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Adolescents' problematic internet and smartphone use in (cyber)bullying experiences: A network analysis

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Background: This study investigates both offline and online bullying perpetration and victimization in association with problematic internet use (PIU) and problematic smartphone use (PSU), while also considering the related psychosocial difficulties. **Methods:** A total of 3939 adolescents (49.4% boys, aged 13–15 years) from a representative sample of schools in Slovakia was obtained from the Health Behavior in School-aged Children (HBSC) project in 2018. Due to the lack of similar complex research and the expected mutual associations among the constructs, we compared exploratory network models that provided separate estimates for boys and girls. **Results:** The constructs formed similarly clustered networks for both genders, with a few notable differences. Unlike PIU, PSU was not associated with bullying experiences in boys or girls; however, PSU and PIU were partially related in girls. Bullying experiences formed a strong cluster in both networks. Two strong bridges were identified, and they are potential candidates for intervention in both boys and girls: first, traditional bullying victimization connected the cluster of bullying experiences to psychosocial difficulties; and, second, frequently missing sleep or meals due to internet use (behavioral salience) that is connected to the bullying cluster with PIU. **Conclusions:** The findings offer an indication for the preventive and interventive work of practitioners who deal with adolescents, as well as complex gender comparisons for the mutual relations of problematic internet and smartphone use, bullying experiences, and the psychosocial difficulties of youth. This study provides evidence that problematic digital media can play a role in bullying experiences irrespective of whether bullying happens offline or online.

Key practitioner message

- Existing research found isolated relationships among psychosocial difficulties, problematic internet use (PIU), problematic smartphone use (PSU), and bullying experiences; however, no studies offer complex models.
- We applied network modeling to explore mutual relationships among individual symptoms.
- PSU was not associated with bullying experiences in the network for either gender.
- We identified traditional bullying victimization and the frequent missing of sleep and meals due to the internet as the most important intervention candidates for both genders.
- The girls' network showed the symptoms of conflict and withdrawal (in PIU) as additional intervention candidates.

Keywords: adolescence; Bullying; cyber bullying; problematic internet use; problematic smartphone use

Introduction

The use of digital technologies has become the most important leisure-time activity for adolescents, and it is one of the most important socializing factors in their development. Although it provides undeniable opportunities, it is associated with several challenges and risks that did not exist in the pre-internet society (e.g., cyberbullying, addictive or problematic use of the internet – PIU, or smartphones – PSU) and that can exacerbate other traditional risks (e.g., school bullying that can transit online). However, only a limited amount of literature has addressed the associations among traditional bullying and cyberbullying, on one hand, and PIU and PSU, on the other hand.

Traditional bullying is defined as repetitive episodes of aggressive behavior with the intention of doing harm on physical, psychological, or social levels, and it has a typical disproportional power position between the perpetrator and the victim (Olweus, 1993). The definition of cyberbullying is derived from the conceptualization of traditional bullying, and it is usually understood to be

repetitive and intentional harmful behavior conducted via digital devices (e.g., smartphones) and online internet applications (e.g., social networking sites) (Smith et al., 2008). Both phenomena tend to converge and overlap – cyberbullying often happens as an extension of school situations and school bullying (Modecki, Minchin, Harbaugh, Guerra, & Runions, 2014; Ševčíková, Šmahel, & Otavová, 2012). Both traditional bullying and cyberbullying have been associated with shared underlying explanatory mechanisms (Chan & Wong, 2015). Both types of hurtful behavior are associated with maladaptive behaviors and impulsivity (Kokkinos, Antoniadou, & Markos, 2014; Kowalski, Giumetti, Schroeder, & Lattanner, 2014), depressiveness, and other emotional and behavioral difficulties (Camerini, Marciano, Carrara, & Schulz, 2020; Chan & Wong, 2015; Gámez-Guadix, Orue, Smith, & Calvete, 2013). Externalizing problems (i.e., behavioral and impulsivity issues) were found to be particularly strong in predicting perpetration. Emotional difficulties were found to be important for predicting victimization (Holfeld & Mishna, 2019). Traditional bullying seems to be more prevalent compared to cyberbullying, and boys are more often the perpetrators and victims (Arnarsson et al., 2019). With respect to cyberbullying, boys are more often its perpetrators than girls (Craig et al., 2020), and girls are more likely to be the victims (Barlett & Coyne, 2014). Gender differences were found to be prevalent also across bullying and cyberbullying experiences – boys were found to be more likely cyberbullying perpetrators if they were previously victims of traditional bullying (Zsila et al., 2018).

PIU and PSU are operationalized as the inability to control one's use of the digital medium, which leads to harmful consequences. They include symptoms typical for addictions, like significant preoccupation, associated mood changes, difficulties with limiting or controlling usage, and significant life impairment due to the usage. Both PIU and PSU represent umbrella terms that cover various usage patterns (e.g., gaming, watching videos, social networking; Fineberg et al., 2018). Some studies point out their convergence (Škařupová, Ólafsson, & Blinka, 2016) and that many users suffer from both issues (Lee et al., 2018). Other studies signify potential differences and the need for their differentiation (Montag, Wegmann, Sariyska, Demetrovics, & Brand, 2021): PIU is more typical for excessive gaming (Blinka et al., 2015), and PSU is almost identical to the problematic use of social networking sites (Marino, Canale, Melodia, Spada, & Vieno, 2021). While boys tend to score higher in PIU, girls tend to be higher in PSU (Choi et al., 2015).

There are several reasons why traditional bullying and cyberbullying experiences may be associated with PIU and PSU. According to Problem Behavior Theory, adolescent risks tend to be grouped and emerge in clusters (Jessor & Jessor, 1977). This is largely due to their shared underlying psychosocial factors, like externalizing problems (e.g., impulsivity, problematic behavior) and internalizing problems (e.g., emotional and peer difficulties). These factors were found to play an important role in bullying experiences, as well as in PIU and PSU (Camerini et al., 2020; Carli et al., 2013; Holfeld & Mishna, 2019; Kim & Ha, 2018). Furthermore, several studies suggest that the prevalence of bullying experiences (especially its cyber-variant) is higher in the population of problematic internet users (Casas, Del Rey, & Ortega-Ruiz, 2013; Gámez-Guadix et al., 2013). One of the explanations for this connection is that both phenomena share a digital media platform and, simply, more digital media use translates into more encountered risks (Staksrud, Ólafsson, & Livingstone, 2013). Another explanation is that excessive time spent with digital media can translate into lower involvement in constructive, protective, and beneficial socialization and that may limit adolescents' social skills and competence (Jiang & Peterson, 2012), which may, together with dysregulated emotions, result in inappropriate and aggressive behaviors (Nasaescu, Marin-Lopez, Llorent, Ortega-Ruiz, & Zych, 2018; Rasmussen et al., 2015). Lastly, negative experiences with bullying may lead adolescents to excessive digital media use due to its mood management properties. A regular escape may then lead to addictive patterns of use (Li et al., 2019). Despite this knowledge, we have at our disposal only a limited number of studies that have systematically analyzed traditional school bullying and cyberbullying in relation to excessive digital media use. The only systematic review of the topic (Vessey, Difazio, Neil, & Dorste, 2022) was recently completed, and it identified 14 empirical studies that researched the association between bullying experiences and excessive digital media use. The conclusion is that there is solid evidence that cyber victimization and perpetration incidents are connected to PIU. However, the majority of the studies concerned only cyberbullying experiences, while traditional bullying was not properly considered (Vessey et al., 2022).

To sum up, mutual relationships exist between perpetration and victimization in both traditional bullying and cyberbullying. At the same time, all bullying experiences are potentially related to excessive digital media use. Lastly, both bullying experiences and excessive digital media use, and their relationships, may be partially explained by shared psychosocial factors. However, we have no study at our disposal that has explored all of the potential associations in a single model. Thus, the purpose of this study is to fill this gap with a large representative sample of adolescents and a network analysis as the main analytical strategy. Due to expected gender differences, the analysis was conducted separately for boys and girls. The network approach assumes variables (e.g., symptoms) that mutually cause each other. This theoretical framework matches our expectations because we assume that the interacting items of the measured problematic behavior play different roles in the network. We specifically focus on exploring *bridges* (Fried et al., 2017), i.e., specific variables/items that connect clusters of symptoms and that represent candidates for intervention in practice (Jones, Ma, & McNally, 2021).

Methods

Sample and procedure

Data from the Health Behavior in School-aged Children (HBSC) study, conducted in Slovakia in 2018, were used. The project conducted a two-stage sampling procedure to obtain a representative sample of school children, aged 11–15. First, 140 elementary schools located in all of the regions of Slovakia were invited to participate. These were selected through weighted

random selection (i.e., type of school, region) from a list of all eligible schools in Slovakia (N = 1616), which was obtained from the Slovak Institute of Information and Prognosis for Education. The school-response rate was (73.6%). Second, schools that decided to participate had one class per grade within the target group randomly selected. Parents had the opportunity to refuse participation if they disagreed with their child's involvement. The data were collected anonymously by a team of trained administrators and in the absence of teachers. The data collection, management, and storage strictly followed the HBSC protocol.

Consequently, a representative sample of 8405 adolescents in Slovakia was obtained. Since the PSU scale was administered only to those of age 13+, we proceeded only with children aged 13+ years, which composed of 5054 adolescents (mean age: 14.35 years; 51.7% boys). After handling the missing data (see below), the final sample consisted of 3939 adolescents (mean age: 13.90 years, 49.4% boys).

Measures

Data for the present analyses were collected with questionnaires from the standardized research protocols for the 2017/2018 HBSC study (Inchley, Currie, Cosma, & Samdal, 2018), except for the Excessive Internet Use Scale and Mobile Phone Problematic Use Scale, which were used only in Slovakia. The complete wording of the items is available in Supporting Information (Table S1).

Bullying was assessed by four items that addressed the frequency of bullying-related experiences. We measured traditional bullying with two questions that asked about the frequency of taking part in perpetrating behavior (item *blP*) or being a victim of such behavior (item *blV*). The response format had five options that ranged from 1 = "*did not participate*" to 5 = "*multiple times per week*". This measure was derived from the Olweus Bullying Scale (Olweus, 1993). Besides traditional bullying, we also assessed cyberbullying experience using similar items and response format as for traditional bullying (items *cblP* and *cblV*).

Problematic Internet Use (PIU) was assessed with the five-item *Excessive Internet Use Scale* (eukidsonline.net; Škařupová, Ólafsson, & Blinka, 2015). This instrument captures five domains of the symptoms of addiction – salience, withdrawal symptoms, relapse, tolerance, and conflict – and adapts them for internet use. Applying a 4-point response format (ranging from 1 = "*never*" to 4 = "*very often*"), participants rated how often they had experienced the symptoms in the preceding 12 months. The scale's McDonald's omega was 0.78 in our sample.

Problematic smartphone use (PSU) was measured by the *Mobile Phone Problematic Use Scale* (Foerster, Roser, Schoeni, & Röösli, 2015). The scale includes 10 items that addressed four domains related to the symptoms of addiction (e.g., loss of control, withdrawal, negative life consequences, and craving) and a fifth domain that reflected the social component of mobile phone use (i.e., peer dependence). One item was omitted from the original measure due to its irrelevance to the adolescent sample (i.e., "*I have received mobile phone bills I could not afford to pay*"). Participants were offered a 5-point response format (that ranged from 1 = "*totally disagree*" to 5 = "*totally agree*"). The scale's McDonald's omega was 0.90 in our sample.

Psychosocial difficulties were assessed with the difficulties part of the *Strengths and Difficulties Questionnaire* (SDQ; Goodman, 2001). The 20-item scale potentially captured a spectrum of difficulties that included hyperactivity/inattention, behavioral problems (both forming externalizing problems clusters), peer problems, and emotional difficulties (both forming internalizing problem clusters). Respondents were asked whether they had any of the difficulties described. Items were scored on a 3-point scale (i.e., "*not true*," "*somewhat true*," "*certainly true*"), and five items were reversed to express the degree of problems as the remaining 15 items (i.e., the higher the score, the more frequent the problem). Conventionally, we used item labels to denote the content of each item (e.g., *Restless*).

Statistical analysis

The data were analyzed using R (version 4.1.2; R Development Core Team, 2011) and RStudio software (version 2021.09.1). The complete analytic script and data are available in the Supporting Information. Missing data were originally present in all of the items, ranging from 2.1% (*Restless*) to 19.01% (*PSU9*) per item. We conducted a two-step procedure for data preparation. First, cases with too many missing values ("NAs") were deleted to ensure only valid responses: NA > 5 for SDQ; NA > 2 for PIU; NA > 3 for PSU and any non-complete cases for four bullying items, since those were central to our research purpose. Second, we applied the Classification and Regression Trees (CART; Burgette & Reiter, 2010) method for multiple imputation, which performs well on non-normal and ordinal data, according to Wongkamthong and Akande (2020). We also calculated descriptive statistics for each item of the full sample (i.e., mean, standard deviation, median, minimum, maximum, skewness, and kurtosis) and other statistics for each gender subsample (i.e., mean, standard deviation, and median).

To determine the mutual associations among PIU, PSU, psychosocial difficulties, and bullying experiences, we freely estimated two network models (one for each gender, n_{boys} = 1941 and n_{girls} = 1998) using the *qgraph* package (Epskamp et al., 2021). Generally, a network model consists of *nodes* (measured variables) and *edges* (connections between the nodes after controlling for all of the variables). We chose the stepwise *ggmModSelect* estimation method and nonparanormal transformation, which handles non-normal data well (Zhao, Liu, Roeder, Lafferty, & Wasserman, 2012). The network models were plotted via the *qgraph* package, with the threshold = 0.099 applied, which omitted edges we considered too weak. We plotted average layouts for an easier comparison of the networks and estimated centrality indices (i.e., strength, closeness, betweenness, and expected influence for each node).

We also identified *bridge items* (i.e., variables that could play a role in maintaining the comorbidity of the examined problems and be potential candidates for intervention). We estimated *bridge strength* with the *networktools* package (Jones, 2018) to show which variable/item from a certain cluster most strongly connected to all of the variables in another cluster.

Both the networks and the indices were tested for stability by the *bootnet* package (Epskamp & Fried, 2020) by applying nonparametric bootstrapping (n = 1000). The indices were also tested by the case-dropping subset bootstrap (n = 1000). Following Epskamp, Borsboom, and Fried (2018), we considered the *correlation stability coefficient* (CS) (r = .7) ≥ .5 to indicate good stability.

Finally, we compared the two networks. We followed Fried et al.'s (2018) procedure to obtain the *similarity coefficient* (i.e., correlating the adjacency matrices of the two networks), including their edge-weight matrices, using Spearman's correlation.

Results

The descriptive statistics of the items, after imputation, are presented in Supporting Information (Table S2). Fifteen items had absolute skewness >1 and 17 had absolute kurtosis >1. The median differed between the genders only in five items: *Worries*, *Unhappy*, *Fears*, *PIU3*, and *PSU9*. Bivariate Spearman's correlation coefficients were also calculated for all of the items (see Table S3).

Figure 1 presents networks estimated separately for each gender. Edges between the nodes represent partial correlations between the items. Both networks were formed by several distinguishable clusters, based on the measured constructs. PSU and PIU are densely internally connected regardless of the gender subsample. This finding points to the relatively high reliability of the measures. The four bullying items are also closely

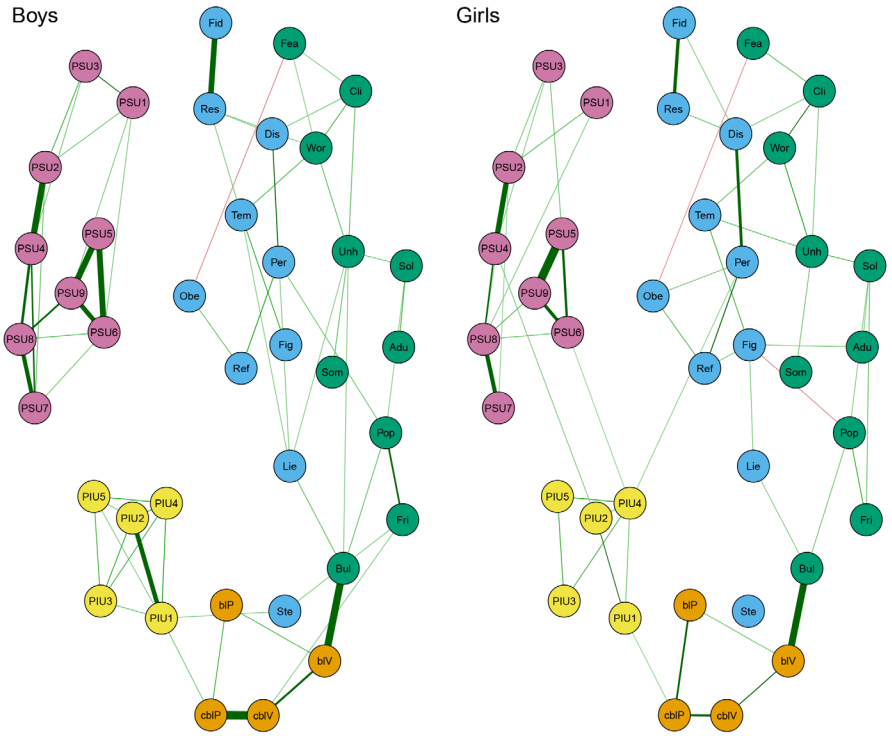

Figure 1. Network plot for boys and girls

interconnected; however, in both networks, the *Bullied* item (labeled "Bul") of the SDQ measure is also strongly associated with the bullying victimization item.

Overall, the two structures look similar at first. However, several edges are different for the two samples. First, the boys' answers on PSU are not connected to their PIU responses. For the girls, these two constructs are interconnected via two edges ≥0.1, namely *PSU4 – PIU2* and *PSU6 – PIU4*. The latter item also binds to the *Reflective* item from the SDQ. PIU is connected to cyberbullying perpetration in both networks through *PIU1*. In boys, cyberbullying experiences were connected more strongly than in girls, whose experience with cyberbullying perpetration seemed to be explained more equally by both cyberbullying victimization and traditional bullying perpetration.

More items interconnected psychosocial difficulties with bullying experiences among boys, compared to girls (i.e., *Lies*, *Friends*, *Popular*, *Unhappy*, and *Steals* items in boys and *Lies*, *Friends*, and *Popular* in girls). Finally, psychosocial difficulties were interconnected by a number of items for both genders, with the exception of the *Steals* item in the girls' network, where no meaningful edges were found.

Stability of the results

Based on the results of network stability tests, bootstrapping all of the edges for each network showed that edges with value >0.1 are stably different from zero (see Figures S1 and S2); therefore, in hindsight, we find our decision to put the threshold on edges <0.099 to be adequate. Statistical differences between all of the edges for both networks are available in Figures S3 and S4.

We estimated centrality indices to infer the overall importance of each node in the network (see Figure S5). However, only the expected influence index, which quantifies relative node importance when negative edges are present, reached good stability and, therefore, only it can be interpreted (see Figures S6 and S7). The CS-coefficients were below the acceptable level (0.5) in betweenness for the networks, so this centrality should be interpreted with caution. Overall, the expected influence of the nodes was similar for the genders. The most influential ($z > 1$) variables were *Unhappy*, *PSU6*, *PIU2*, *PSU8*, *PSU4*, and *PSU9* for boys and *PSU6*, *PIU2*, *PSU8*, *PIU1*, *Bullied*, *PSU4*, and *Unhappy* for girls (see Figure S5). The largest gender differences in expected influence were present in the *Unhappy*, *Bullied*, *Persistent*, and *Somatic* items.

Intervention-related findings

To identify items that are potentially important for intervention, we estimated bridge strength for the selected nodes, based on the estimated network plots for each gender. Generally, when strong bridging variables represent symptoms or behavior that can be regulated in practice (e.g., in therapy), the connection between the clusters (of other symptoms) can be gradually weakened by this intervention. In the following inference, we consider bullying victimization and *Bullied* to be parallel based on their content. Partial correlations (i.e., edge weights) are available in Tables S4 and S5.

For boys, *Bullied* was a bridge to psychosocial difficulties, and it was mostly connected to *Lies* (weight = 0.12) and *Popular* (0.13). The second identified bridge was *PIU1* (i.e., behavioral salience – missing sleep and eating), which was most strongly connected to *cyberbullying perpetration* (0.12) and *Steals* (0.10). In the girls' network, we also found *Bullied* and *PIU1* to be bridges, while the former was strongly connected to *Lies* (0.12) and *Popular* (0.13), and the latter was strongly associated with *cyberbullying perpetration* (0.10). For girls, there were

two additional bridges: *PIU4* was strongly connected to *Persistent* (0.11) and *PSU6* (0.10), while *PIU2* was strongly connected to *PSU4* (0.12). Bridge strength was also tested for stability and it performed well (Figures S8 and S9). The CS coefficient was >0.5 for both boys and girls.

Finally, we compared both the networks by correlating their adjacency matrices. The Spearman correlation coefficient was .66, indicating substantial similarity for boys and girls.

Discussion

This study aimed to explore PIU and PSU in association with traditional bullying and cyberbullying perpetration and victimization, while also accounting for psychosocial difficulties. The results showed that the networks were largely similar for boys and girls. All the bullying experiences seem to be interrelated. Traditional bullying victimization was the bridge between the bullying cluster and the psychosocial difficulties (mainly to not being popular among peers, having no friends, and being accused of lying). Another important bridge was formed by missing sleep and meals (behavioral salience) in PIU that, through cyberbullying perpetration, connected the bullying cluster with the PIU cluster. PSU was largely isolated from the rest of the studied constructs, and it was not notably related to bullying experiences.

There are several important findings. First, all bullying experiences were mutually interconnected. The relationship between cyberbullying perpetration and victimization was notably strong in boys. Second, out of the whole spectrum of psychosocial difficulties measured by the SDQ, the peer relationship difficulties (i.e., *not being popular*, *having no friends*, *being accused of lying*) played a relevant role in bullying experiences because they were bridged by being a victim of traditional school bullying with the rest of the bullying experiences. This suggests that bullying in any form is predominantly related to the adolescent's problem with socialization with peers. Third, the association between PIU and bullying experiences was bridged to cyberbullying perpetration by the item for missing sleep or meals due to excessive internet use. The negative impact of the lack of sleep in adolescence has been linked to bullying before (e.g., Donoghue & Meltzer, 2018); however, with an unclear direction of causality (due to the cross-sectional nature of our study, we could not investigate the direction). On one hand, sleep difficulties may be a result of bullying due to the increased psychological distress (Sampasa-Kanyinga, Chaput, Hamilton, & Colman, 2018). On the other hand, bullying and a lack of sleep may be connected through the displacement of peer social ties by excessive time spent on the internet. In other words, PIU may be characterized by lower social bonds and lower social competence. This reasoning has some support in recent findings (Hygen et al., 2020) in the case of excessive gaming. Although gaming itself was not directly measured in our study, it has been shown to be the most important part of PIU (Blinka et al., 2015). The lack of sleep due to media consumption and aggressive behavior experiences could be mediated by the consumption of high-caffeine drinks (Holubcikova, Kolarcik, Madarasova Geckova, Reijneveld, & van Dijk, 2017; Husarova et al., 2018). The direction of causality and the potential mediation effects should be the focus of future research. Since bridge symptoms are considered to be important in maintaining the connections between disorders (Jones et al., 2021), based on our results, the potential interventions should focus on the lack of sleep and associated factors, on the one hand, and bullying victimization and peer relationships, on the other.

Another important study finding is that PSU was mostly isolated from all other constructs, including PIU and bullying experiences. That was especially true for boys. The relationship between PIU and PSU was maintained only in girls, albeit weakly. This is surprising, especially because PSU is generally associated with the intensive use of online social networking sites (Marino et al., 2021), which is a dominant environment for peer communication where aggressive communication may occur (Martínez-Ferrer, Moreno, & Musitu, 2018). Indeed, previous studies have found an association between social networking site use and mainly cyberbullying experiences (Craig et al., 2020). It is possible that the PSU construct might have been overshadowed by the effects of PIU in our study. On the other hand, a comparative study (Jin Jeong, Suh, & Gweon, 2020) of PIU and PSU found that the PSU group was more similar to a non-problematic group of adolescents than to the PIU group. We may speculate that the status of PSU is less pathological than that of PIU. Both phenomena are defined similarly and use the same addiction criteria, but their actual impact and their position within the spectrum of adolescent problems may differ. However, this should be verified by further studies.

The strengths of our study include a large, national, representative sample that was oriented towards the general population and that had a high response rate. Nonetheless, there are several limitations that need to be considered. Our results were derived from a cross-sectional design that fully relied on self-reported data. In addition, self-reports of sensitive experiences, including perpetration and victimization due to traditional bullying or cyberbullying, are subject to bias and misclassification because of the social stigmas associated with their occurrence (Juvonen & Graham, 2014). Last, the study variables of PIU and PSU are generalized measures that should include more specific digital behaviors, like gaming and social networking.

Conclusions

The mutual relationships of bullying experiences, problematic digital media use, and the psychosocial difficulties of adolescents are relatively similar for boys and girls. In both models, PSU was relatively isolated from bullying experiences. All bullying experiences formed a strong cluster. The findings also propose several candidates for intervention: bullying victimization, which connects the bullying cluster to psychosocial difficulties (especially not being popular, having no friends, and being accused of lying); and the neglect of sleep and meals due to internet use, which connects the PIU to the bullying cluster.

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Ethical information

The study was approved by the Ethics Committee of the Medical Faculty at the Pavol Jozef Safarik University in Kosice, Slovak Republic (16N/2017). Informed, passive consent was obtained by all of the participants and their parents had the opportunity to disallow participation in this study.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Data for R.
Appendix S2. Analytical script for R.
Figure S1. Bootstrapped CIs of all edges for boys' network.
Figure S2. Bootstrapped CIs of all edges for girls' network.
Figure S3. Bootstrapped edge differences in boys' network.
Figure S4. Bootstrapped edge differences in girls' network.
Figure S5. Centrality plot for both networks.
Figure S6. Case-dropping bootstrap of centrality indices of boys' network.
Figure S7. Case-dropping bootstrap of centrality indices of girls' network.
Figure S8. Case-dropping bootstrap of bridge strength of boys' network.
Figure S9. Case-dropping bootstrap of bridge strength of girls' network.
Table S1. Item wording.
Table S2. Descriptive statistics of the items.
Table S3. Bivariate Spearman correlation coefficients of items.
Table S4. Weights matrix for boys' network.
Table S5. Weights matrix for girls' network

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