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Clusters of Contemporary Risk and Their Relationship to Mental Well-Being Among 15-Year-Old Adolescents Across 37 Countries

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A B S T R A C T

Purpose: Adolescents' mental well-being has become a growing public health concern. Adolescents' daily lives and their engagement in risks have changed dramatically in the course of the 21st century, leading to a need to update traditional models of risk to include new exposures and behaviors. To date, studies have examined the relationship between (mainly traditional) risk behaviors and adolescent mental well-being or looked at risk factors that jeopardize mental well-being such as lack of social support but have not combined them together to highlight the most significant risks for adolescent mental well-being today. The present study included new and traditional risk behaviors and risk factors, robustly derived an empirically based model of clusters of risk, and examined the relative association of these clusters to adolescent mental well-being.
Methods: Data from the 2017–2018 Health Behaviours in School-aged Children study were used. The sample included 32,884 adolescents (51.7% girls) aged 15 years from 37 countries and regions. The principal component analysis was used to determine the existence of clusters of risk, using 21 items related to adolescent mental well-being that included both risk behaviors (e.g., substance use) and risk factors (e.g., peer support). Analysis was conducted in both a randomly split training and test set and in gender separate models. Mixed-effects logistic regressions examined the association between clusters of risk and mental well-being indices (low life satisfaction and psychosomatic complaints).

IMPLICATIONS AND CONTRIBUTION

The findings from a contemporary, large, cross-national representative sample of adolescents aged 15 years from 37 countries suggest a seven-factor model of risk for mental well-being for adolescent boys and girls. They highlight a need to target contemporary risks such as low social support and problematic social media use in prevention programs aimed at

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Results: Seven clusters of risk were identified: substance use and early sex, low social support, insufficient nutrition, bullying, sugary foods and drinks, physical health risk, and problematic social media use (SMU). Low social support and SMU were the strongest predictors of low life satisfaction (odds ratios = 2.167 and 1.330, respectively) and psychosomatic complaints (odds ratio = 1.687 and 1.386, respectively). Few gender differences in predictors were found. Exposure to bullying was somewhat more associated with psychosomatic complaints for girls, whereas physical health risk was associated with reduced relative odds of low life satisfaction among boys. Split-sample validation and out-of-sample prediction confirmed the robustness of the results.
Conclusions: The results highlight the importance of contemporary clusters of risk, such as low social support and SMU in the mental well-being of young people and the need to focus on these as targets for prevention. We propose that future studies should use composite risk measures that take into account both risk behaviors and risk factors to explain adolescents' mental well-being.

improving adolescent mental well-being.

Over the past few years, the mental well-being of young people has become a growing public health concern, with declines in adolescent mental health, particularly among girls, documented in many countries [1–3]. Although there is an abundance of evidence on the negative impact of traditional risk behaviors (such as substance use, early sexual intercourse initiation, and fighting) on adolescent mental well-being [4], adolescents' daily lives and their exposure to risks have changed considerably in the course of the 21st century [5] (e.g., increased use of social media and decline in risky behaviors). These changes require us to update traditional models of risk to include new behaviors and risk factors and to examine how these are associated with the mental well-being of today's adolescents. This article aimed to explore a contemporary and empirically based model of clusters of risk for adolescent boys and girls and to examine how they are associated with adolescent mental well-being.

Adolescent involvement in risk taking has long been empirically found to cluster [6–8]. Problem Behavior Theory [9,10] provides a framework in which risks can be understood to be organized and covariate, at times fulfilling healthy developmental functions, and yet, at times, flagging youth at risk of lower levels of adaptation and mental well-being [11,12]. The U.S. Centers of Disease Control and Prevention (CDC) Youth Risk Behavior Survey categorized risk behaviors across six domains that are associated with leading causes of morbidity and mortality among American youth [13]: (1) behaviors that contribute to unintentional injuries and violence, (2) tobacco use, (3) alcohol and other drug use, (4) risky sexual behaviors, (5) unhealthy dietary behaviors, and (6) physical inactivity [13]. The CDC's clusters of risk were developed in 1989 and published in 1993, based on the accumulated scientific evidence about adolescent lifestyles and patterns of health-related behaviors [14]. However, 30 years on, the nature of risk taking is changing with new opportunities to engage in risks. The CDC clusters were also developed in the U.S., raising questions as to their applicability outside U.S. borders.

When developing a contemporary model of clusters of risk, it is important to consider several significant changes that have occurred in the 21st century. First, new risk behaviors and exposures have emerged. For example, social media use (SMU) has become an integral part of adolescents' daily lives [15]. Although findings have been mixed regarding the relationship between *frequency* of SMU and mental health [16], problematic or addiction-like SMU (e.g., loss of control, preoccupation, and withdrawal symptoms) has been clearly identified as a new risk behavior [17]. Second, engagement in traditional risk behaviors, such as alcohol use, cigarette smoking, and marijuana, has declined consistently among adolescents in Europe and the U.S. [1,5]. Yet, limited research has been carried out to show how more traditional risk behaviors may or may not cluster with newer ones [18].

In addition, risks to adolescents' mental well-being include not only involvement in risk behaviors but also exposure to additional risk factors, such as changes in levels of social support and bullying victimization, both traditional and cyber [19]. Social relationships with parents and peers have changed considerably in the past two decades, in part because of the rise in social media. A lack of social relationships (parent, peer, and teacher) has long been recognized as a prominent risk for young people's mental well-being [20,21]. Although adolescents tend to report better relationships with their parents [22], there is a strong decline in face-to-face contact with peers and a simultaneous increase in feelings of loneliness among adolescents across European and North American countries [1,5]. In addition, the rise in SMU has also led to exposure to new forms of (cyber) bullying with empirically proven associations to poor adolescent mental well-being [23]. As such, the present study aimed to understand the predictors of adolescent's mental well-being through a broader conceptualization of risk, including both social risk factors and new and traditional risk behaviors.

Recently, research on clustering of risk behaviors has started to include emergent types of adolescent risk behaviors, such as cyber-bullying and problematic SMU. A recent Canadian study [18] found three risk profiles (overt risk taking, aversion to a healthy lifestyle, and screen time syndrome), which were related to injury levels among adolescents. However, this study did not consider other domains of well-being and was restricted to data from one country. Other studies have examined contemporary risk factors, but only as single factors (e.g., screen time and unhealthy eating habits; [24]). The problem with this approach is that there are limited domains that are addressed in any particular analysis, which does not allow an understanding of the relative risk of different clusters of risk. Research on *contemporary clusters*, including both traditional (e.g., tobacco use) and new (e.g., problematic SMU) risks and risk behaviors and their links with adolescent mental well-being is scarce, and no such cross-national analysis of large representative samples of

adolescents exists. Finally, although studies within the framework of the Health Behaviour in School-aged Children (HBSC) have examined multiple risk behaviors and their association to injury and mental health [25–29], little research has examined how these behaviors cluster together with other risk factors (not just behaviors) using both traditional and new risks and how such clusters distinctly associate with mental well-being.

The Present Study

The present study aimed to develop a contemporary model of clustered risk for the mental well-being of adolescent boys and girls. It extends previous research by examining not only the risk behaviors but also additional empirically proven risk factors to examine whether and how these may cluster and predict adolescent mental well-being. This study takes into account a wide variety of both traditional and new risks relevant to both genders and applies the model to adolescents across 37 countries and regions in Europe and North America. In line with Problem Behavior Theory [9,10], we assumed that risks would covary and cluster in an organized way. However, given the significant changes in adolescents' lives and the lack of an up-to-date theoretically driven and empirically tested model of how traditional and newer risk behaviors and factors cluster together, the study takes a data-driven approach for identifying how risks cluster. Moreover, considering gender differences across these behaviors (e.g., girls report lower mental well-being and tend to engage in different risk behaviors than boys) [25], the present study also examined whether clusters of risk and their relationship with mental well-being are consistent across genders.

We addressed the following research questions:

1. Which clusters of risk can be identified among adolescents across Europe and North America in the year 2018?
2. To what extent do each of these risk clusters relate to adolescent mental well-being (psychosomatic complaints and life satisfaction [LS])?
3. Do the relations between risk clusters and mental well-being differ between boys and girls?

As such, the study also explored whether it is the new risk behaviors (e.g., SMU) or risk factors (e.g., social support) as opposed to the declining more traditional risk behaviors (e.g., smoking and drinking), which predict adolescent mental well-being more strongly.

Methods

The HBSC study is a World Health Organization collaborative cross-sectional study. The study is school based, and data are collected every 4 years from a nationally representative random cluster sample of 11-, 13- and 15-year-old adolescents in each participating country. The primary sampling units are classes within schools. The present study used data from the 2017–2018 survey in which 47 countries across Europe, North America, and the Middle East took part. Data collection procedures in all countries were conducted in accordance with a standardized international protocol. More detailed information about the methodology of the HBSC study is reported elsewhere [30]. The present study used data from the adolescents aged 15 years only because several of the risk behaviors (e.g., cannabis use and early sexual intercourse) are not answered in many countries by younger children. As such, the sample included 32,884 adolescents (51.7% girls) from 37 participating countries. Only countries with all study variables were included in the analysis. Institutional ethical consent was obtained in each participating country.

Measures

Full details of the development and validity of the measures can be found in the HBSC 2017–2018 protocol [31]. Because of space limitations, we briefly describe them here. Unless referenced otherwise, measures were developed for the HBSC study.

Substance use: Three items about how often in the past 30 days adolescents had smoked cigarettes or used cannabis (1, never; and 7, 30 days or more) or been drunk (1, never; and 5, more than 10 times) [32]; *Early sex*: "Have you ever had intercourse?" (1, yes; and 2, no); *Healthy and unhealthy eating*: four items: "How many times a week do you usually eat or drink…(fruits, vegetables, sweets, coke, or other soft drinks that contain sugar?") (1, never; and 7, every day more than once) [33]; *Bullying:* Four items: "How often have you taken part in bullying (been bullied by) another person(s) at school in the past couple of months?" In the past couple of months how often have you taken part in cyberbullying (been cyberbullied)? (1, not at all; and 5, several times a week) [34]; *Physical fighting:* "During the past 12 months, how many times were you in a physical fight?" (1, not at all; and 5, four times or more) [35]; *Injuries:* "During the past 12 months, how many times were you injured and had to be treated by a doctor or nurse?" (1, not at all; and 5, four times or more) [36]; *Vigorous physical activity:* "Outside school hours: how *often* do you usually exercise in your free time so much that you get out of breath or sweat" (1, never; and 7, every day) [37]; *Problematic SMU* was measured through two measures: (1) levels of online contact with strangers (1, never; and 5, almost all the time) and (2) through the 9-item Problematic Social Media Use Scale [38] (e.g., during the past year have you often felt bad when you could not use social media? yes/no; Cronbach's $\alpha = .76$). *Lack of social support* was measured by four forms of support: classmate support (three items, Cronbach's $\alpha = .78$); teacher support (three items, Cronbach's $\alpha = .83$); peer support (four items, Cronbach's $\alpha = .93$); and family support (four items, Cronbach's $\alpha = .94$) [39].

Outcome measures. Life Satisfaction was assessed with the Cantril ladder [40,41]. Participants rated how happy they feel about their life on a visual analogous scale ranging from the worst possible life (0) to the best possible life [10]. The scale was dichotomized according to the accepted HBSC cut-off (1 [low LS] to $\leq$5; and 0 to $\geq$6).

Psychosomatic complaints. The HBSC Symptom Checklist is a nonclinical measure of subjective health complaints and includes eight complaints: headache, abdominal pain, backache, feeling low, irritability or bad mood, feeling nervous, sleeping difficulties, and dizziness. It assesses the frequency of health complaints over the last 6 months (Cronbach's $\alpha = .82$) [42]. The scale was dichotomized (1, 2, or more complaints more than once a week; and 0, otherwise) [30].

Sociodemographic variables. Adolescents reported their gender. Socioeconomic status was assessed through the 6-item HBSC Family Affluence Scale (FAS III) [43].

Analysis

Following descriptive analyses, we randomly divided the sample into two datasets ("training set" and "test set"), within each country. This division was made to ensure that the results which we found could be shown to be robust. Within this split, we first used the training set for data reduction (Principal Component Analysis [PCA]) and inference analysis (mixed-effects logistic regression). The test set was then used for confirmatory analysis of the results from the training set and for out-of-sample prediction.

PCA was carried out with Oblimin rotation using 21 items. We used Parallel analysis [37] to define the threshold by which we can determine the number of factors to retain from the PCA. In this procedure, eigenvalues generated from the empirical data matrix are compared with eigenvalues obtained from a simulated matrix of random values of the same dimensionality (i.e., using the same number of variables and sample size). If the PCA eigenvalue from the data is greater than the eigenvalue from the corresponding random data, the factor can be retained. Kaiser–Meyer–Olkin Measure of sampling adequacy [44,45], and Bartlett's test of sphericity [46] were used to test data suitability for structure detection. All factors extracted from the PCA analysis (regression method) have a mean of 0 and a standard deviation of around 1. Factors were transformed in such a way that higher scores represent higher risk.

Next, we fitted a mixed-effects logistic regression separately for LS and psychosomatic complaints to examine the relationship between the different factors we retained from the PCA and background variables (gender and family affluence) with these indicators of adolescent mental well-being. The mixed-effects design included PCA factors, gender (boys = 1), family affluence, and different gender by factors interactions as fixed effects. Family affluence scores were standardized by country. Random effects included a random intercept, and random slopes for both gender and family affluence effects, clustered by country. We used different evaluation matrices to test model fitting (e.g., Akaike information criterion [AIC], Bayesian information criterion [BIC], likelihood ratio [LR] tests, Brier score, Receiver Operating Characteristic, and Tjur's R^2) [47]. To control the familywise error rate, the significance threshold was set to $p < .01$. We limit our discussion of results to those findings that were replicated using our test set data. Data were analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY) and Stata Statistical Software: Release 16 (StataCorp., College Station, TX). We used SPSS for data pre-processing (organizing the data, descriptive statistics, splitting the data into test, and training sets) and PCA analyses. Stata was used for regression analyses, model fitting computations, and out-of-sample prediction.

Out-of-sample prediction

We aimed to fully reproduce our analytic approach to validate our results. Based on the training set component score coefficient matrix from the PCA, we extracted factor scores for each observation in the test set. Afterward, we used the fitted regression coefficients to predict outcomes (predicted probability for negative LS/psychosomatic complaints). Thereafter, we used different evaluation matrices to test model predictions versus actual responses (e.g., using Brier score, Receiver Operating Characteristic, and Tjur's R^2) in the test set.

Table 1
Description of international study sample, HBSC data, 2018

Number of countries	37	
Total participants	32,884	
Mean (SD)	889 (468)	
Median (IQR)	769 (333)	
Minimum	277	Malta
Maximum	2,383	Czech Republic
Age		
Mean (SD)	15.51 (.36)	
Median (IQR)	15.50 (.50)	
Minimum	14.6	
Maximum	16.5	
Gender, n (%)		
Boys	15,896	(48.3%)
Girls	16,988	(51.7%)
Data set type, n (%)		
Training set	16,433	(49.7%)
Test set (Hold-out)	16,451	(50.3%)

Country/WHO region included Albania, Armenia, Austria, Belgium (Flemish), Belgium (French), Canada, Croatia, Czech Republic, Denmark, England, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Republic of Moldova, Romania, Russia, Scotland, Slovenia, Spain, Sweden, Switzerland, Ukraine, Wales.

Results

The sample description can be seen in Table 1. Descriptive statistics per country for main outcome variables are presented in Supplemental Tables 1 and 2. Mean adolescent low LS was 15.9%, the lowest in Romania (7.7%) and highest in Malta (24.9%). The mean adolescent psychosomatic complaints was 42%, lowest in Kazakhstan (27.5%) and highest in Italy (61.8%). We found a positive cross-country association between the two variables ($r = .375$, $p < .05$), that is, a higher level of negative LS was associated with more psychosomatic complaints.

PCA–constructing risk factors

PCA followed by Oblimin rotation (Delta = 0) was used to examine the structure of our training set data that included 21 items from 16,433 participants. We found that a seven-component solution accounted for 54.7% of the total variance. As depicted in Table 2, we found that all seven factors' eigenvalues were greater compared with the eigenvalues obtained from the corresponding random data (parallel analysis), confirming that the retained factors were not spurious. As presented in Table 2, we replicated this solution and extracted a similar structure using the test set. The PCA analysis revealed seven factors: substance use and early sex, low social support, insufficient nutrition, bullying, sugary foods and drinks, physical health risk, and SMU risk. Similar results were obtained when PCA analysis was conducted by gender (Supplemental Tables 3–5). Table 3 presents the correlations between factors and outcome variables. Psychosomatic complaints were significantly ($p < .01$) positively correlated with all factors. Negative LS was significantly ($p < .01$) positively correlated with all factors except sugary foods and physical health risk. Similar to the country-level pattern, we

Table 2
Principal component analysis using 21 risk-related items (training and test sets), HBSC data, 2018

Training set (test set results in parentheses)				Eigen values			Parallel analysis	
Component	Items	Loadings[a]	Number of items	Total	Percentage of variance	Cumulative %	Mean Eigen value	Percentile Eigen value
Substance use and early sex	Smoking daily	.77 (.78)	4	3.16 (3.13)	15.05 (14.90)	15.05 (14.90)	1.06	1.07
	Cannabis last 30 d	.77 (.76)						
	Drunkenness last 30 d	.71 (.72)						
	Early sex	.47 (.48)						
Low social support	Classmate	.70 (.68)	4	1.83 (1.82)	8.71 (8.67)	23.76 (23.58)	1.05	1.06
	Peer	.65 (.67)						
	Family	.63 (.65)						
	Teacher	.62 (.62)						
Insufficient nutrition	Vegetables	.86 (.86)	2	1.67 (1.68)	7.96 (8.01)	31.72 (31.60)	1.05	1.05
	Fruits	.85 (.85)						
Bullying	Cyberbullied others	.74 (.75)	4	1.41 (1.43)	6.72 (6.83)	38.44 (38.43)	1.04	1.04
	Cyber victimized	.73 (.75)						
	Bullied others	.63 (.61)						
	Been bullied	.61 (.61)						
Sugary foods and drinks	Sweets	.85 (.85)	2	1.27 (1.29)	6.05 (6.13)	44.50 (44.57)	1.03	1.04
	Soft drinks	.76 (.78)						
Physical health risk	Times injured	.69 (.67)	3	1.10 (1.08)	5.22 (5.15)	49.72 (49.72)	1.03	1.03
	Vigorous physical activity	.63 (.63)						
	Times physical fight	.56 (.57)						
SMU risk	Contact online strangers	.83 (.80)	2	1.06 (1.06)	5.05 (5.03)	54.76 (54.75)	1.02	1.02
	Problematic social media use	.60 (.63)						

Principal component analysis with Oblimin rotation (Delta = 0) with Kaiser Normalization. Kaiser–Meyer–Olkin Measure of Sampling Adequacy = .715 (test set = .712); Bartlett's test of sphericity: $\chi^2_{(210)} = 46078.662$, $p < .000$ (test set: $\chi^2_{(210)} = 45886.535$, $p < .000$).
SMU = social media use.
[a] Loadings represents absolute partial standardized regression coefficient of each item with a particular factor based on the factor pattern matrix. All risk factors extracted from this analysis transformed in such a way that higher scores represent higher risk (e.g., high substance use, low social support, etc.).

found a significant positive association between LS and psychosomatic complaints.

The relationship between risk factors and LS

Table 4 displays the results of the mixed-effects logistic regression analysis for adolescent LS for both data sets. In the training set, this model (log-likelihood of full model = −5966.951, AIC = 11973.9, and BIC = 12128.04) was superior compared with a null model (LR test: $\chi^2_{(19)} = 2267.42$, $p < .000$; log-likelihood = −7100.663, AIC = 14203.33, and BIC = 14211.03), and a fixed-effects model (LR test: $\chi^2_{(3)} = 131.62$, $p < .000$; log-likelihood = −6032.763, AIC = 12099.53, and BIC = 12230.55). Other fit indices showed a reasonable fit to the data (Table 4). Being a boy and greater family affluence were associated with reduced relative odds of low LS (odds ratios [ORs] = .586 and .761, respectively). Between the factors, low social support and problematic SMU showed the largest effect on LS (ORs = 2.167 and 1.330, respectively). Finally, gender moderated the physical health risk effect on LS. Physical health risk was associated with reduced relative odds of low LS among boys (OR = .93, SE = .033, z = −2.02, $p < .05$, 95% confidence interval [CI]: .86–.99 in the training set; OR = .81, SE = .03, z = −5.68, $p < .001$, 95% CI .75–.87 in the test) but not among girls (OR = 1.05, SE = .032, z = 1.57, p = .12, 95% CI: .99–1.11 in the training set; OR = 1.02, SE = .038, z = .58, p = .56, 95% CI: .95–1.10 in the test set).

The relationship between risk factors and psychosomatic complaints

Table 5 displays the results of the mixed-effects logistic regression analysis for adolescent psychosomatic complaints for

Table 3
Pearson correlations between risk factors and outcome variables[a] (test set coefficients in parentheses), HBSC data, 2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Substance use and early sex	-							
(2) Low social support	.100** (.110**)	-						
(3) Insufficient nutrition	.133** (.124**)	.121** (.115**)	-					
(4) Bullying	.168** (.145**)	.210** (.214**)	.063** (.059**)	-				
(5) Sugary foods and drinks	.125** (.109**)	.006 (.007)	.073** (.081**)	.092** (.067**)	-			
(6) Physical Health risk	.186** (.197**)	.017* (.023**)	−.041** (−.042**)	.114** (.126**)	.0003 (.01)	-		
(7) SMU risk	.152** (.145**)	.122** (.130**)	.127** (.116**)	.131** (.135**)	.060** .071**	.057** (.051**)	-	
(8) Life satisfaction (low = 1)	.108** (.095**)	.305** (.309**)	.101** (.103**)	.121** (.122**)	−.013 (−.003)	−.008 (−.032**)	.151** (.162**)	-
(9) Psychosomatic complaints (two or more once a week = 1)	.120** (.149**)	.275** (.291**)	.058** (.073**)	.158** (.138**)	.060** (.062**)	.032** (.033**)	.211** (.235**)	.283** (.294**)

SMU = social media use.
*$p < .05$; **$p < .01$.
[a] Correlations between risk factors and outcome variables are point biserial correlation.

Table 4
Summary of mixed-effects logistic regression analysis for variables predicting low life satisfaction (low life satisfaction = 1; training set, N = 16,433; test set, N = 16,451), HBSC data, 2018

DV: life satisfaction									
	Specification	Training set				Test set			
		Estimate	Robust standard error[a]	95% CI		Estimate	Robust standard error[a]	95% CI	
				LL	UL			LL	UL
Background variables	Family affluence	.761***	.023	.717	.807	.756***	.027	.704	.811
	Gender (boys = 1)	.586***	.037	.519	.663	.566***	.039	.496	.648
Risk factors	Substance use and early sex	1.222***	.033	1.159	1.289	1.146***	.035	1.079	1.217
	Low social support	2.167***	.088	2.001	2.347	2.116***	.074	1.975	2.267
	Insufficient nutrition	1.206***	.046	1.120	1.300	1.199***	.037	1.129	1.274
	Bullying	1.107**	.036	1.039	1.179	1.129***	.035	1.062	1.200
	Sugary foods and drinks	.863***	.036	.795	.937	.949	.030	.892	1.009
	Physical health risk	1.054	.031	.995	1.118	1.024	.039	.950	1.104
	SMU risk	1.330***	.046	1.243	1.424	1.374***	.036	1.305	1.447
Two-way interactions	Gender by substance use and early sex	.940	.039	.867	1.019	.995	.042	.915	1.081
	Gender by low social support	1.017	.048	.928	1.115	1.060	.052	.962	1.167
	Gender by insufficient nutrition	.931	.052	.835	1.038	.969	.045	.885	1.062
	Gender by bullying	.998	.047	.910	1.095	.997	.039	.923	1.076
	Gender by sugary foods and drinks	1.109	.063	.993	1.240	1.042	.052	.944	1.149
	Gender by physical health risk	.876**	.043	.796	.964	.793***	.043	.713	.883
	Gender by SMU risk	.888*	.052	.791	.997	.873***	.031	.813	.936
	Intercept	.177***	.012	.155	.201	.183***	.011	.162	.207

Random effects (clustered by country)									
	Specification	Training set				Test set			
		Estimate	Robust standard error[a]	95% CI		Estimate	Robust standard error[a]	95% CI	
				LL	UL			LL	UL
Random intercept	Intercept (VAR)	.109	.029	.065	.182	.090	.030	.047	.173
Random slope(s)	Gender (VAR)	.014	.009	.004	.049	.029	.015	.010	.082
	Family affluence (VAR)	.007	.007	.001	.054	.020	.010	.008	.053

Model evaluation		Training set	Test set
In-sample	Pseudo R^2 (McFadden's)	.160	.163
	Pseudo R^2 (Tjur's)	.165	.166
	Sanders-modified Brier score	.110	.114
	ROC area	.78 ($p < .000$)	.78 ($p < .000$)
Out-of-sample	Pseudo R^2 (Tjur's)	.164	
	Sanders-modified Brier score	.114	
	ROC area	.78 ($p < .000$)	

CI = confidence interval; DV = dependet variable; LL = lower limit; ROC = Receiver Operating Characteristic; SMU = social media use; UL = upper limit; VAR = variance.
*$p < .05$; **$p < .01$; ***$p < .001$.
[a] Robust standard error adjusted for 37 clusters in country; Estimates are in odds ratio in the fixed effect part only.

both data sets. In the training set, this model (log-likelihood of full model = −9525.549, AIC = 19091.1, and BIC = 19245.24) was superior compared with a null model (LR test: $\chi^2_{(19)} = 3265.13$, $p < .000$; log-likelihood = −11158.12, AIC = 22318.23, and BIC = 22325.94), and with a fixed-effects model (LR: $\chi^2_{(3)} = 245.14$, $p < .000$; log-likelihood = −9648.119, AIC = 19330.24, and BIC = 19461.26). Other model fit indices imply a good fit to the data (Table 5). Compared with other factors, low social support and problematic SMU showed the largest effect on psychosomatic complaints (ORs = 1.687 and 1.386, respectively). The model also uncovered a gender effect: being a boy was associated with reduced relative odds of psychosomatic complaints (OR = .319). Finally, we found that gender moderates the bullying effect on psychosomatic complaints. Exposure to bullying is associated with more psychosomatic complaints among girls (OR = 1.37, SE = .05, z = 8.08, $p < .001$, 95% CI: 1.28–1.49 in the training set; OR = 1.32, SE = .06, z = 6.09, $p < .001$, 95% CI: 1.20–1.44 in the test set) compared with boys (OR = 1.22, SE = .03, z = 8.57, $p < .001$, 95% CI: 1.16–1.27 in the training set; OR = 1.13, SE = .03, z = 4.75, $p < .001$, 95% CI 1.07–1.19 in the test set).

Validation and out-of-sample prediction

The main results reported were replicated with the test set. More importantly, out-of-sample prediction supported the validity of both models (i.e., their ability to predict LS/psychosomatic complaints with the test set data). We used various model fit indices (e.g., Tjur's R^2 and Brier score) to estimate model prediction. Supplemental Tables 6 and 7 display model fit indices by country as well as Brier score decomposition metrics. Overall, predicting psychosomatic complaints gave slightly better results compared with LS (as also evident in the in-sample model fit indices). Best models to predict LS were in Canada (Brier score = .13; Tjur's R^2 = .22), Estonia (Brier score = .10; Tjur's R^2 = .21),

Table 5
Summary of mixed-effects logistic regression analysis for variables predicting psychosomatic complaints (two or more once a week = 1; training set, N = 16,433; test set, N = 16,451), HBSC study, 2018

DV: psychosomatic complaints									
	Specification	Training set				Test set			
		Estimate	Robust standard error[a]	95% CI		Estimate	Robust standard error[a]	95% CI	
				LL	UL			LL	UL
Background variables	Family affluence	.958*	.020	.920	.998	.971	.022	.928	1.016
	Gender (boys = 1)	.319***	.014	.292	.349	.289***	.017	.258	.324
Risk factors	Substance use and early sex	1.187***	.039	1.114	1.266	1.282***	.049	1.191	1.381
	Low social support	1.687***	.059	1.575	1.808	1.806***	.064	1.684	1.936
	Insufficient nutrition	1.031	.032	.971	1.096	1.116***	.028	1.062	1.172
	Bullying	1.381***	.054	1.279	1.490	1.321***	.061	1.206	1.447
	Sugary foods and drinks	1.117***	.030	1.061	1.176	1.130***	.029	1.074	1.189
	Physical health risk	1.209***	.031	1.150	1.272	1.251***	.040	1.175	1.332
	SMU risk	1.386***	.038	1.313	1.463	1.506***	.046	1.419	1.599
Two-way interactions	Gender by Substance use and early sex	.964	.034	.900	1.032	.958	.041	.881	1.041
	Gender by low social support	1.011	.042	.932	1.097	.962	.037	.891	1.038
	Gender by insufficient nutrition	1.062	.044	.980	1.152	.986	.037	.916	1.062
	Gender by bullying	.881**	.040	.806	.964	.860***	.041	.783	.944
	Gender by sugary foods and drinks	1.005	.035	.939	1.075	.998	.043	.917	1.086
	Gender by physical health risk	.944	.036	.877	1.016	.884***	.026	.834	.936
	Gender by SMU risk	.964	.032	.902	1.029	.897**	.033	.834	.964
	Intercept	1.231**	.088	1.069	1.416	1.321***	.088	1.160	1.505
Random effects (clustered by country)									
	Specification	Training set				Test set			
		Estimate	Robust standard error[a]	95% CI		Estimate	Robust standard error[a]	95% CI	
				LL	UL			LL	UL
Random intercept	Intercept (VAR)	.115	.034	.064	.204	.096	.028	.055	.170
Random slope(s)	Gender (VAR)	.009	.008	.002	.048	.023	.009	.011	.050
	Family affluence (VAR)	.002	.002	.000	.012	.001	.003	.000	4.001
Model evaluation				Training set		Test set			
In-sample		Pseudo R^2 (McFadden's)		.146		.165			
		Pseudo R^2 (Tjur's)		.192		.213			
		Sanders-modified Brier score		.196		.192			
		Roc Area		.75 ($p < .000$)		.77 ($p < .000$)			
Out-of-sample		Pseudo R^2 (Tjur's)		.201					
		Sanders-modified Brier score		.192					
		Roc Area		.77 ($p < .000$)					

CI = confidence interval; DV = dependet variable; LL = lower limit; ROC = Receiver Operating Characteristic; SMU = social media use; UL = upper limit; VAR = variance.
*$p < .05$; **$p < .01$; ***$p < .001$
[a] Robust Std. Err. adjusted for 37 clusters in country; Estimates are in odds ratio in the fixed effect part only.

and Sweden (Brier score = .12; Tjur's R^2 = .20), whereas the worst models were in Albania (Brier score = .13; Tjur's R^2 = .09) and Romania (Brier score = .07; Tjur's R^2 = .07). Best models to predict psychosomatic complaints were in Canada (Brier score = .18; Tjur's R^2 = .24), Portugal (Brier score = .18; Tjur's R^2 = .21), and Sweden (Brier score = .19; Tjur's R^2 = .21), whereas the poorest models were in Armenia (Brier score = .22; Tjur's R^2 = .12) and Malta (Brier score = .22; Tjur's R^2 = .12).

Discussion

The present study aimed to build a contemporary model of clusters of risk for adolescents and to examine relationships of these clusters to two measures of mental well-being: life satisfaction and psychosomatic complaints. PCA identified seven distinct groups of clustered risk: substance use and early sex, low social support, insufficient nutrition, bullying, sugary foods and drinks, physical health risk, and SMU risk. The findings support a theoretical perspective, in line with Problem Behavior Theory [9,10], in which contemporary and traditional risks cluster in an organized and predictable way across countries and genders. The associations between clusters and adolescent mental well-being, and in particular, the strong relationships between SMU and social support with mental well-being emphasize the relevance of a model of adolescent mental well-being which incorporates contemporary risk factors and risk behaviors.

The first aim of the study was to identify which clusters of risk can be identified among adolescents across Europe and North America in the year 2018. First, despite research showing a decline in adolescent involvement in traditional risk behaviors [5], substance use and early sex [32] were found to be the factor explaining the highest variance, suggesting that traditional risk factors are still of importance. Second, the analysis showed that some of the factors were found to be surprisingly distinct, such as *insufficient nutrition* and *sugary foods and drinks*, suggesting that they may reflect different components of young people's consumption habits, with potentially different meanings. In addition, the clustering together of traditional and cyber-bullying

perpetration and victimization strengthens previous research showing the significant overlap between bullying perpetration and victimization [48] and new research showing overlaps between cyber and traditional victimization [19]. The clustering together of physical activity, injury, and fighting was also unexpected yet notable. Previous research shows the associations between injuries and physical activity [49] and physical fighting [50] among adolescents. PCA analysis identifies variables with significant (but not complete) shared variance. Speculatively, the results suggest that this cluster represents highly active young people, whose lives involve high physicality in multiple domains, such as fighting, sport, and resulting injuries.

The second goal of the study was to examine the relative relationships between risk clusters and mental well-being. For both LS and psychosomatic complaints, a lack of social support and high levels of problematic SMU were the strongest predictors. Exposure to bullying was also a strong predictor for psychosomatic complaints. The findings highlight the pivotal role of a lack of strong connection (parental, peer, and teacher support) as a risk to young people's mental well-being [20,21] as well as the potentially negative impact of SMU [16]. These findings are of concern in light of studies showing an increase in young people's feelings of loneliness [51] and studies highlighting the changing nature of young people's social relationships (e.g., more online [1]). Overall, results show the importance of contemporary risk factors in understanding young people's mental well-being.

Although there were many similarities in the risk clusters associations with the two components of mental well-being, there were also some distinctions. For example, although insufficient nutrition was associated with LS, sugary foods and drinks and physical health risk were associated with psychosomatic complaints. Similarly, lower levels of family affluence associated only with lower LS but not with psychosomatic complaints [52]. These findings strengthen a multidimensional view of mental well-being [53] and suggest that risks for health may be specific and not general. As such, general measures of adolescent mental well-being may miss the specificity of problems and fail to identify adolescents at risk. These specific risks also reinforce the need to have a clustered approach.

The third research aim was to explore gender differences in risk factors and their relationship to mental well-being. In line with previous studies [54], we found that compared with boys, girls report higher levels of health complaints and lower levels of LS. Moreover, we found that risk factors were very similar for boys and girls as well as the associations with mental well-being. There was only some very limited gender specificity in predicting outcomes, that is, the findings showed that physical health risk has a lower risk for LS for boys, and exposure to bullying was a greater risk for psychosomatic complaints for girls. The few observed interactions are consistent with theories on gendered health effects, suggesting that girls are more likely to internalize social stressors than boys [55], whereas engagement in so-called "masculine" behaviors such as fighting and physical activity is more accepted or even associated with a higher prestige in society for boys as compared with girls [56]. As such, the results suggest that there may not be a need for gender-specific monitoring and surveillance of risk, but that there may be a need to highlight gender risk profiles for specific outcomes. Yet, despite the consistent effects across gender, because the prevalence of different risk factors is known to differ across gender [30], there may be a differential burden on society for boys and girls in terms of mental well-being.

The strengths of the study include the large, representative sample, the robustness of the findings, and the replicability across data sets and gender. Out-of-sample prediction, using the simplest form of cross-validation (i.e., the classical replication setup), further confirmed our findings. Future studies can adopt our analysis approach and take advantage of more sophisticated cross-validation methods as K-fold cross-validation [57]. Limitations include the cross-sectional, self-report nature of the HBSC study. The measures used were those available in the HBSC study and could not include other potential risk factors and risk behaviors, such as gambling or video game addiction, and additional determinants of mental well-being such as genetics and family history. In addition, some of the correlations may have been significant, although small, because of the large sample size. Policy recommendations from the results include the need to assess multiple risks and to target the most salient risks for mental well-being, which include contemporary risks, such as problematic SMU [58] as well as lack of social support [20,51]. In conclusion, the results highlight the importance of contemporary clusters of risk, such as low social support and SMU in the mental well-being of young people and the need to focus on these as targets for prevention. We propose that future studies should use composite risk measures that take into account both risk behaviors and risk factors to explain adolescents' mental well-being.

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Supplementary Data

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References

[1] Twenge JM. IGen: Why today's super-connected kids are growing up less rebellious, more tolerant, less happy–and completely unprepared for adulthood–and what that means for the rest of us. New York: Simon and Schuster; 2017.
[2] Bor W, Dean AJ, Najman J, et al. Are child and adolescent mental health problems increasing in the 21st century? A systematic review. Aust N Z J Psychiatry 2014;48:606–16.
[3] Potrebny T, Wiium N, Lundegård MM-I. Temporal trends in adolescents' self-reported psychosomatic health complaints from 1980-2016: A systematic review and meta-analysis. PLoS One 2017;12:e0188374.
[4] Leather NC. Risk-taking behaviour in adolescence: A literature review. J Child Health Care 2009;13:295–304.
[5] De Looze M, van Dorsselaer S, Stevens G, et al. The decline in adolescent substance use across Europe and North America in the early twenty-first century: A result of the digital revolution? Int J Public Health 2019;64:229–40.
[6] van Nieuwenhuijzen M, Junger M, Velderman MK, et al. Clustering of health-compromising behavior and delinquency in adolescents and adults in the Dutch population. Prev Med 2009;48:572–8.
[7] Jackson C, Sweeting H, Haw S. Clustering of substance use and sexual risk behaviour in adolescence: Analysis of two cohort studies. BMJ open 2012;2:e000661.
[8] Mun EY, Windle M, Schainker LM. A model-based cluster analysis approach to adolescent problem behaviors and young adult outcomes. Dev Psychopathol 2008;20:291–318.
[9] Jessor R. Risk behavior in adolescence: A psychosocial framework for understanding and action. Dev Rev 1992;12:374–90.
[10] Jessor R. The origins and development of problem behavior theory. New York: Springer; 2016.
[11] Paxton RJ, Valois RF, Watkins KW, et al. Associations between depressed mood and clusters of health risk behaviors. Am J Health Behav 2007;31:272–83.
[12] Hallfors DD, Waller MW, Ford CA, et al. Adolescent depression and suicide risk: Association with sex and drug behavior. Am J Prev Med 2004;27:224–31.
[13] Kann L. Youth risk behavior surveillance—United States, 2015. MMWR Surveill Summ 2016;65:1–174.
[14] O'Carroll PW, Harel Y, Waxweiler RJ. Measuring adolescent behaviors related to intentional injuries. Public Health Rep 1993;108:15–9.
[15] Boniel-Nissim M, Lenzi M, Zsiros E, et al. International trends in electronic media communication among 11-to 15-year-olds in 30 countries from 2002 to 2010: Association with ease of communication with friends of the opposite sex. Eur J Public Health 2015;25:41–5.
[16] Best P, Manktelow R, Taylor B. Online communication, social media and adolescent wellbeing: A systematic narrative review. Child Youth Serv Rev 2014;41:27–36.
[17] Van Den Eijnden R, Koning I, Doornwaard S, et al. The impact of heavy and disordered use of games and social media on adolescents' psychological, social, and school functioning. J Behav Addict 2018;7:697–706.
[18] Kwong JL, Klinger DA, Janssen I, et al. Derivation of some contemporary scales to measure adolescent risk-taking in Canada. Int J Public Health 2018;63:137–47.
[19] Cosma A, Walsh SD, Chester KL, et al. Bullying victimization: Time trends and the overlap between traditional and cyberbullying across countries in Europe and North America. Int J Public Health 2020;65:75–85.
[20] Chu PS, Saucier DA, Hafner E. Meta-analysis of the relationships between social support and well-being in children and adolescents. J Soc Clin Psychol 2010;29:624–45.
[21] Heerde JA, Hemphill SA. Examination of associations between informal help-seeking behavior, social support, and adolescent psychosocial outcomes: A meta-analysis. Dev Rev 2018;47:44–62.
[22] Brooks F, Zaborskis A, Tabak I, et al. Trends in adolescents' perceived parental communication across 32 countries in Europe and North America from 2002 to 2010. Eur J Public Health 2015;25:46–50.
[23] Fahy AE, Stansfeld SA, Smuk M, et al. Longitudinal associations between cyberbullying involvement and adolescent mental health. J Adolesc Health 2016;59:502–9.
[24] Pearson N, Griffiths P, Biddle SJ, et al. Clustering and correlates of screen-time and eating behaviours among young adolescents. BMC Public Health 2017;17:533.
[25] Pickett W, Garner MJ, Boyce WF, et al. Gradients in risk for youth injury associated with multiple-risk behaviours: A study of 11,329 Canadian adolescents. Soc Sci Med 2002;55:1055–68.
[26] Pickett W, Schmid H, Boyce WF, et al. Multiple risk behavior and injury: An international analysis of young people. Arch Pediatr Adolesc Med 2002;156:786.
[27] Bruckauf Z, Walsh SD. Adolescents' multiple and individual risk behaviors: Examining the link with excessive sugar consumption across 26 industrialized countries. Soc Sci Med 2018;216:133–41.
[28] Harel-Fisch Y, Abdeen Z, Walsh SD, et al. Multiple risk behaviors and suicidal ideation and behavior among Israeli and Palestinian adolescents. Soc Sci Med 2012;75:98–108.
[29] de Looze M, Pickett W, Raaijmakers Q, et al. Early risk behaviors and adolescent injury in 25 European and North American countries A cross-national consistent relationship. J Early Adolesc 2012;32:104–25.
[30] Inchley J, Currie D, Young T, et al. Growing up unequal: Gender and socioeconomic differences in young people's health and well-being. Health Behavior in School aged Children (HBSC) study: International report from the 2013/14 survey. Copenhagen, Denmark: World Health Organisation; 2016.
[31] Inchley J, Currie D, Cosma A, et al. Health behaviour in school-aged children (HBSC) study protocol: Background, methodology and mandatory items for the 2017/18 survey. St Andrews, Scotland: CAHRU; 2018.
[32] de Looze M, Ter Bogt TF, Raaijmakers QA, et al. Cross-national evidence for the clustering and psychosocial correlates of adolescent risk behaviours in 27 countries. Eur J Public Health 2014;25:50–6.
[33] Vereecken CA, Maes L. A Belgian study on the reliability and relative validity of the health behaviour in school-aged children food-frequency questionnaire. Public Health Nutr 2003;6:581–8.
[34] Olweus D. Bullying at school: What we know and what we can do. Malden (MA): Blackwell Publishers; 1993.
[35] Brener ND, Collins JL, Kann L, et al. Reliability of the youth risk behavior survey questionnaire. Am J Epidemiol 1995;141:575–80.
[36] Waxweiler RJ, Harel Y, O'Carroll PW. Measuring adolescent behaviors related to unintentional injuries. Public Health Rep 1993;108:11.
[37] Booth M, Okely A, Chey T, et al. The reliability and validity of the physical activity questions in the WHO health behaviour in schoolchildren (HBSC) survey: A population study. Br J Sports Med 2001;35:263–7.
[38] van den Eijnden RJ, Lemmens JS, Valkenburg PM. The social media disorder scale. Comput Hum Behav 2016;61:478–87.
[39] Zimet GD, Dahlem NW, Zimet SG, et al. The multidimensional scale of perceived social support. J Pers Assess 1988;52:30–41.
[40] Cantril H. The pattern of human concerns. New Brunswick, NJ: Rutgers U. P; 1965.
[41] Levin KA, Currie C. Reliability and validity of an adapted version of the Cantril Ladder for use with adolescent samples. Soc Indicat Res 2014;119:1047–63.
[42] Haugland S, Wold B, Stevenson J, et al. Subjective health complaints in adolescence: A cross-national comparison of prevalence and dimensionality. Eur J Public Health 2001;11:4–10.
[43] Currie C, Molcho M, Boyce W, et al. Researching health inequalities in adolescents: The development of the health behaviour in school-aged children (HBSC) family affluence scale. Soc Sci Med 2008;66:1429–36.
[44] Cerny BA, Kaiser HF. A study of a measure of sampling adequacy for factor-analytic correlation matrices. Multivariate Behav Res 1977;12:43–7.
[45] Kaiser HF. A second generation little jiffy. Psychometrika 1970;35:401–15.
[46] Bartlett M. Tests of significance in factor analysis. Br J Stat Psychol 1950;3:77–85.
[47] Tjur T. Coefficients of determination in logistic regression models—a new proposal: The coefficient of discrimination. Am Statistician 2009;63:366–72.
[48] Haynie DL, Nansel T, Eitel P, et al. Bullies, victims, and bully/victims: Distinct groups of at-risk youth. J Early Adolesc 2001;21:29.
[49] Janssen I, Dostaler S, Boyce WF, et al. Influence of multiple risk behaviors on physical activity–related injuries in adolescents. Pediatrics 2007;119:e672–80.
[50] Walsh SD, Molcho M, Craig W, et al. Physical and emotional health problems experienced by youth engaged in physical fighting and weapon carrying. PLoS One 2013;8:e56403.

[51] Madsen KR, Holstein BE, Damsgaard MT, et al. Trends in social inequality in loneliness among adolescents 1991–2014. J Public Health 2018;41:e133–40.
[52] Levin KA, Dallago L, Currie C. The association between adolescent life satisfaction, family structure, family affluence and gender differences in parent–child communication. Soc Indicat Res 2012;106:287–305.
[53] Ryff CD, Keyes CLM. The structure of psychological well-being revisited. J Pers Soc Psychol 1995;69:719–27.
[54] Fink E, Patalay P, Sharpe H, et al. Mental health difficulties in early adolescence: A comparison of two cross-sectional studies in England from 2009 to 2014. J Adolesc Health 2015;56:502–7.
[55] Hankin BL, Mermelstein R, Roesch L. Sex differences in adolescent depression: Stress exposure and reactivity models. Child Dev 2007;78:279–95.
[56] de Looze M, Elgar FJ, Currie C, et al. Gender inequality and sex differences in physical fighting, physical activity, and injury among adolescents across 36 countries. J Adolesc Health 2019;64:657–63.
[57] Bi Q, Goodman KE, Kaminsky J, et al. What is machine learning: A primer for the epidemiologist. Am J Epidemiol 2019;188:2222–39.
[58] Valkenburg PM, Peter J. Online communication among adolescents: An integrated model of its attraction, opportunities, and risks. J Adolesc Health 2011;48:121–7.