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ORIGINAL CONTRIBUTION

Differences in predictors of traditional and cyber-bullying: a 2-year longitudinal study in Korean school children

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Abstract Traditional bullying has received considerable research but the emerging phenomenon of cyber-bullying much less so. Our study aims to investigate environmental and psychological factors associated with traditional and cyber-bullying. In a school-based 2-year prospective survey, information was collected on 1,344 children aged 10 including bullying behavior/experience, depression, anxiety, coping strategies, self-esteem, and psychopathology. Parents reported demographic data, general health, and attention-deficit hyperactivity disorder (ADHD) symptoms. These were investigated in relation to traditional and cyber-bullying perpetration and victimization at age 12. Male gender and depressive symptoms were associated with all types of bullying behavior and experience. Living with a single parent was associated with perpetration of traditional bullying while higher ADHD symptoms were associated with victimization from this. Lower academic achievement and lower self esteem were associated with cyber-bullying perpetration and victimization, and anxiety symptoms with cyber-bullying perpetration. After adjustment, previous bullying perpetration was associated with victimization from cyber-bullying but not other outcomes. Cyber-bullying has differences in predictors from traditional bullying and intervention programmes need to take these into consideration.

Keywords Cyber-bullying · Bullying · Depression · Attention-deficit hyperactivity disorder · Longitudinal study

Introduction

Bullying has been defined as a subset of aggressive behavior that is characterized by over time repetition and an imbalance of power [1]. Experiences of bullying and victim behaviors have been found to be associated with psychopathology such as depression, anxiety, and behavioral problems, findings which are remarkably consistent across studies [2]. Bullying is a pervasive problem among children and adolescents, and may take various forms including physical, verbal, relational, or cyber [3], the last of these of growing importance as children spend more times in cyber environments. Adolescent victims of cyber-bullying have been found to be more likely to have problems at school, feelings of being unsafe at school and psychological distress [4, 5]. Both cyber- and traditional bullies are likely to be school peers [4–6], to approve of bullying morally [7], and exhibit symptoms of depression [5]. Cyber-bullying can occur at any time, can spread quickly, and often occurs outside school property, making it difficult for adults to monitor and regulate [8]; it was also found to be more strongly associated with depressive

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symptoms according to a national cross-sectional study than traditional bullying [5]. Bullying prevention programs have only mixed evidence in terms of their effectiveness in changing bullying among young people [9]. There is evidence that comprehensive youth violence prevention programmes can decrease aggressive behavior and increase prosocial behaviors in primary school children [10]. However, further observational evidence is required on risk factors for violence including cyber-bullying in young children in order to develop and target prevention programs. To address whether individual and psychological factors are independently associated with young children's involvement in traditional bullying and cyber-bullying, we analyzed data from a 2-year longitudinal study in Korean primary school children.

Methods

Data were analyzed from a school-based prospective survey of mental health carried out in Kwangju, South Korea from 2004 to 2006. All participants and parents gave written formal informed consent at each examination. This study was approved by the Chonnam National University Hospital Institutional Review Board.

Participants and procedure

The participants and methods have been described previously [11]. In brief, 1,344 fourth grade students and their parents from five primary schools in Kwangju, South Korea were carried out the study in 2004.

Under the direction of the project psychiatrist, each child provided data and completed all questionnaires, which were appropriately validated for 4th graders, in their classrooms during school hours. This took an average of 60 min. Each parent received a sealed questionnaire and information via the child, completed the questionnaire at home, and returned it in a sealed envelope via the child. Two years later, when the children were 6th graders (age 12–13 years), a follow-up school visit was conducted with attempts made to follow up all previous participants as well as other current pupils in that grade. The mean (SD) follow-up period was 2.0 (0.3) years. Essentially identical procedures were used to identify bullying and psychopathology although cyber-bullying was only evaluated at follow-up.

Measures

Traditional bullying

We used two self-report scales completed by children: the Peer-Victimization Scale (PVS), and the Bullying Behavior Scale (BBS) [12]. The PVS consists of six forced items, three of which refer to being a victim of negative physical actions (i.e., being hit and pushed, picked on, and bullied) and three of which refer to being a victim of negative verbal actions (i.e., being teased, called hurtful names, and laughed at). The BBS is based on the PVS; it involves changing the phrasing from passive to active, so it consists of six forced items, three of which refer to being a perpetrator of negative physical actions and three of which refer to being a perpetrator of negative verbal actions. As both the PVS and the BBS employ the same forced choice format as the Self-Perception Profile for Children (SPPC) [13], we scored both according to Harter's instructions for scoring SPPC subscales. We scored responses on a scale of 1–4, with higher scores reflecting greater victimization and bullying. For the purpose of classification, Austin and Joseph used a cut-off score of 2.50 or above on both the PVS and the BBS [12]. Korean versions of the PVS and the BBS have been validated [14]. Cut-off scores of 2.60 or above on the PVS and 2.50 or above on BBS suggest that students should be categorized as a victim or a bully, respectively.

Cyber-bullying

We used four self-report items completed by children about threatening or upsetting emails/texts, malicious rumors or abusive personal information involving use of the internet and/or mobile phones, evaluating perpetration of or victimization from cyber-bullying. The perpetration and victimization of cyber-bullying were assessed in the same way (forced choice format) as described for traditional bullying, with higher scores reflecting greater involvement of cyber-bullying. Internal consistency reliability for items was found to be satisfactory (Cronbach's alpha for the cyber-bullying scale 0.61). Until now, no established questionnaire cut-offs exist for characterizing being a cyber-bully or cyber-victim [15]. Thus, in this study, we assumed that scores at or above the upper quartile indicated involvement of cyber-bullying to avoid an unnecessary loss of information with regard to various degrees of perpetration/victimization.

Depression

We administered the Children's Depression Inventory (CDI) [16]. The CDI requires a third-grade reading level and is suitable for children between the age 7 and 17. Total scores range from 0 to 54, with higher scores indicating higher depression. Kovacs recommended that scores $\geq$17 in a heterogeneous population be considered indicative of depression, and the reliability and validity of the Korean form of the CDI have been established as acceptable [17].

Anxiety

We use the State-Trait Anxiety Inventory for Children (STAI-C) [18]. It includes 20 'State Anxiety' items and 20 'Trait Anxiety' items. Responses are scored on a scale of 1–3, and total scores range from 20 to 60, with higher scores reflecting greater anxiety. The reliability and validity of the Korean form of the STAI-C have been established [19]. In this study, we defined anxiety on the basis of scores at or above the median.

Self-esteem

We used the short version of the Self-Esteem Inventory (SEI) [20]. The Korean translation includes 25 trait-descriptive sentences to which subjects respond by indicating whether the sentences describe them [21]. Total SEI scores range from 0 to 25, with higher scores reflecting higher self-esteem. Scores at or below the median were used to define low self-esteem.

Coping strategies

We used the adolescent version of the Ways of Stress Coping Checklist [22]. It is composed of four factor structures: 'problem focused', 'seeks social support', 'wishful thinking', and 'avoidance'. Responses are scored on a scale of 1–4, with higher scores reflecting more frequently used strategies. An appropriately modified Korean version has been developed with factor structures of 'problem-solving strategies' and 'passive strategies' [23]. Scores at or above the median defined good problem-solving strategies and passive strategies, respectively.

Psychopathology

The Strengths and Difficulties Questionnaire (SDQ-S) was administered, which includes 25 items divided into five scales of five items each: hyperactivity, emotional symptoms, conduct problems, peer problems, and prosocial behavior [24]. A score of total difficulties is computed by combining all scales except the prosocial behavior scale. For each scale, except for the prosocial behavior scale, higher scores indicate more problems. The sum of the scores ranges from 0 to 40. Clinically significant cut-off points approximated the 90th percentile as previously recommended [24]. The Korean translation has been evaluated and reported as satisfactory [25]. We used the cut off scores (i.e., $\geq$20 for total psychopathology) of previous Korean study [25].

Attention deficit hyperactivity disorder

Parents completed the Korean version of DuPaul's Attention deficit hyperactivity disorder Rating Scale (K-ARS) [26]. K-ARS has an 18-item measure used to assess inattention and hyperactivity. Items are rated on a 4-point scale (0 = never or rarely, 3 = very often). The K-ARS has good reliability and validity among Korean children with scores $\geq$17 recommended for defining ADHD.

Height and weight

We used routine data from the schools on children height and weight. School health nurses routinely measure height and weight annually with the child wearing underwear, and without shoes. We divided the children into three groups: <10 percentile, 10–90 percentile, and $\geq$90 percentile according to their height and weight. BMI values were calculated as weight height^{-2} (kg/m^2). Gender- and age-specific cut-off points were based on reference data from the Korean Pediatric Society.

Socio-demographic characteristics

Data were recorded on gender, family structure, number of friends, adverse life events (illness, divorce, bereavement, financial difficulty, interpersonal relationship breakup, and theft), five levels of socioeconomic status, and five levels of academic achievement. We divided family structure into two groups according to whether one or both parents were present. Child-reported number of friends was grouped into "0", "1–2", "3–4", "5–9", and "10+".

Parent's psychopathology

The General Health Questionnaire-12 (GHQ-12) was completed by parents [27]. Its scores range from 0 to 12, with higher scores reflecting higher psychopathology. The validity and reliability of the Korean translation of GHQ-12 have been established [28].

Statistical analysis

Statistical analyses were conducted using Stata 11 (StataCorp, College Station, TX, 2009). Unadjusted logistic regression analyses were carried out to examine associations between individual and psychological variables at baseline with respect to traditional bullying and cyber-bullying at follow-up. Multivariable logistic regression models were then used to test the independence of these associations. These models were assembled as follows: first, the environmental factors (i.e., sociodemographic and

anthropometric measures) were entered simultaneously to investigate their mutual independence; second, the two variables measuring perpetration of and victimisation from bullying at baseline were entered, adjusted for each other and the previously entered variables; third, the psychological variables were entered separately, adjusted for previous bullying and environmental factors, but not adjusted for each other because of the risk of colinearity. Finally, significant associations between previous and current bullying behavior/experience were adjusted for depression at baseline as an exploratory procedure.

Imputation of missing data

Of 1,344 children who were eligible at baseline 1,197 participated and 1,187 had complete data. Of the 1,197, 1,106 (92.4 %) children participated at follow-up, supplemented by 129 children who transferred into the samples at follow-up and who did not have baseline data forming a final follow-up sample of 1,106. There were no statistical differences in baseline variables between responders and non-responders at follow-up. The number of children who had complete data at baseline and follow-up was 948, and complete data were available for 734 (77.4 %) of 948 participating children and their parents in multivariate analysis. The remainder had at least one variable missing. The percentage of missing data was no greater than 15 % for any one variable (e.g., percentage of bullying at age 10 was 89 %, percentages of psychological variables and demographics were 99 %). To minimize the impact of missing data, we used multiple imputations (MI) by chained equations combined using Rubin's rules in Stata to impute missing data [29]. Thirty copies of the data were formed in the imputation process, each with missing data imputed [30]. The MI data augmentation procedure used here assumes that the data have a multivariate normal distribution. Suitable transformations were necessary for this assumption to hold. After imputation, the complete data were transformed back to their original scale prior to any analyses being performed. All subsequent analyses were conducted using imputed data.

Additional information on multiple imputation procedures

We imputed data on children who participated at follow-up who had missing data points. The imputation procedure uses all the known covariates associated with the missingness mechanism and bullying, together with the interrelationships between the bullying measures (bullying scales, victimisation scales), to predict values for missing data. The observed covariates considered were sex, living with parents (dichotomous), socioeconomic status, academic level (ordinal), behavioral and psychological characteristics (continuous). The observed baseline bullying and victimization scores (continuous) were also included to preserve relationships with the incomplete baseline variables.

Results

Sample description

The children at baseline comprised 603 boys (50.8 %) and 584 girls (49.2 %), and those at follow-up comprised 481 boys (55.1 %) and 467 girls (44.8 %). Participating parents at baseline included 15.7 % fathers, 70.3 % mothers, and 14.0 % who did not specify their gender and those at follow-up comprised 14.7 % fathers, 69.5 % mothers, and 15.8 % who did not specify their gender. The mean (SD) heights of the children at baseline and follow-up were 136.9 (6.7) and 150.2 (0.9) cm, respectively, and the mean weights 33.4 (6.8) and 41.7 (0.1) kg, respectively. The mean (SD) ages of fathers at baseline and follow-up were 42.0 (3.8) and 43.8 (2.0) years, respectively, and those of mothers were 38.8 (3.6) and 40.7 (3.1) years, respectively. The prevalence of bullies, victims, and bully-victims at baseline and follow-up were 142 (12.0 %) versus 130 (11.1 %), 63 (5.3 %) versus 63 (5.4 %), and 85 (7.2 %) versus 60 (5.1 %), respectively. The mean (SD) cyber-bullying perpetration and victimization scores at follow-up were 2.84 (1.21) and 2.70 (1.17), respectively. There were no school differences in sample characteristics.

Baseline factors associated with perpetration of/victimization from traditional bullying and cyber-bullying at follow-up

As summarized in Table 1, unadjusted analyses indicated the following baseline factors were significantly associated with perpetration of/victimization from traditional bullying and cyber-bullying at follow-up: male gender, higher depression, and lower self esteem. Low academic level, previous perpetration of bullying, and higher anxiety were associated with perpetration of traditional bullying and perpetration of/victimization from cyber-bullying. Living with single parent was associated with perpetration of/victimization from traditional bullying and victimization from cyber-bullying, while higher ADHD symptoms were associated with perpetration of/victimization from traditional bullying. Higher psychopathology was associated with perpetration of traditional bullying and cyber-bullying, while previous victimization of bullying was associated with victimization from traditional bullying and cyber-bullying.

Table 1 Associations between characteristics at age 10 years with traditional and cyber-bullying perpetration/victimization by age 12 years

Characteristics at age 10	Traditional bullying				Cyber-bullying			
	Perpetration		Victimization		Perpetration		Victimization	
	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value
Environmental factors								
Male	1.49 (1.18, 1.87)	0.001	1.59 (1.27, 2.00)	<0.001	1.28 (1.02, 1.60)	0.030	1.42 (1.13, 1.78)	0.003
Low academic level	1.15 (1.01, 1.30)	0.035	1.14 (0.99, 1.30)	0.065	1.21 (1.06, 1.37)	0.004	1.29 (1.14, 1.47)	<0.001
Height, ≥90 percentile	1.02 (0.93, 1.11)	0.745	1.00 (0.90, 1.10)	0.959	0.99 (0.90, 1.09)	0.828	0.96 (0.88, 1.06)	0.439
Weight, ≥90 percentile	1.10 (0.99, 1.21)	0.056	1.05 (0.95, 1.16)	0.383	1.02 (0.92, 1.12)	0.726	1.02 (0.93, 1.13)	0.667
Obesity by BMI	1.14 (0.93, 1.41)	0.147	1.13 (0.97, 1.34)	0.119	1.05 (0.78, 1.42)	0.746	1.22 (0.89, 1.68)	0.222
Fewer friends, 5 groups	0.95 (0.84, 1.07)	0.398	0.90 (0.79, 1.02)	0.084	1.10 (0.90, 1.35)	0.344	0.98 (0.87, 1.10)	0.741
Low economic status, 5 groups	0.99 (0.89, 1.11)	0.891	1.02 (0.90, 1.16)	0.793	0.96 (0.86, 1.09)	0.552	0.99 (0.88, 1.11)	0.850
Single parent	2.29 (1.57, 3.32)	<0.001	1.72 (1.17, 2.54)	0.006	1.37 (0.93, 2.01)	0.108	1.53 (1.06, 2.20)	0.022
Parent's GHQ scores	1.04 (0.81, 1.32)	0.770	1.04 (0.82, 1.33)	0.737	0.94 (0.76, 1.17)	0.598	0.95 (0.75, 1.21)	0.662
Number of adverse life events	1.11 (0.98, 1.26)	0.089	1.11 (0.98, 1.26)	0.111	1.09 (0.97, 1.24)	0.145	1.11 (0.98, 1.25)	0.105
Previous bullying behavior/experience								
Perpetration group	1.51 (1.11, 2.06)	0.009	1.32 (0.98, 1.78)	0.065	1.47 (1.11, 1.93)	0.007	1.61 (1.23, 2.10)	0.001
Victimization group	1.09 (0.92, 1.31)	0.321	1.21 (1.01, 1.46)	0.042	1.13 (0.95, 1.35)	0.173	1.22 (1.02, 1.46)	0.034
Psychological factors								
Depression	1.62 (1.26, 2.07)	<0.001	1.62 (1.24, 2.12)	0.001	1.45 (1.14, 1.85)	0.002	1.56 (1.24, 1.96)	<0.001
Anxiety	1.29 (1.03, 1.62)	0.027	1.16 (0.92, 1.47)	0.212	1.39 (1.12, 1.71)	0.003	1.30 (1.05, 1.61)	0.016
Lower Self esteem	1.39 (1.10, 1.74)	0.005	1.37 (1.08, 1.75)	0.010	1.43 (1.15, 1.76)	0.001	1.48 (1.18, 1.84)	0.001
Passive Coping strategy	1.10 (0.89, 1.37)	0.374	1.00 (0.80, 1.26)	0.982	1.09 (0.87, 1.36)	0.450	1.13 (0.89, 1.42)	0.315
Total psychopathology	1.51 (1.08, 2.10)	0.016	1.44 (1.03, 2.01)	0.031	1.42 (1.04, 1.95)	0.029	1.11 (0.81, 1.51)	0.530
ADHD symptoms	5.05 (1.49, 17.07)	0.009	6.46(1.94, 21.48)	0.002	1.83 (0.54, 6.24)	0.334	3.35 (0.94, 11.99)	0.062

ADHD attention-deficit hyperactivity disorder, *BMI* body mass index, calculated as weight height^{-2} (kg/m^2), *GHQ* General Health Questionnarie-12, *CI* confidence interval, *OR* odds ratio

Multi-variable regression models of traditional bullying

After adjustment for other environmental factors, as summarized in columns 1 and 2 of Table 2, male gender and living with a single parent remained associated with perpetration of and victimization from traditional bullying. Previous perpetration also remained associated with perpetration of traditional bullying.

After adjustment for previous bullying experience and environmental factors, higher depression remained associated with both perpetration of and victimization from traditional bullying, and higher ADHD symptoms were associated with victimization from traditional bullying. When further adjusted for baseline depression, the association between traditional bullying and previous perpetration was reduced below significance levels [odds ratio 1.37, 95 % CI (0.97, 1.96); $p = 0.076$].

Multi-variable regression models of cyber-bullying

After adjustment for other environmental factors: As summarized in column 3 and 4 of Table 2, male gender and low academic achievement remained associated with both perpetration of and victimization from cyber-bullying. And after adjustment for all these factors, previous perpetration experience remained associated with both cyber-bullying perpetration and victimization.

After adjustment for previous bullying experience and environmental factors, perpetration of cyber-bullying remained significantly associated with higher depression, higher anxiety and lower self-esteem at baseline, and victimization from cyber-bullying was significantly associated with baseline lower self-esteem. After further adjustment for depressive symptoms, the association between perpetration of cyber-bullying and previous perpetration

Table 2 Multi-variable logistic regression of associations between characteristics at age 10 and involvement in traditional and cyber-bullying by age 12 years

Characteristics at age 10	Associations with bullying outcomes at age 12 years (odds ratio, 95 % CI)			
	Traditional bullying at age 12		Cyber-bullying at age 12	
	Perpetration	Victimization	Perpetration	Victimization
Environmental factors[a]				
Male gender	1.5 (1.2, 1.9)**	1.6 (1.3, 2.0)**	1.3 (1.0, 1.6)*	1.5 (1.2, 1.9)**
Low academic level	1.1 (1.0, 1.3)	1.1 (1.0, 1.3)	1.2 (1.1, 1.4)*	1.3 (1.1, 1.5)**
Weight, ≥90 percentile	1.1 (1.0, 1.2)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)
Fewer friends, 5 groups	1.0 (1.9, 1.1)	0.9 (0.8, 1.0)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)
Single parent	2.2 (1.5, 3.2)**	1.6 (1.1, 2.4)*	1.3 (0.8, 1.8)	1.4 (0.9, 2.1)
Number of adverse life events	1.0 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)
Previous bullying behavior/experience at age 10[b]				
Perpetration group	1.5 (1.1, 2.1)*	1.2 (0.8, 1.7)	1.4 (1.0, 2.0)*	1.5 (1.1, 2.0)*
Victimization group	1.0 (0.8, 1.2)	1.2 (0.9, 1.4)	1.0 (0.9, 1.3)	1.1 (0.9, 1.4)
Psychological factors at age 10[c]				
Depression	1.4 (1.1, 1.9)*	1.5 (1.1, 2.0)*	1.3 (1.0, 1.7)*	1.3 (1.0, 1.7)*
Anxiety	1.2 (1.0, 1.5)	1.1 (0.9, 1.4)	1.3 (1.0, 1.6)*	1.2 (0.9, 1.5)
Lower Self esteem	1.3 (1.0, 1.6)	1.2 (1.0, 1.6)	1.3 (1.0, 1.6)*	1.3 (1.0, 1.6)*
Total psychopathology	1.3 (0.9, 1.9)	1.3 (0.9, 1.8)	1.2 (0.9, 1.7)	0.9 (0.6, 1.3)
ADHD symptoms	3.5 (1.0, 12.4)	5.0 (1.4, 17.2)*	1.5 (0.4, 5.3)	2.6 (0.7, 9.7)

ADHD attention-deficit hyperactivity disorder, *CI* confidence interval

[a] Mutually adjusted for other environmental factors but not for any other covariates

[b] Mutually adjusted and adjusted for all environmental factors but not for psychological factors

[c] Individually entered and adjusted for both bullying measures and all environmental factors

* $p \leq 0.05$

** $p \leq 0.001$

experience fell below significance [odds ratio 1.33, 95 % CI (0.95, 1.84); $p = 0.087$], however, the association between previous perpetration and victimization from cyber-bullying remained significant [odds ratio 1.39, 95 % CI (1.01, 1.89); $p = 0.041$].

Discussion

In a prospective longitudinal study of primary school children in South Korea, we investigated factors predicting later involvement in or experience of cyber-bullying as well as traditional bullying. We found that male gender and higher depressive symptoms at baseline were associated with both types of bullying and with both perpetration and victimization. Living with a single parent was associated with perpetration of traditional bullying, while higher ADHD symptoms were associated with victimization from this. Lower academic achievement and lower self-esteem were associated with both perpetration of and victimization from cyber-bullying. Higher anxiety symptoms were associated with later perpetration of cyber-bullying. Victimization from bullying was not associated with any bullying behavior/experience 2 years later. Previous perpetration of bullying was associated with reported perpetration of both traditional and cyber-bullying and with victimization from cyber-bullying; however, the first two associations were potentially confounded by depression at baseline.

Environmental risk factors for bullying behavior/experience

Male gender was associated with all forms of bullying perpetration and victimization. In previous studies of traditional bullying, boys are more usually the aggressors but there is little gender difference in being a victim [1], although Kim et al. [31] reported that boys are victimized more often than girls among Korean middle school students. In cyber-bullying, gender differences have been less clear-cut [32, 33]. Cyber-bullying is in some respects a form of indirect bullying (not face to face), so might be assumed to appeal to girls more than boys. However, the technological aspect might appeal more to boys. Boys

exhibit overt aggressive acts from an early age more regularly than girls do, as has been found consistently in studies of aggression and conduct problems [1]. In this respect, our finding that male gender is associated with both traditional and cyber-bullying behaviors and experiences suggest a need for further research into cyber-bullying, clarifying reasons understanding gender differences in order to help develop more sophisticated prevention and intervention programmes.

In our sample, low academic level was associated with perpetration and victimization of cyber-bullying, but not with traditional bullying. In a previous study of traditional bullying, Schwartz [34] found that children who exhibited poor academic performance in school were more likely to be targets of traditional bullying. Research on peer rejection has also considered relationships with academic achievement and school adjustment [35]. Other studies have not found associations between lower academic grades and involvement in direct traditional bullying behavior [1, 11]; however, because of a strong cultural emphasis on achievement in Asian countries, academic competence tends to be an important correlate of social acceptance in peer groups [36]. One possible explanation for our finding is that perpetration of and victimization from cyber-bullying reflects at least some children turning away from peer-relationships to the "cyber world" and related activities as an escape route from problems with academic achievement, therefore increasing opportunities for perpetration of cyber-bullying and/or risks of victimization. What has yet to be established is whether poor academic achievement leads directly to involvement in cyber-bullying or whether more general overuse of the internet or other e-activity leads to both poorer school achievement and increased exposure of cyber-bullying.

Among other environmental contexts, we found that living with a single parent was associated with both perpetration of and victimization from traditional bullying. In younger children, it is important to identify risk factors for early involvement in bullying to prevent children from becoming involved in persistent bullying [37].

Associations between previous and current bullying behavior/experience

The relationships between previous bullying behavior/experience and traditional- and cyber-bullying were also an important finding. Previous research has shown that children exposed to interpersonal violence are more likely to show aggression, potentially as a result of social learning with children perceiving violence to be an acceptable method of resolving conflict [1]. Furthermore, children who bully others often showed persistent maladaptive behavioral patterns [2]. In our sample, previous perpetration of traditional bullying was associated with perpetration of traditional bullying; however, after further adjustment for depressive symptoms, the association was attenuated. This suggests that previous bullying does not have an inevitable relationship with later behavior. On the other hand, previous perpetration of traditional bullying was associated with victimization from cyber-bullying, and this association persisted after adjustment for depressive symptoms. It has been well established that being a victim of traditional bullying has negative short- and long-term consequences [2, 38]. Cyber-aggression and cyber-victimization have been found to be associated with higher levels of traditional peer aggression and victimization, respectively [39]. In cyber-bullying, the perpetrator is less likely to see any direct response from the victim, which might reduce direct gratification but might also reduce inhibition [3]. One possible explanation for our finding is that a perpetrator of traditional bullying might subsequently become a victim of cyber-bullying by their previous victims. Another is that they may be more likely to report relatively neutral experiences as victimization because of depression, anxiety, or reporting style. Either way, there is a need to develop early interventions to break cycles of bullying and victimization in schools.

Psychological factors and bullying behavior/experience

In our study, depression at baseline was significantly associated with later perpetration of and victimization from traditional bullying and cyber-bullying, an association which persisted after adjustment for all other environmental factors and previous bullying behavior/experience. Previous cross-sectional studies have consistently found that depression is associated with exposure to traditional bullying and cyber-bullying [3, 5, 11, 38, 40, 41], clarified further in a few longitudinal studies [42, 43]. Traditional bullying victimization in 10th grade children has been found to be associated with depressive symptoms 1 year later [43], and students involved in traditional bullying have been found to have a significantly higher risk for suicidal ideation and suicidal behavior [31]. However, (as far as we know), few longitudinal studies have investigated the association between depression and later bullying behavior, particularly cyber-bullying. Our findings suggest that depressive symptoms have an association with later bullying perpetration and/or experience, further emphasizing the need for early detection and management.

Higher anxiety was associated with perpetration of cyber-bullying in our sample. Associations between traditional bullying, cyber-bullying and anxiety have been found in many cross-sectional studies [38], but has received little prospective investigation. One possible reason is that children with higher anxiety become involved in

perpetration of cyber-bullying as an escape from anxiety and/or aggression, which may possibly be seen as preferable because of the detachment between perpetrator and victim [3]. Lower self-esteem was associated with both perpetration of and victimization from cyber-bullying. Whether traditional bullies have low self-esteem has been an area of dispute, although there is cross-sectional evidence for this [11]. Our prospective findings were of less consistent associations compared with those of depression, lower self-esteem only being associated with perpetration of and victimization from cyber-bullying, and not predictive of traditional bullying. Lower self-esteem is likely to influence children's ability to adjust to new situations [1], resulting in increased vulnerability potentially reflected in increased internet exposure and/or likelihood of bullying behavior/experience through this medium. ADHD symptoms were associated with a fivefold increased risk of victimization from traditional bullying. In a cross-sectional study of 4th grade children, ADHD diagnosis was associated with a threefold increased likelihood of bullying perpetration and a tenfold increased likelihood of bullying victimization [44]. Our findings suggest that the understanding and managing of children's psychopathology (ADHD, depression, anxiety) are essential part of a bullying intervention and may help in reducing the number of children who become involved in traditional and cyber-bullying behaviors.

Associations between psychopathology and bullying behaviors have been extensively debated regarding the direction of causality. On the one hand, children with internalizing or externalizing problems have been found to have a higher risk of involvement with bullying [45]. On the other hand, deteriorating behavioral, emotional, and psychosocial functioning have been found in children experiencing peer victimization [42, 46]. Considering externalizing ADHD symptoms and internalizing depressive symptoms, our results support a role for psychopathology in the origin of bullying behavior and experience including cyber-bullying.

Strengths of the study include the large representative samples of school children, good follow-up rates and comprehensive assessments including from informants. Certain limitations should be considered. First, there might be reporting bias among children involved in traditional bullying and cyber-bullying. The measures used to assess cyber-bullying referred to e-mail, chat room, text messages, and phone calls, and may therefore have missed other domains in these rapidly shifting contexts. For traditional bullying, self-report is generally acceptable in studies about bullying behaviors, since children are often the most accurate informants. However, self-reporting may be limited among perpetrators who wish to minimize or lack insight into their behavior, and the victimized group may be over sensitized to normal events. Second, cyber-bullying was only investigated for a single school year and age differences were not evaluated. It should be borne in mind that at least one study has reported cyber-bulling to be more prevalent among middle and high school students rather than in early adolescence years [47]. However, some studies have not found any significant age effects or interactions for cyber-bullying [3]. In 2009, the Seoul Metropolitan Office of Education reported that 41.4 % of primary school children possessed a mobile phone [48], the percentage increasing by 10 % for each new year (from 15.4 % at 1st grade to 66.4 % at 6th grade). This trend might increase a child's opportunity for involvement in cyber-bullying. Third, because cyber-bullying is a relatively new phenomenon, there were no fully validated questionnaires at the time of our study. However, a recently published questionnaire (the Personal Experiences Checklist, PECK) has been recently developed and provides a measure of different types of bulling, including overt or physical bullying, covert bullying and cyber-bullying [49]. Finally, the children in this study cannot be assumed to be nationally or internationally representative and further research is required to investigate the extent to which such associations are specific to particular schools, settings or cultures.

Implications

This study used school-based longitudinal data with individual and psychological factors measured at age 10 years investigated as predictors of traditional and cyber-bullying measured at age 12. Thus, our findings suggest specific factors potentially contributing to the risk of these behaviors and experiences. Clear advantages are therefore provided over cross-sectional findings; however, further repeated measurements of cyber-bullying involvement over time (allowing for changes in the way this manifest) would helpful to establish more precisely the relative timing of exposure and outcome. A particular focus should be the identification of risk factors for early involvement in bullying to prevent this persisting. Providing additional support for families (single-parent), schools (enhancing academic achievement) and children (those with ADHD, anxiety or depressive symptoms) may help to decrease the likelihood of bullying outcomes. Our findings suggest that there may be differences between traditional and cyber-bullying with respect to their aetiology, and interventions may need to be appropriately focused: for example, managing depressive symptoms to prevent perpetration of traditional bullying, while enhancing academic achievement and self-esteem to prevent cyber-bullying, particularly in boys.

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