE had a mean of 3.97 ( $SD = 0.90$ ) at T1 and 3.88 ( $SD = 0.91$ ) at T2 on a 5-point Likert scale. The means imply positive attitudes towards physical education. Moreover, the participants' DSSM was low for both T1 and T2 ( $M_{T1} (SD) = 1.55 (0.69)$ ;  $M_{T2} (SD) = 1.61 (0.75)$ ), showing that a majority of the sample perceived being "Rarely" disturbed in their sleep.

As per our expectation, all variables correlated significantly ( $p < .01$ ) at both times. The intercorrelations were small. For the same pair of variables, the concurrent correlation was higher than the overtime correlation. The patterns were consistent across time points. For example, the correlations between burnout and DSSM were almost identical (.23 and .24,  $p < .01$ ) at T1 and T2, as they were between burnout and IPE,  $r = -.16$  and  $-.17$ ,  $p < .01$ , at T1 and T2.

### The Relationships among DSSM, School Burnout, and IPE

Since all the correlations were found to be significant, we continued and tested the autoregressive and cross-lagged paths without exclusion of any variables. The model controlled gender and age for both T1 and T2; gender was a significant covariate for burnout, DSSM, and IPE at T1 and IPE at T2; and age significantly covaried with DSSM at T1 and T2. The standardised coefficients of the saturated model are shown in Fig. 1. The results suggest that school burnout, DSSM and IPE had strong autoregression from T1 to T2. The coefficients were .64, .48, and .59,  $p < .001$ , respectively.

The results show some significant cross-lagged coefficients with small effect sizes. There were reciprocal cross-lagged paths between adolescents' school burnout and DSSM. In other words, school burnout at Time 1 positively predicted later disturbed sleep related to social media and phone use at Time 2, and vice versa. This finding supports the perspective that students suffering from school burnout are likely to seek escape by indulging more in social media as a way of coping with the burnout effect (Walburg et al., 2016). At the same time students' indulgence with social media may end up

having reduced sleep time which is positively correlated to burnout.

Moreover, school burnout at Time 1 negatively predicted later IPE at Time 2, but not the other way around. There were no significant cross-lagged paths between IPE and DSSM. This finding implies that IPE has no significant bearing to either DSSM or school burnout.

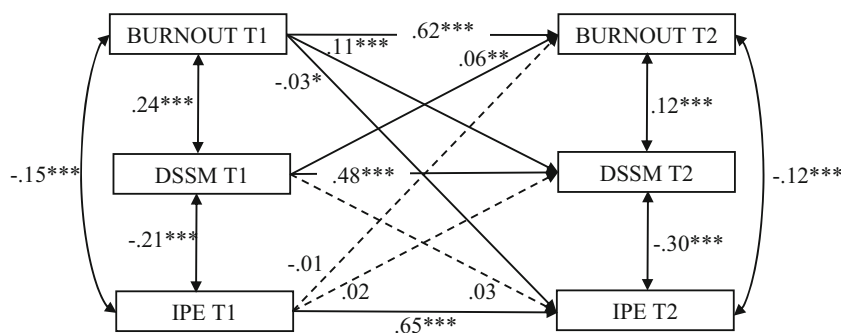
### Discussion

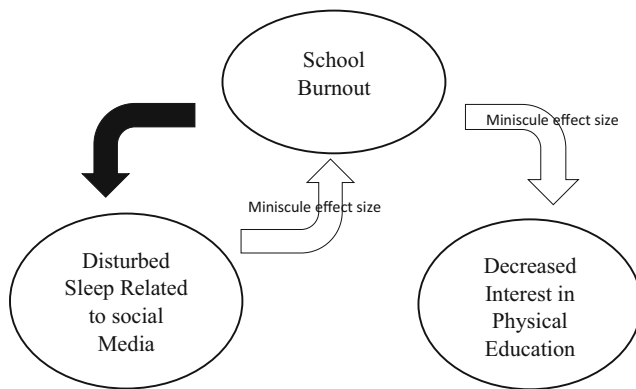
This study found that, among Taiwanese adolescents, IPE, school burnout, and DSSM were all significantly correlated. If the study had only examined cross sectional data (concurrent  $|r| = .16-.24$ ), the conclusion would confirm all hypotheses based on the extant literature. Our longitudinal data further revealed the direction of these relationships over time. Statistically significant cross-lagged associations relating burnout to DSSM, DSSM to burnout, and burnout to IPE were found. However, the last two associations were too small ( $r^2 < .01$ ) to denote practical significance or to avoid a high false positive result (Orben & Przybylski, 2019). The adolescents experiencing school burnout at Time 1 were more likely to experience DSSM at Time 2, but DSSM at Time 1 had a miniscule association with burnout at Time 2. The relation between burnout and DSSM was not utterly reciprocal. H1 was only partially supported. Similarly, the level of burnout at Time 1 was not substantively associated with IPE at Time 2. H2 was therefore disconfirmed. Moreover, the within person differences in IPE at Time 1 were not significantly related to differences in burnout or DSSM at Time 2. Thus, H3 and H4 were not supported, either. The relation is sketched in Fig. 2.

### Interest in Physical Education Could Not Predict Later School Burnout and Disturbed Sleep Related to Social Media

Our results negate the hypothesis that adolescents motivationally engaged in physical education reduced DSSM and school burnout. The hypothesis was based on previous findings that

**Fig. 1** Cross-Lagged Association Between Adolescents' School Burnout, Disturbed Sleep Related to Social Media and Phone Use (DSSM), and Interest in Physical Education (IPE) at Time 1 (T1) and Time 2 (T2). Note. Statistics are standardized coefficients. Dotted lines represent nonsignificant relations. \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$





**Fig. 2** The Relation of School Burnout, Disturbed Sleep Related to Social Media, and Interest in Physical Education

physical activities may improve sleep (e.g., Banno et al., 2018; Brand et al., 2017) and reduce job burnout (Ali et al., 2020). The different results could be caused by the research design. From the Pearson correlation results, interest in physical education had significantly negative correlations with both DSSM and school burnout. This was consistent with previous studies. Even though cross-sectional correlation results revealed statistical significance between all the variables, the cross-lagged paths showed no link of earlier IPE to later burnout or DSSM. Our finding echoes Ochentel et al.'s (2018) review of well controlled experimental research in the occupational context. Exercise alone may not alleviate burnout symptoms. Other than previous studies being cross-sectional, the difference in scales used to measure disturbed sleep may have also contributed to the odds in our results. Whereas we focused on disturbed sleep related to the use of social media, Brand et al. (2017) looked at symptoms of insomnia, and the meta-analysis by Banno et al. (2018) included studies related to general sleep problems. Finally, many studies that supported the effectiveness of physical activities on burnout and sleep employed specific interventions or combined with cognitive behavioural therapy. However, in the current study, physical education is a compulsory subject in the school curriculum. Lack of intrinsic motivation for physical education or not being able to do physical activities they enjoy in their physical education classes may diminish its effect on burnout and DSSM. The different findings might be related to purpose-built interventions and involvement of interesting activities in obligatory physical education.

### Interest in Physical Education and Disturbed Sleep Related to Social Media and Phone Use Do Not Directly Interact

The cross-lagged paths between IPE and DSSM were insignificant. This is consistent with the findings of Mitchell et al. (2016) who examined the association of physical activity patterns with sleep late at night: higher physical activities could not improve women's sleep at night. However, this

contradicts Kalak et al. (2012), who found that even a 30-min daily morning run is sufficient to improve sleep quality among adolescents. Previous studies that applied physical activities to remedy sleep problems often chose participants with severe sleep disturbance (Ali et al., 2020; Gerber et al., 2015; Mendelson et al., 2016), whereas the middle schoolers in the present study reported low DSSM. The results could depend on the characteristics of the subjects. Moreover, a longitudinal study by Semplonius and Willoughby (2018) claimed that sleep and physical activities are linked through emotion regulation. Moderators or mediators may be taken to fully realize the role of physical education.

### School Burnout Contributes to Disturbed Sleep Related to Social Media and Phone Use Rather than the Inverse

Burnout at Time 1 positively predicts DSSM at Time 2. However, DSSM at Time 1 is not substantially associated with burnout at Time 2. Burnout and DSSM do not interact reciprocally. Although prior relevant work revealed reciprocal positive cross-lagged paths between school burnout and excessive Internet use (Salmela-Aro et al., 2017) and insufficient sleep as a predisposing factor of burnout and daytime sleepiness (Lehto et al., 2019), the current study suggests a different notion. The more school burnout students suffer, the more they are likely to escape to SM to ward off the effects of burnout, resulting in higher DSSM. On the other hand, no noticeable evidence shows that DSSM leads to burnout.

### Conclusion

Adolescents experiencing school burnout and DSSM are more likely to have both their academic performance and general wellbeing undermined (Gerber et al., 2015; Lehto et al., 2019) or vice versa (Evers et al., 2020). This study was the first to explore the role of physical education to concurrently address the problems of adolescents' school burnout and DSSM longitudinally. The cross-sectional correlations are consistent with findings of previous studies. The cross-lagged panel analysis revealed more details of longitudinal interactions. Even though the former has suggested that physical activity mitigates the problem of DSSM or school burnout, the latter has not confirmed the suggestion. Interest in physical education may not easily break the bond of the negative factors of school burnout and disturbed sleep related to social media use by adolescents.

Reflecting on the demands-resources model, interest in physical education failed to function as a resource to balance school burnout and DSSM. Rather, it might be a negative outcome of school burnout. Based on the comparison of the research designs as well as findings in the previous and current studies, schools may have to employ special programmes or

actively integrate strategies into physical education to create an effect on releasing students from burnout and disturbed sleep related to social media and phone use. For instance, incorporating self-regulated learning strategies into physical interventions could be effective, as suggested by Kolovelonis et al. (2012).

Furthermore, school burnout and DSSM should not be treated solely as outcomes. Burnout contributed to DSSM and could increase demands for adolescents' learning. Therefore, another approach in addition to interventions in physical education may be to tackle the bond of school burnout and DSSM. Students may be taught how to cope with burnout and avoid phone use and SM message disturbance before bed and during sleep. For example, adolescents may be guided to set personal goals on the outcomes they want to realize, such as the reduction of SM use during the night. Likewise, Abenavoli et al. (2013) found that mindfulness can protect against emotional burnout.

There are a number of limitations to this study, and as such our results should be interpreted with caution. This study had only two waves of data. Longer study periods with additional waves may help gain a better insight into the relationship of these variables. Likewise, future research could adopt wearable devices to measure exercise and sleep variables rather than relying on retrospective self-reported instruments which may be prone to some subjectivity. Moreover, the coefficients on the cross-lagged paths were small. Due to these weak associations, potential mediating and moderating factors may be considered in future studies. The interval between waves may also influence the strength of associations. Finally, a higher percentage of subjects who missed the second survey were males and possessed higher DSSM. Although the overall missing rate was low, it could still create some coverage errors in the results. For example, physical education might have a more definite effect on those who have severe burnout or DSSM. Future studies may investigate this group.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s12144-021-01709-4>.

**Data Availability** All data generated or analysed during this study are included in the supplementary information files.

## Declarations

**Ethical Approval and Informed Consent** The ethical and consent statement is available in the cover letter.

**Conflict of Interest** The authors declare that they have no conflict of interest.

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