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Original article

What Counteracts Problematic Social Media Use in Adolescence? A Cross-National Observational Study

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A B S T R A C T

Purpose: Social media use has increased rapidly during the past decade, raising concerns about adolescents who display problematic social media use (PSMU), as indicated by addiction-like symptoms (e.g., preoccupation, tolerance). We aimed to assess the extent to which an individual resource (health literacy), and social resources (friend support and family support), moderated the association between a range of individual characteristics (gender, age, family affluence, and depressive feelings) and PSMU; also the association between PSMU and health outcomes (self-rated health, life satisfaction, and sleep difficulties), both cross-nationally and nationally.
Methods: Our sample included 22,226 adolescents from six European countries. We used data from the Health Behaviour in School-aged Children cross-sectional survey (2017/2018). Random-effects models and moderator analyses were applied.
Results: Six moderations were found, with the resources moderating the association between individual characteristics and PSMU. One moderation emerged cross-nationally, namely that a higher level of family support was associated with a lower likelihood of PSMU, especially among adolescents who did not have frequent depressive feelings. In addition, five national moderations were identified. For example, a higher level of health literacy was associated with a lower likelihood of PSMU among Finnish girls. The resources were also found to moderate the association between PSMU and health outcomes, with two moderations emerging cross-nationally. For instance, a higher level of family support was related to higher self-rated health, especially among problematic users. In addition, nine national moderations were identified; these included a higher

IMPLICATIONS AND CONTRIBUTION

A strong body of research demonstrates that if left untreated, problematic social media use (PSMU) can substantially harm adolescent health and wellbeing. These results suggest that health literacy, family support, and friend support have the potential to moderate the associations between individual characteristics and PSMU and also the association between PSMU and health outcomes in adolescence.

Conflicts of interest: The authors declare they have no conflicts of interest.
Data Sharing: The HBSC survey data that were used in this study are available at https://www.uib.no/en/hbscdata from October 2022, subject to the approval of the Data Manager of the HBSC study (https://www.uib.no/en/hbscdata). The statistical analyses will be available at https://orcid.org/0000-0002-1877-4712 on acceptance for publication.
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level of health literacy being associated with having less sleep difficulties, especially among problematic users in Germany.

Discussion: In adolescence, health literacy, family support, and friend support have the potential to moderate the association between individual characteristics and PSMU, and between PSMU and health outcomes, cross-nationally and nationally. We recommend the use of universal and targeted interventions to promote individual and social resources to counteract PSMU.

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Social media have become strongly integrated into adolescents' daily lives [1]. Adolescents routinely report that the social media make them feel more connected to their friends, thus fostering a more complete sense of social self-identity [2]. Nevertheless, concerns have been raised about adolescents who display problematic social media use (PSMU), as indicated by addiction-like symptoms including preoccupation (i.e., considerable time spent on thinking about the activity), tolerance, withdrawal, persistence (i.e., relapse), escape from negative feelings, conflict, displacement of activities, problems in important life domains, and deception [3,4]. In the cross-national Health Behaviour in School-aged Children (HBSC) study conducted in 2018, which included data from 45 countries, 4%–18% of 15-year-olds reported PSMU [5]. A solid evidence base suggests that if untreated, PSMU can seriously threaten adolescent health and wellbeing [6,7]. There have been calls for approaches aimed at identifying those adolescents who are more prone to digital threats such as PSMU and finding ways to counteract the negative outcomes [8,9]. Theoretical support has been derived from the Differential Susceptibility to Media Effects Model (DSMM), which was developed to explain why some individuals are more susceptible than others to media effects and to indicate how the media effects can be counteracted [10].

The DSMM combines, systematizes, and expands on previous media-effects theories. It comprises an integrated set of propositions that describe the association between media-related variables (such as PSMU) and nonmedia variables. According to the model, media effects are conditional on dispositional, developmental, and social susceptibility, together labeled as differential susceptibility variables. Dispositional susceptibility encompasses all personal dimensions that could predispose to media use, such as gender, personality traits, moods, cognitions, values, and motivations. Developmental susceptibility is characterized as emotional, social, and cognitive development that could influence media use. Finally, social susceptibility includes all social-context factors that could be related to media use. The DSMM assigns two roles to differential susceptibility variables. First, they can work as predictors of media use. Second, they can reduce or stimulate media-related outcomes through moderation [10].

As suggested by the model, differential susceptibility variables (i.e., individual characteristics) play a substantial role in explaining why some adolescents are more susceptible to PSMU. Cross-national findings indicate that girls are more likely than boys to have higher levels of PSMU [5], with national studies showing that girls also have a higher risk of developing PSMU [11]. Furthermore, PSMU seems to increase with age, with 13-year-olds and 15-year-olds reporting more problematic use than their younger counterparts (aged 11 years) [11]. In addition, adolescents from less affluent families in certain countries report more PSMU [5], and research indicates that adolescents who are relatively more deprived are more susceptible to PSMU [12]. Cross-national and single-country studies have also shown that adolescents with frequent depressive feelings show higher levels of PSMU [11,13,14]. Given that individual characteristics are associated with PSMU, it has been deemed essential to identify and study adolescents with the characteristics in question (i.e., adolescents in vulnerable situations), with the aim of lessening health disparities [8,9,15].

Adolescence has also been recognized as a critical period for major developmental tasks; these include acquiring the emotional and cognitive abilities for independence and for forming life-long relationships, but they also involve risk behavior and susceptibilities [16]. So far, only a few studies have examined those differential susceptibility variables that could work as individual resources (e.g., Paakkari et al.) [11] and social resources (e.g., Boniel-Nissim et al.) [14]. The difference as compared to many other differential susceptibility variables (e.g., gender, age) is that the resources can be developed through education, interventions, and policies aimed at protecting adolescents from PSMU. For such investigations, the DSMM [10] suggests modeling the resources as *moderator variables*, the aim being to explain systematic variations in how the resources influence—and possibly counteract—PSMU and associated negative health outcomes. With this aim in view, the present study aimed to investigate whether health literacy and social support from family and friends can moderate the association between individual characteristics and PSMU, and furthermore, the association between PSMU and health outcomes in adolescence (Figure 1) [10].

Health literacy as an individual resource refers to personal knowledge and competencies (mediated by the availability of resources and by organizational structures) that enable people to access, understand, appraise, and use services and information in ways that promote and maintain wellbeing and good health for themselves and others around them [17]. Previous studies have shown that health literacy operates as a mediator [18] and as a moderator [19] and has the potential to promote positive health as well as to protect adolescents from negative health behavior and negative health outcomes. Higher health literacy has also been shown to have a negative association with PSMU (e.g., Paakkari et al.) [11]. Furthermore, health literacy can be developed through education; hence, it belongs to the potential factors that might help to decrease unfair and avoidable disparities in health [17]. There have therefore been calls for further research on whether health literacy can counteract PSMU and its negative health consequences [11]. It should also be noted that adolescence comprises a valuable period in life for promoting health literacy because it is the phase in which independent

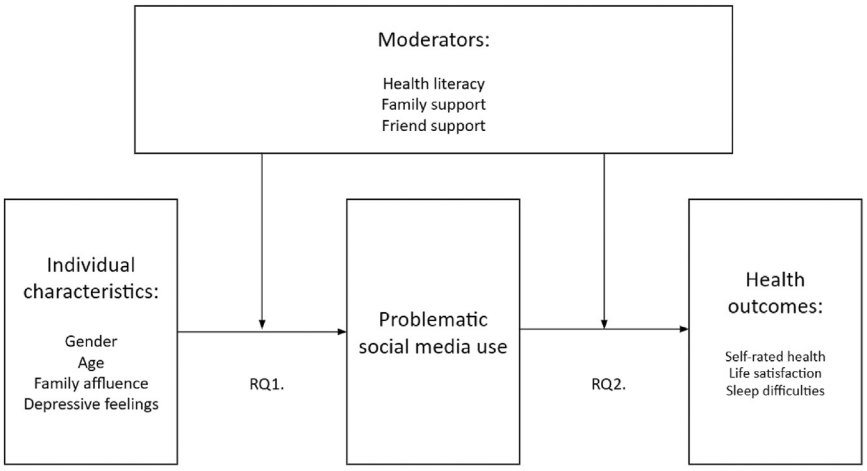


Figure 1. The moderations of health literacy, family support, and friend support in the associations between individual characteristics and PSMU, and between PSMU and health outcomes. Theoretical support has been derived from the Differential Susceptibility to Media Effects Model [10].

decision-making develops [20], and in which the foundation for health behavior, health, and wellbeing is laid [16].

Substantial evidence exists for the protective role of social support (comprising a social susceptibility variable) regarding adverse health outcomes (e.g., Rueger et al.) [21]. For instance, high levels of social support were linked to higher life satisfaction and less psychosomatic complaints in an international study that examined adolescent risk behaviors and their association with adolescent mental wellbeing [22]. Perceived social support has also been shown to be negatively associated with PSMU [23] and to have the potential to work as a moderator in the association between the social determinants of health and PSMU [12].

Because adolescence is a period marked by rapid changes and growth, friend and family contexts may provide different types of social support. In adolescence, one begins to move away from the family and to approach the peer group to a greater degree [2]. However, at the same time, family support does not cease to be significant at this stage. The adolescent thus needs diverse sources of support to overcome the challenges of adolescence [21]. Consequently, consideration of different sources of support—including family and peer contexts—is important for understanding whether social support can counteract PSMU and associated negative health outcomes during adolescence [14].

To our knowledge, no study has so far investigated the extent to which individual resources (such as health literacy) and social resources (such as family support and friend support) could moderate and possibly counteract digital threats such as PSMU and its negative health consequences during adolescence. As noted above, these are resources which might be influenced through education and interventions. Furthermore, cross-national and single-country studies have indicated that individual characteristics play a role in the development of PSMU [5,11,14]. There would therefore be a good reason to pay attention to how the resources in question are linked to individuals in vulnerable situations. These could include girls, adolescents of a higher age, adolescents with lower family affluence [5], and adolescents with depressive symptomology [13].

In the present study, both cross-national and national perspectives were adopted, because country-level variation was expected, and because this could potentially enhance the appropriate targeting of policy, intervention, and prevention efforts. Based on the existing literature, we hypothesized that cross-nationally and nationally, health literacy, family support, and friend support would moderate the association between (1) individual characteristics and PSMU and (2) the association between PSMU and health outcomes. Specifically, we hypothesized the resources which might counteract PSMU, especially among adolescents who are in vulnerable situations in terms of PSMU, and which might enhance health outcomes especially among problematic social media users, with reduced health disparities as a consequence [8,9,15]. In line with the hypotheses, the specific research questions for the study were framed as follows:

RQ1: Do health literacy, family support, and friend support moderate the association between individual characteristics (gender, age, family affluence, and depressive feelings) and PSMU?

RQ2: Do health literacy, family support, and friend support moderate the association between PSMU and health outcomes (self-rated health [SRH], life satisfaction, and sleep difficulties)?

Methods

Study design and data sources

The data were collected as part of the HBSC study (a collaborative cross-sectional survey with World Health Organization, examining adolescents' health and wellbeing, and repeated every four years in more than 50 countries). We made use of the latest 2017/2018 data, which included nationally representative samples of 13-year-old and 15-year-old adolescents from six European countries: Finland (n = 2,194), Germany (n = 2,922), Belgium (n = 2,688), Estonia (n = 3,147), the Czech Republic (n = 7,768), and Poland (n = 3,507). Countries that included all the study variables in their 2017/2018 survey were included. These countries strictly adhered to the sampling method and data collection procedures of the HBSC international research protocol, which involved random selection of schools and classes for sampling [24]. The surveys were administered during school hours in classroom settings, and participation was anonymous and voluntary. The participating countries obtained ethical

approval from their institutional ethics committee for the study procedures [24].

Problematic social media use

PSMU was measured via the nine-item Social Media Disorder Scale, which assesses symptoms of addiction (such as preoccupation and tolerance) using a dichotomous (No/Yes) answer scale. The cut-off value for the problematic user group was six or more "yes" answers [4]. Based on the values obtained, the respondents were categorized into two groups: a *nonproblematic* use group = 0 and a *problematic* use group = 1, in line with Boer et al. [25]. The scale has been found to be reliable, valid, and cross-nationally comparable [3]. The internal consistency of the scale was adequate (with Cronbach's alpha ranging from 0.72 to 0.84 between countries).

Individual characteristics

Self-reported gender (boy = 0; girl = 1) and age (13 years = 0; 15 years = 1) were measured by asking participants to select the correct alternative.

The Family Affluence Scale (FAS) III [26] measured the self-reported socioeconomic position. FAS III includes six items: ownership of a car, ownership of a dishwasher, having one's own bedroom, number of family computers, number of family bathrooms, and number of family vacations during the past 12 months. The computed scores were recoded into two categories to indicate relative family affluence: high family affluence (highest 80%) = 0 and low family affluence (lowest 20%) = 1. The relative family affluence was studied in line with the suggestions of Elgar et al. [27], in addition to the HBSC international report [28]. The scale was dichotomized to allow appropriate group-level comparison, here bearing in mind adolescents in vulnerable situations and possible inequities [8,9,15]. The FAS III has been validated and shown to be appropriate in adolescent studies [26].

The depressive feelings variable was measured as part of the HBSC symptoms checklist [29]. The responses ranged from 1 = *rarely or never* to 5 = *about every day*. The responses were categorized into two groups. Hence, the responses *feeling low rarely or never* and *feeling low monthly* were combined and labeled as *not having frequent depressive feelings*= 0. The responses *feeling low about every week*, *more than once a week*, and *about every day* were combined and labeled as having *frequent depressive feelings* = 1. The variable was dichotomized to allow appropriate group-level comparison, again bearing in mind adolescents in vulnerable situations and possible inequities [8,9,15]. The item has been validated in an adolescent sample and has been found to have adequate reliability [30].

Sample distributions for individual characteristics are shown in Table A1.

Individual and social resources as moderators

Health literacy was measured by the Health Literacy for School-Aged Children instrument [31,32]. The scale consists of 10 items (e.g., "I have good information about health") and measures adolescents' perceived competencies and knowledge to make health-related decisions. The range of responses is from 1 = *not at all true* to 4 = *absolutely true*. The response values were summed, and the sum score (ranging from 10 to 40 points) was used as a continuous scale [32]. The internal consistency of the items was good (with Cronbach's alpha ranging from 0.83 to 0.96 between countries).

Family support [33] was measured via a multidimensional scale consisting of four items on perceived support: (1) emotional support, (2) talking about problems with the family, (3) the family's willingness to help in making decisions, and (4) family help. The scale ranged from 1 = *very strongly disagree* to 7 = *very strongly agree*. The scale (continuous) was calculated via the sum score. The scale has been validated in adolescent samples [34,35]. The internal consistency of the items was very good (with Cronbach's alpha ranging from 0.91 to 0.97 between countries).

Friend support [33] was measured via a multidimensional scale consisting of four items on perceived support: (1) emotional support, (2) talking about problems with friends, (3) being able to count on friends, and (4) friends' help. The scale ranged from 1 = *very strongly disagree* to 7 = *very strongly agree*. The scale (continuous) was calculated via the sum score. The scale has been validated in adolescent samples [34,35]. The internal consistency of the items was good (with Cronbach's alpha ranging from 0.89 to 0.96 between countries).

Health outcomes

Self-rated health (SRH) was measured by a single question on the individual's evaluation and perception of their health [36]. The response options were *poor, fair, good,* and *excellent*. SRH was treated as a continuous variable. SRH has been shown to be a robust item [37] and valid in adolescent samples [38].

Life satisfaction was measured via a single question in which respondents rated their life satisfaction using Cantril's ladder [39]. The responses ranged from 0 (= *worst possible life*) to 10 (= *best possible life*). Life satisfaction was treated as a continuous variable. The scale has been validated in adolescent samples and has exhibited adequate validity and reliability [40].

Sleep difficulty was measured as part of the HBSC symptoms checklist [29]. The response options ranged from 1 (= *rarely or never*) to 5 (= *about every day*). Sleep difficulty was treated as a continuous variable, and the outcome was inverted to correspond to other health outcomes. The item has been validated in adolescent samples and has exhibited adequate reliability [30].

Statistical analyses

Basic data-screening activities were performed before any analyses were conducted. Missing data ranged from 6.2% to 26.3% in the analyses. The majority of the analyses had a moderate level of missing data, with values between 6% and 15%. The only analyses containing more than 20% missing data were those from the Czech Republic with health literacy as the moderator. To address this, the analyses were conducted using both a Complete Case Analysis (CCA) and imputation. Both sets of analyses yielded similar results; thus, the analyses using CCA were found to facilitate reproducibility [41].

As a first step, regression analyses were performed to test the associations between individual characteristics and PSMU (Table A2) and the association between PSMU and health outcomes (Table A3). Second, the resources (health literacy, family support, and friend support) were added to the regression models (RQ1, Table A4; RQ2, Table A5). Third, interaction terms were constructed for RQ1 ($B_{\text{individual characteristic}^{*}\text{resource}}$) and RQ2

Table 1
The moderations of health literacy, family support, and friend support in the associations between individual characteristics and PSMU; cross-nationally

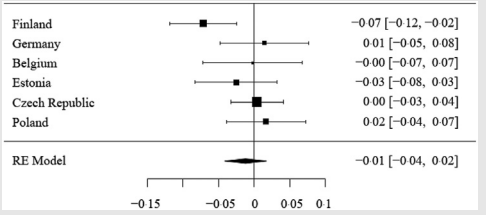
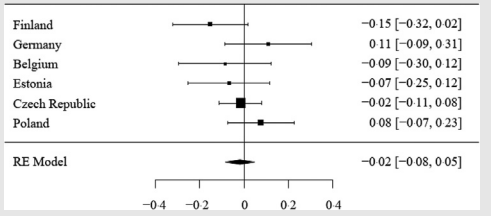
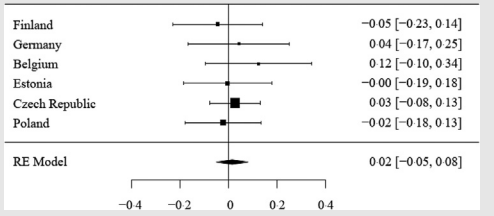
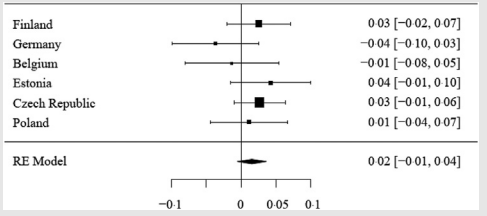
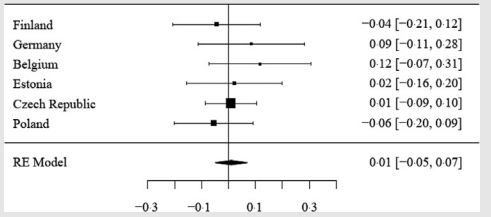
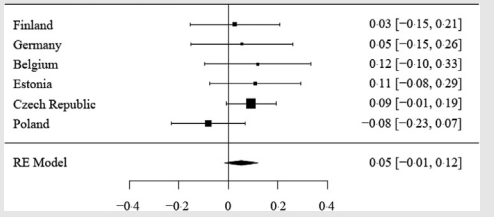
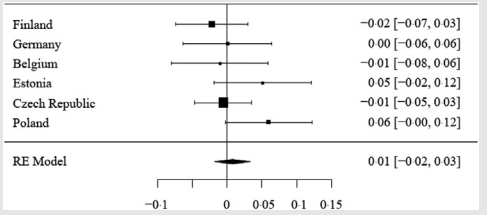
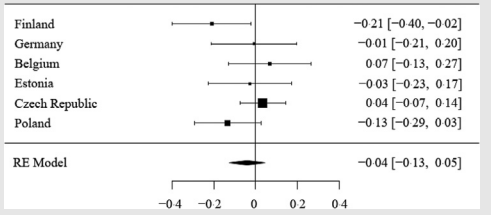
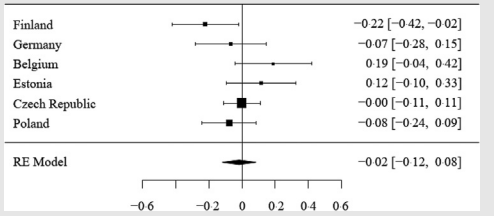
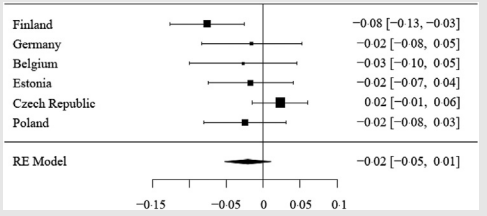
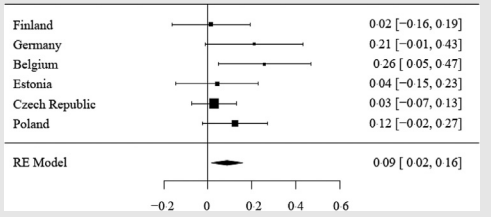
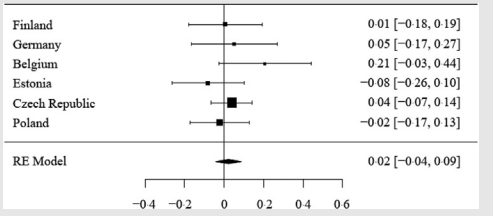
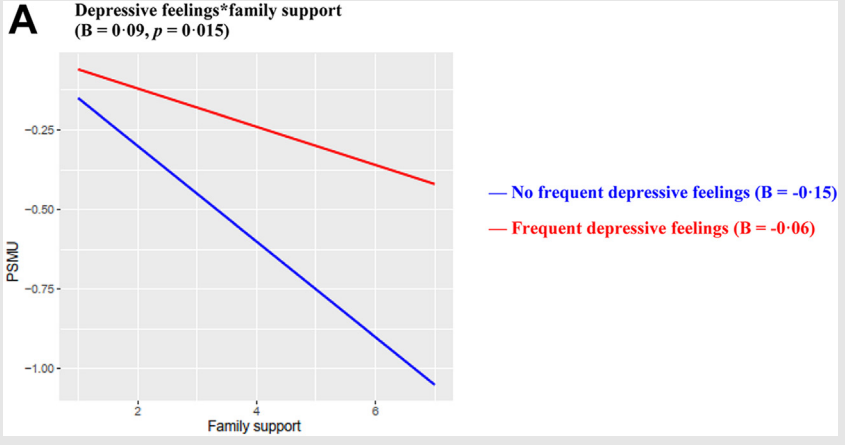
	Health literacy	Family support	Friend support
Gender			
Age			
Family affluence			
Depressive feelings			

Table 1
Continued

Health literacy	Family support	Friend support
		

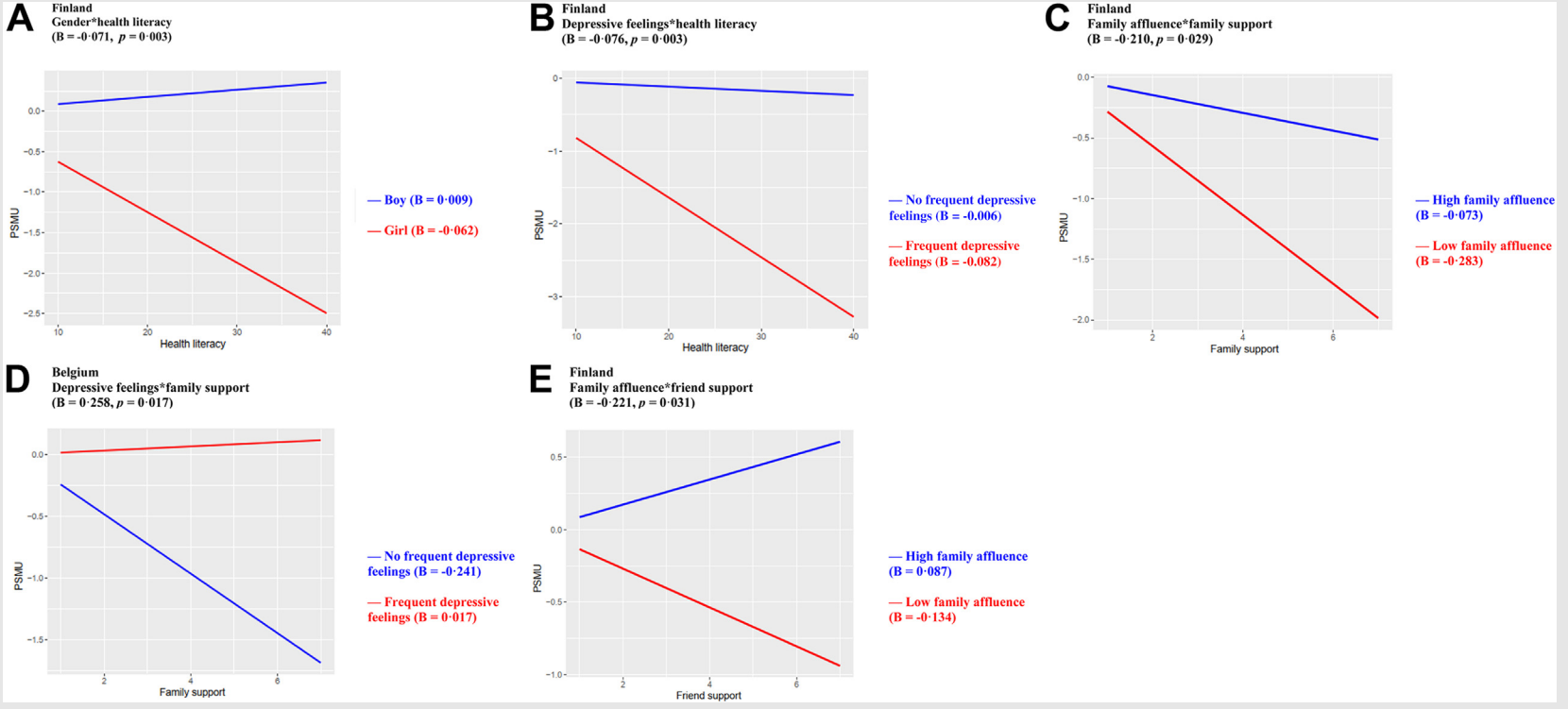
Regression formula (e.g., in the case of frequent depressive feelings, the estimated effect of family support on PSMU is $B_{\text{family support}} + B_{\text{depressive feelings*family support}} = -0.15 + 0.09 = -0.06$; cross-nationally).
Graphic representation of the moderations.

Table 2
The moderations of health literacy, family support, and friend support in the associations between individual characteristics and PSMU; nationally

	Finland			Germany			Belgium			Estonia			Czech Republic			Poland		
	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*
Models: Health literacy as the moderator																		
HL	0.009	0.019	.63	−0.063	0.021	.003**	−0.050	0.028	.074	−0.044	0.022	.043*	−0.048	0.014	< .001***	−0.049	0.021	.020*
Gender	2.461	0.784	.002**	−0.631	0.911	.49	0.605	1.060	.57	0.976	0.860	.26	0.120	0.548	.83	−0.117	0.851	.89
Gender * HL	−0.071	0.024	.003**	0.014	0.032	.65	−0.002	0.035	.95	−0.025	0.029	.39	0.004	0.019	.83	0.017	0.028	.56
			$R^2 = 0.029$			$R^2 = 0.025$			$R^2 = 0.035$			$R^2 = 0.020$			$R^2 = 0.024$			$R^2 = 0.029$
			$\Delta R^2 = 0.006$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
HL	−0.044	0.016	.008**	−0.041	0.021	.046*	−0.045	0.024	.070	−0.076	0.019	< .0001***	−0.059	0.013	< .0001***	−0.046	0.020	.021*
Age	−0.687	0.748	.36	0.636	0.912	.49	0.231	1.027	.82	−1.346	0.861	.12	−0.787	0.548	.15	−0.528	0.851	.53
Age * HL	0.025	0.023	.27	−0.037	0.032	.24	−0.013	0.034	.70	0.043	0.029	.15	0.027	0.019	.15	0.012	0.028	.68
			$R^2 = 0.023$			$R^2 = 0.025$			$R^2 = 0.036$			$R^2 = 0.020$			$R^2 = 0.025$			$R^2 = 0.029$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$
HL	−0.026	0.014	.061	−0.057	0.020	.004**	−0.047	0.022	.032*	−0.068	0.016	< .0001***	−0.044	0.011	< .0001***	−0.057	0.017	< .001***
FAS	0.721	0.837	.39	0.041	0.934	.96	0.273	1.053	.80	−1.488	1.051	.16	0.142	0.596	.81	−1.836	0.953	.054
FAS * HL	−0.022	0.027	.41	0.000	0.033	.99	−0.011	0.036	.77	0.051	0.036	.15	−0.006	0.021	.78	0.060	0.032	.058
			$R^2 = 0.023$			$R^2 = 0.024$			$R^2 = 0.035$			$R^2 = 0.020$			$R^2 = 0.024$			$R^2 = 0.030$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$
HL	−0.006	0.015	.71	−0.052	0.019	.005**	−0.042	0.021	.051	−0.051	0.020	.009**	−0.055	0.012	< .0001***	−0.029	0.019	.13
Depressive	3.026	0.808	< .001***	1.569	0.991	.11	1.910	1.086	.079	1.203	0.853	.16	0.419	0.559	.45	1.681	0.851	.048*
Depressive * HL	−0.076	0.026	.003**	−0.015	0.035	.66	−0.027	0.037	.47	−0.017	0.029	.56	0.023	0.019	.23	−0.025	0.028	.38
			$R^2 = 0.030$			$R^2 = 0.025$			$R^2 = 0.036$			$R^2 = 0.019$			$R^2 = 0.024$			$R^2 = 0.030$
			$\Delta R^2 = 0.008$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$
Models: Family support as the moderator																		
Family	−0.042	0.066	.52	−0.210	0.070	.003**	−0.104	0.090	.25	−0.168	0.076	.027*	−0.079	0.038	.038*	−0.183	0.062	.003**
Gender	0.939	0.493	.057	−0.862	0.562	.13	0.925	0.605	.13	0.496	0.533	.35	0.324	0.255	.20	−0.037	0.396	.93
Gender * Family	−0.153	0.086	.077	0.110	0.100	.27	−0.087	0.106	.41	−0.068	0.094	.47	−0.015	0.049	.76	0.076	0.077	.32
			$R^2 = 0.022$			$R^2 = 0.019$			$R^2 = 0.034$			$R^2 = 0.019$			$R^2 = 0.018$			$R^2 = 0.030$
			$\Delta R^2 = 0.002$			$\Delta R^2 = 0.002$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Family	−0.103	0.059	.083	−0.196	0.069	.004**	−0.225	0.071	.002**	−0.220	0.065	< .001***	−0.092	0.034	.007**	−0.106	0.054	.051
Age	0.336	0.460	.47	−0.918	0.558	.10	−0.742	0.533	.16	−0.315	0.499	.53	−0.009	0.248	.97	−0.030	0.381	.94
Age * Family	−0.045	0.083	.59	0.086	0.101	.39	0.118	0.097	.22	0.022	0.090	.82	0.009	0.049	.85	−0.055	0.074	.46
			$R^2 = 0.020$			$R^2 = 0.018$			$R^2 = 0.034$			$R^2 = 0.019$			$R^2 = 0.018$			$R^2 = 0.030$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Family	−0.073	0.050	.14	−0.155	0.065	.017*	−0.187	0.062	.002**	−0.202	0.056	< .001***	−0.097	0.028	< .001***	−0.094	0.046	.042*
FAS	1.143	0.515	.026 *	0.111	0.568	.84	−0.406	0.546	.46	0.045	0.533	.93	−0.052	0.282	.85	0.488	0.399	.22
FAS * Family	−0.210	0.097	.029 *	−0.007	0.104	.94	0.069	0.101	.49	−0.026	0.102	.79	0.035	0.056	.53	−0.133	0.081	.10
			$R^2 = 0.023$			$R^2 = 0 \cdot .018$			$R^2 = 0.033$			$R^2 = 0.019$			$R^2 = 0.018$			$R^2 = 0.031$
			$\Delta R^2 = 0.004$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$
Family	−0.130	0.053	.014 *	−0.221	0.060	< .001***	−0.241	0.058	< .0001***	−0.230	0.067	< .001***	−0.097	0.029	< .001***	−0.198	0.055	< .001***
Depressive	0.527	0.479	.27	−0.101	0.593	.86	−0.228	0.559	.68	0.355	0.521	.50	0.820	0.261	.002**	0.266	0.386	.49
Depressive * Family	0.015	0.091	.87	0.212	0.113	.06	0.258	0.108	.017 *	0.042	0.095	.66	0.029	0.053	.59	0.124	0.076	.10
			$R^2 = 0.019$			$R^2 = 0.019$			$R^2 = 0.036$			$R^2 = 0.018$			$R^2 = 0.018$			$R^2 = 0.030$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.003$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Friend support as the moderator																		
Friend	0.052	0.071	.46	−0.169	0.077	.028*	−0.119	0.087	.17	−0.121	0.071	.090	−0.100	0.043	.020*	−0.010	0.065	.88
Gender	0.375	0.540	.49	−0.361	0.583	.53	−0.145	0.628	.82	0.217	0.498	.66	0.133	0.258	.61	0.427	0.361	24
Gender * Friend	−0.046	0.094	.63	0.043	0.107	.68	0.124	0.112	.27	−0.003	0.093	.97	0.027	0.054	.62	−0.023	0.080	78
			$R^2 = 0.016$			$R^2 = 0.020$			$R^2 = 0.029$			$R^2 = 0.014$			$R^2 = 0.017$			$R^2 = 0.024$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Friend	0.014	0.064	.83	−0.171	0.071	.016*	−0.098	0.074	.18	−0.168	0.061	.005**	−0.132	0.037	< .001***	0.014	0.053	.79
Age	−0.068	0.527	.90	−0.740	0.577	.20	−0.755	0.619	.22	−0.706	0.507	.16	−0.329	0.251	.19	0.108	0.348	.76
Age * Friend	0.027	0.092	.77	0.054	0.105	.61	0.119	0.109	.28	0.108	0.093	.25	0.093	0.051	.072	−0.080	0.076	.29
			$R^2 = 0.016$			$R^2 = 0.020$			$R^2 = 0.029$			$R^2 = 0.015$			$R^2 = 0.018$			$R^2 = 0.025$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Friend	0.087	0.057	.13	−0.124	0.066	.062	−0.106	0.066	.11	−0.150	0.053	.004**	−0.083	0.030	.006**	−0.003	0.045	.96
FAS	1.288	0.566	.023 *	0.417	0.585	.48	−1.005	0.663	.13	−0.608	0.581	.30	0.137	0.278	.62	0.225	0.379	.55

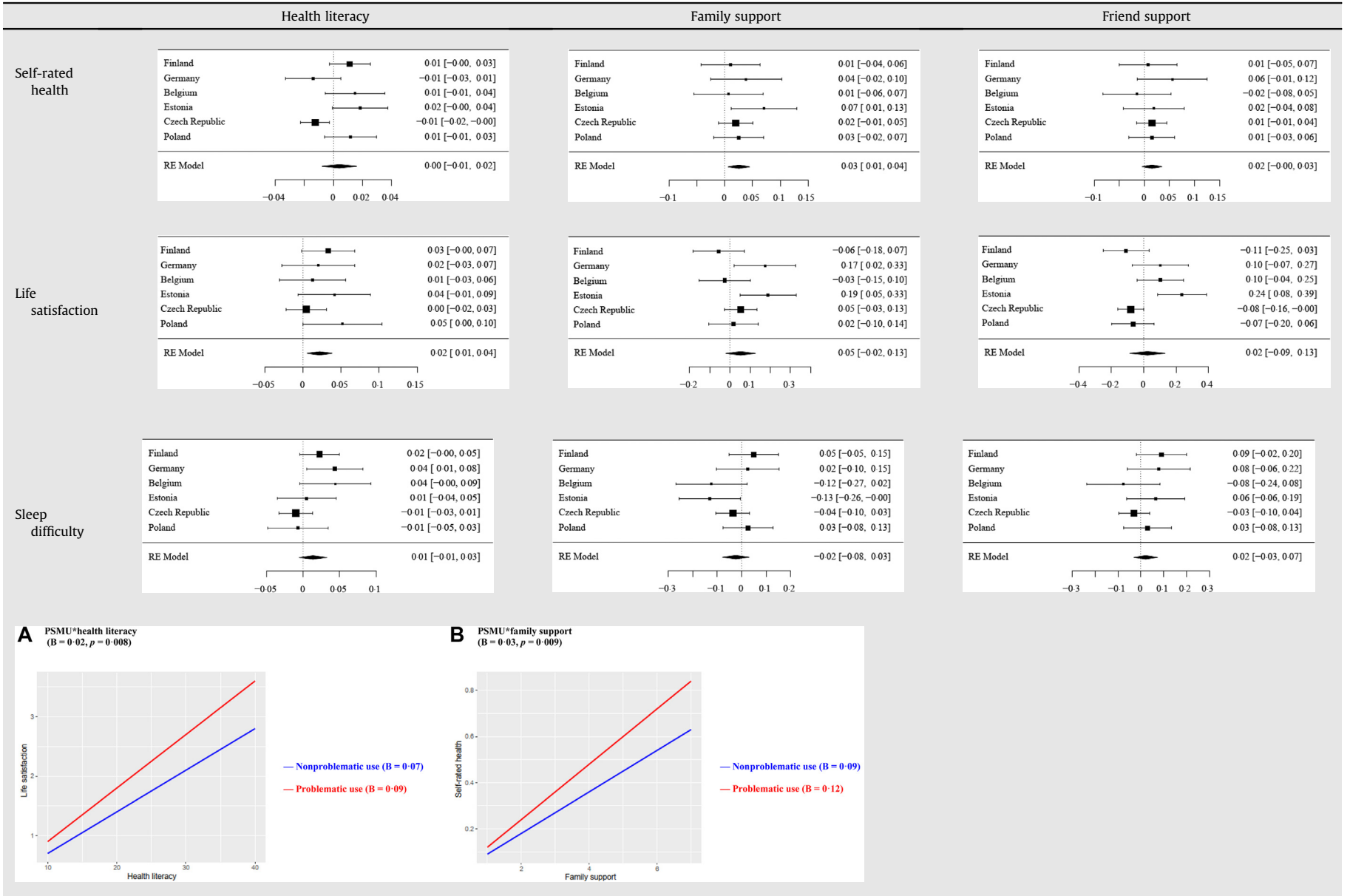
Table 2
Continued

	Finland			Germany			Belgium			Estonia			Czech Republic			Poland		
	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*
FAS * Friend	−0.221	0.103	.031 * $R^2 = 0.019$ $\Delta R^2 = 0.003$	−0.067	0.109	.54 $R^2 = 0.021$ $\Delta R^2 = 0.001$	0.190	0.118	.11 $R^2 = 0.030$ $\Delta R^2 = 0.002$	0.115	0.108	.29 $R^2 = 0.015$ $\Delta R^2 = 0.001$	−0.001	0.057	.99 $R^2 = 0.017$ $\Delta R^2 = 0.000$	−0.078	0.085	.36 $R^2 = 0.024$ $\Delta R^2 = 0.000$
Friend	0. 024	0. 061	.69	−0.164	0.065	.012*	−0.111	0.066	.091	−0.083	0.066	.21	−0.097	0.032	.003**	−0.014	0.053	.80
Depressive	0. 750	0.543	.17	0.792	0.593	.18	0.066	0.658	.92	1.148	0.500	.022*	0.795	0.261	.002**	1.038	0.351	.003**
Depressive * Friend	0.006	0.095	.95 $R^2 = 0.016$ $\Delta R^2 = 0.000$	0.051	0.111	.64 $R^2 = 0.020$ $\Delta R^2 = 0.000$	0.207	0.119	.082 $R^2 = 0.031$ $\Delta R^2 = 0.003$	−0.081	0.093	.38 $R^2 = 0.015$ $\Delta R^2 = 0.001$	0.038	0.053	.47 $R^2 = 0.017$ $\Delta R^2 = 0.000$	−0.023	0.077	.77 $R^2 = 0.024$ $\Delta R^2 = 0.000$



Regression formula (e.g., when family affluence is low, the estimated effect of family support on problematic SMU is $B_{\text{family support}} + B_{\text{family affluence*family support}} = -0.073 + -0.210 = -0.283$ in Finland).
Individual characteristics were controlled (e.g., if the interaction term was gender*health literacy, control was applied to age, family affluence, and depressive feelings).
Graphic representations of the moderations.

Table 3
The moderations of health literacy, family support, and friend support in the associations between PSMU and health outcomes; cross-nationally



Regression formula (e.g., among problematic social media users, the estimated effect of health literacy on life satisfaction is $B_{\text{health literacy}} + B_{\text{PSMU*health literacy}} = 0.07 + 0.02 = 0.09$; cross-nationally).
Graphic representations of the moderations.

($B_{PSMU*resource}$) to investigate whether health literacy, family support, and friend support moderated the association between individual characteristics and PSMU and between PSMU and health outcomes (Figure 1). Multiple sets of stratified analyses were performed to find the most suitable regression models. For example, we tested step-by-step whether the moderator variables and interaction terms should be included in a single model within the country-level analyses or tested separately. Based on the model performance, consistency, interpretability [42], and the underlying construct of "social support" within the friend support and family support variables [33], separate models were chosen. The analyses were performed for each of the six countries separately. The regression coefficients of the variables were used to examine the nature of the associations. If the regression coefficient of the interaction term was significant ($p < .05$), this was taken to indicate a moderation [43]. Tjur's R^2 [44] was calculated when the outcome was the categorical PSMU, while Adjusted R^2 was used when the outcomes were the continuous health indicators.

Cross-national associations and moderations were examined via meta-analytic techniques. The aim was to synthesize the results from the six European countries by (1) pooling the regression coefficients of the variables and interaction terms, (2) calculating their respective standard errors, and (3) examining the directions and magnitude of the outcomes via effect sizes. The random-effects model was chosen for three reasons: (1) we aimed at generalizing the results beyond the countries included, (2) true homogeneity between countries could not be assumed, and (3) each estimate was assumed to have a different underlying true effect, and these effects to have a distribution [45]. Forest plots were created to highlight the results. The analyses were performed using metafor [46] and base packages on R-software [47].

Results

In the cross-national analyses, gender and depressive feelings (i.e., individual characteristics; Table A2) and health literacy, family support, and friend support (i.e., resources; Table A4) were significantly associated with PSMU. Only depressive feelings, health literacy, and family support were associated with PSMU in all the countries studied in the national analyses. In relation to other individual characteristics and to friend support, the statistically significant associations showed national variations. PSMU (Table A3), health literacy, family support, and friend support (Table A5) were significantly associated with all the measured health outcomes, both cross-nationally and nationally.

The moderations of health literacy, family support, and friend support in the associations between individual characteristics and PSMU (RQ1)

One significant moderation emerged cross-nationally (Table 1). The forest plots from the random-effects models demonstrated family support as moderating the association between depressive feelings and PSMU across all countries ($B_{depressive\ feelings*family\ support} = 0.09$, $p = .015$). Higher family support was more strongly associated with a lower likelihood of PSMU among adolescents with no frequent depressive feelings ($B = -0.15$) than among adolescents with frequent depressive feelings ($B = -0.06$); nevertheless, it was related to a lower likelihood of PSMU in both groups.

Nationally, moderations emerged in Finland and Belgium (Table 2). Health literacy emerged as a moderator in the association between gender ($B_{gender*health\ literacy} = -0.071$, $p = .003$) and PSMU, and also in the association between depressive feelings ($B_{depressive\ feelings*health\ literacy} = -0.076$, $p = .003$) and PSMU in Finland. Higher health literacy was related to a lower likelihood of PSMU among Finnish girls ($B = -0.062$) and Finnish adolescents with frequent depressive feelings ($B = -0.082$) (i.e., adolescents in a vulnerable situation regarding PSMU).

Family support ($B_{family\ affluence*family\ support} = -0.210$, $p = .029$) and friend support ($B_{family\ affluence*friend\ support} = -0.221$, $p = .031$) emerged as moderators in the association between family affluence and PSMU in Finland. Higher family support and friend support were associated with a lower likelihood of PSMU among adolescents from families with low affluence (family support, $B = -0.283$; friend support, $B = -0.134$). In Belgium, family support was observed as a moderator in the association between depressive feelings and PSMU ($B_{depressive\ feelings*family\ support} = 0.258$, $p = .017$). Higher family support was related to a higher likelihood of PSMU among adolescents with frequent depressive feelings ($B = 0.017$), but to a lower likelihood among adolescents with no frequent depressive feelings ($B = -0.241$).

The moderations of health literacy, family support, and friend support in the associations between PSMU and health outcomes (RQ2)

Two significant cross-national moderations emerged, such that health literacy acted as a moderator in the association between PSMU and life satisfaction ($B_{PSMU*health\ literacy} = 0.02$, $p = .008$), and family support acted as a moderator in the association between PSMU and SRH ($B_{PSMU*family\ support} = 0.03$, $p = .009$) (Table 3). Across the six countries, differences emerged between problematic and nonproblematic users; hence, higher health literacy was found to relate more strongly to higher life satisfaction, and higher family support to higher SRH among problematic users (health literacy, $B = 0.09$; family support, $B = 0.12$) as compared to nonproblematic users (health literacy, $B = 0.07$; family support, $B = 0.09$).

Nine significant moderations emerged in the national analyses (Table 4). Health literacy was observed as a moderator in the association between PSMU and SRH ($B_{PSMU*health\ literacy} = -0.013$, $p = .014$) in the Czech Republic. Higher health literacy was more strongly associated with higher SRH among nonproblematic ($B = 0.027$) than among problematic users ($B = 0.014$). In Poland, health literacy emerged as a moderator in the association between PSMU and life satisfaction ($B_{PSMU*health\ literacy} = 0.052$, $p = .049$). Having a higher level of health literacy was related to higher life satisfaction among both problematic users and nonproblematic users, although the association was stronger among problematic users ($B = 0.143$ vs. nonproblematic users, $B = 0.091$). In Germany, health literacy ($B_{PSMU*health\ literacy} = 0.044$, $p = .027$) acted as a moderator in the association between PSMU and sleep difficulties. Higher health literacy was more strongly associated with having less sleep difficulties among problematic users ($B = 0.063$) than among nonproblematic ($B = 0.019$) users.

Family support emerged as a moderator in the association between PSMU and SRH ($B_{PSMU*family\ support} = 0.070$, $p = .020$) and between PSMU and sleep difficulties ($B_{PSMU*family\ support} = -0.130$, $p = .043$) in Estonia. Higher family support was related to higher SRH in both groups, but the association was

stronger among problematic users (B = 0.211; nonproblematic users, B = 0.141). By contrast, in terms of having less sleep difficulties, the association with higher family support was stronger among nonproblematic users (nonproblematic users, B = 0.277 vs. problematic users, B = 0.147). Family support also emerged as a moderator in the association between PSMU and life satisfaction in Estonia ($B_{PSMU*family\ support}$ = 0.189, p = .008) and in Germany ($B_{PSMU*family\ support}$ = 0.173, p = .028). In both countries, higher family support was associated with higher life satisfaction in both groups, but the relation was stronger among problematic users (Estonia, B = 0.760; Germany B = 0.567) than among nonproblematic users (Estonia, B = 0.571; Germany B = 0.394).

Friend support emerged as a moderator in the association between PSMU and life satisfaction in Estonia ($B_{PSMU*friend\ support}$ = 0.235, p = .002) and in the Czech Republic ($B_{PSMU*friend\ support}$ = −0.080, p = .046). In Estonia, higher friend support was more strongly related to higher life satisfaction among problematic users (B = 0.508) than among nonproblematic users (B = 0.273). By contrast, in the Czech Republic, higher friend support was associated with lower life satisfaction among problematic users (B = −0.017), but it made higher life satisfaction more likely among nonproblematic users (B = 0.063).

Discussion

To our knowledge, this is so far the only study providing evidence on the degree to which health literacy, family support, and friend support moderate (1) the association between individual characteristics and PSMU and (2) the association between PSMU and health outcomes in a large cross-national cohort. Hence, the study fills a gap in the literature, namely the lack of studies on the individual and social resources that can be developed through education and intervention in efforts to moderate and possibly counteract digital threats such as PSMU [8,9] and its negative health consequences [6,7,11,14]. It was for this purpose that we applied the DSMM [10]. Collectively, our findings provide support for the notion that among adolescents, PSMU and its negative health consequences can be moderated and counteracted by (in particular) health literacy and family support and (in some instances) friend support. The findings relate to both national and cross-national contexts. They point to possible life-long benefits for adolescent health, and thus respond to the calls made by Clark et al. [8] and Kickbusch et al. [9].

As regards our first research question, the resources under study appeared capable of decreasing disparities in health by benefiting adolescents who have vulnerabilities related to PSMU. For example, higher health literacy was associated with benefits among girls [5,11,14] and among adolescents with frequent depressive feelings [13] in Finland (Table 2, Graph A and B). As regards our second research question, the cross-national analyses indicated that health literacy and family support have the potential to narrow the gap in health disparities between problematic and nonproblematic users, bearing in mind that, for example, higher family support was more strongly associated with higher SRH among problematic users than among nonproblematic users (Table 3, Graph B). Such findings provided support for our hypothesis that the resources examined would be more beneficial for adolescents who have greater PSMU-related vulnerability and could enhance health outcomes, especially among problematic social media users.

Nevertheless, a closer examination showed that in some cases, improvements in resources may paradoxically widen the disparities between groups. This “prevention dilemma” (Boccia and Ricciardi) [48] could be seen particularly in the cross-national analyses whereby higher family support was more strongly associated with a lower likelihood of PSMU among adolescents with no frequent depressive feelings than among adolescents with frequent depressive feelings (Table 1, Graph A). On the other hand, one must consider these findings together with cross-national findings indicating positive links between health literacy, family support, and friend support with regard to (1) a lesser likelihood of PSMU and (2) all health outcomes. The findings in this regard would seem to underline the importance of promoting equity over equality per se. This approach—which has been termed “proportionate universalism” [15]—highlights the need to prioritize groups who are already at a disadvantage in efforts to decrease unfair and avoidable disparities in health. In relation to our setting, this would imply a combination of both universal and targeted interventions and health policies, aimed at addressing PSMU and associated health outcomes.

In addition, cross-national and national variation occurred regarding the extent to which the resources benefited different groups of adolescents. In some instances, the resources were associated with reduced health disparities cross-nationally, but similar effects were not systematically detected in the national analyses. For instance, in the cross-national analyses, higher family support was related to higher SRH, with greater benefit among problematic users than among nonproblematic users (Table 3, Graph B). However, with regard to individual countries, only Estonia showed a statistically significant effect in this respect (Table 4, Graph D). Similarly, while health literacy narrowed the health disparities between problematic and nonproblematic users in the cross-national analyses (Table 3, Graph A), some contrary findings were identified in the national analyses (as in the case of the Czech Republic, where higher health literacy was more strongly associated with higher SRH among nonproblematic users than among problematic users; Table 4, Graph A). This raises the question of whether it is ethically sustainable to devote resources to regional interventions (e.g., similar interventions to all countries) if countries do not benefit equally. Similarly, it broadens our earlier discussion on universal approaches to PSMU and related health challenges. However, to advance the discussion on regional approaches, there will be a need for further exploration of cross-national and country-level differences.

Our study had a number of strengths. These include the use of a large-scale, cross-nationally representative sample of adolescents and validated variables. Furthermore, the study used a suitable theoretical framework and was built upon a strong evidence base suggesting that PSMU substantially harms adolescent health and wellbeing [6,7,11,14] and that individual [17] and social resources [21,23] have the potential to counteract adverse health behaviors and health outcomes. In addition, moderator analyses were performed, and random-effects models were used to target cross-national effects.

However, several limitations should be acknowledged. The cross-sectional design cannot establish causality. Moreover, all the measures were based on self-report instruments, which are susceptible to bias. Since they were collected in 2018, they might not encompass variations in the current status of adolescents given, for example, the rapid changes in social media use during the COVID-19 pandemic. It should also be noted that the effect sizes

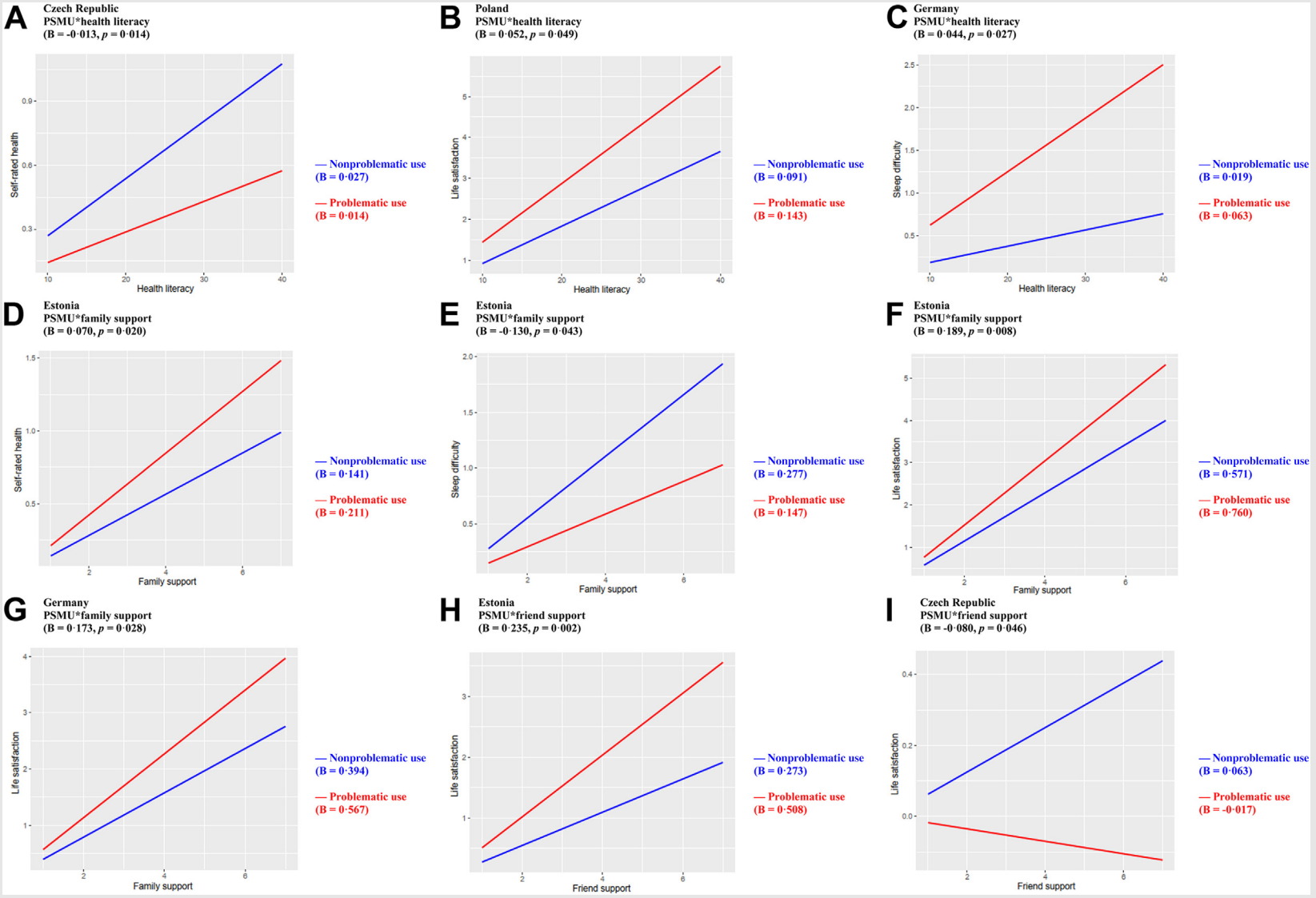
Table 4
The moderations of health literacy, family support, and friend support in the associations between PSMU and health outcomes; nationally

	Finland			Germany			Belgium			Estonia			Czech Republic			Poland		
	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*
Models: Health literacy as the moderator, Self-rated health as the outcome																		
HL	0.035	0.003	< .0001***	0.017	0.003	< .0001***	0.030	0.003	< .0001***	0.031	0.003	< .0001***	0.027	0.001	< .0001***	0.029	0.003	< .0001***
PSMU	−0.556	0.231	.016 *	0.251	0.279	.37	−0.627	0.311	.044*	−0.695	0.281	.014*	0.212	0.149	.15	−0.537	0.275	.051
PSMU * HL	0.011	0.007	.12	−0.014	0.010	.15	0.015	0.010	.15	0.018	0.010	.056	−0.013	0.005	.014*	0.012	0.009	.20
			$R^2 = 0.130$			$R^2 = 0.047$			$R^2 = 0.101$			$R^2 = 0.085$			$R^2 = 0.084$			$R^2 = 0.083$
			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$
Models: Health literacy as the moderator, Life satisfaction as the outcome																		
HL	0.094	0.007	< .0001***	0.049	0.007	< .0001***	0.053	0.006	< .0001***	0.082	0.007	< .0001***	0.059	0.004	< .0001***	0.091	0.008	< .0001***
PSMU	−1.536	0.572	.007**	−1.057	0.703	.13	−0.854	0.656	.19	−1.982	0.709	.005**	−0.761	0.394	.054	−2.256	0.796	.005**
PSMU * HL	0.033	0.018	.060	0.020	0.024	.41	0.013	0.022	.56	0.041	0.024	.089	0.004	0.013	.74	0.052	0.026	.049*
			$R^2 = 0.163$			$R^2 = 0.072$			$R^2 = 0.091$			$R^2 = 0.130$			$R^2 = 0.091$			$R^2 = 0.107$
			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$
Models: Health literacy as the moderator, Sleep difficulty as the outcome																		
HL	0.037	0.005	< .0001***	0.019	0.005	.0004***	0.025	0.007	.0003***	0.042	0.006	< .0001***	0.026	0.003	< .0001***	0.042	0.006	< .0001***
PSMU	−1.327	0.450	.003**	−1.825	0.567	.0013**	−1.746	0.739	.018*	−0.938	0.601	.12	−0.249	0.346	.47	−0.422	0.636	.51
PSMU * HL	0.022	0.014	.11	0.044	0.020	.027*	0.044	0.025	.075	0.005	0.021	.81	−0.010	0.012	.39	−0.007	0.021	.75
			$R^2 = 0.090$			$R^2 = 0.040$			$R^2 = 0.028$			$R^2 = 0.058$			$R^2 = 0.043$			$R^2 = 0.048$
			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.002$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Family support as the moderator, Self-rated health as the outcome																		
Family	0.101	0.010	< .0001***	0.101	0.009	< .0001***	0.072	0.010	< .0001***	0.141	0.009	< .0001***	0.019	0.004	< .0001***	0.093	0.007	< .0001***
PSMU	−0.247	0.150	.10	−0.301	0.180	.094	−0.226	0.171	.19	−0.471	0.166	.005**	−0.261	0.079	< .001***	−0.289	0.117	.014*
PSMU * Family	0.011	0.027	.69	0.039	0.032	.23	0.007	0.032	.83	0.070	0.030	.020*	0.020	0.016	.204	0.026	0.023	.26
			$R^2 = 0.081$			$R^2 = 0.079$			$R^2 = 0.077$			$R^2 = 0.119$			$R^2 = 0.028$			$R^2 = 0.089$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Family support as the moderator, Life satisfaction as the outcome																		
Family	0.394	0.025	< .0001***	0.394	0.021	< .0001***	0.299	0.019	< .0001***	0.571	0.022	< .0001***	0.118	0.010	< .0001***	0.513	0.020	< .0001***
PSMU	−0.128	0.362	.72	−1.260	0.437	.004**	−0.270	0.351	.44	−1.527	0.390	< .0001***	−0.870	0.207	< .0001***	−0.620	0.319	.052
PSMU * Family	−0.055	0.065	.40	0.173	0.079	.028*	−0.025	0.065	.70	0.189	0.071	.008**	0.054	0.041	.19	0.018	0.062	.773
			$R^2 = 0.169$			$R^2 = 0.175$			$R^2 = 0.162$			$R^2 = 0.277$			$R^2 = 0.067$			$R^2 = 0.223$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.002$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Family support as the moderator, Sleep difficulty as the outcome																		
Family	0.159	0.020	< .0001***	0.170	0.018	< .0001***	0.140	0.022	< .0001***	0.277	0.019	< .0001***	0.055	0.008	< .0001***	0.190	0.017	< .0001***
PSMU	−0.827	0.284	.004**	−0.597	0.359	.097	0.244	0.401	.54	−0.006	0.353	.99	−0.365	0.178	.040*	−0.691	0.267	.010**
PSMU * Family	0.049	0.051	.34	0.025	0.065	.70	−0.123	0.074	.095	−0.130	0.064	.043*	−0.036	0.035	.31	0.026	0.052	.62
			$R^2 = 0.093$			$R^2 = 0.062$			$R^2 = 0.035$			$R^2 = 0.101$			$R^2 = 0.038$			$R^2 = 0.072$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Friend support as the moderator, Self-rated health as the outcome																		
Friend	0.086	0.010	< .0001***	0.056	0.009	< .0001***	0.079	0.010	< .0001***	0.073	0.009	< .0001***	0.008	0.004	.048*	0.067	0.007	< .0001***
PSMU	−0.286	0.171	.093	−0.409	0.193	.034*	−0.143	0.194	.46	−0.276	0.166	.097	−0.237	0.075	.002**	−0.262	0.108	.016*
PSMU * Friend	0.007	0.030	.80	0.056	0.035	.117	−0.015	0.035	.66	0.019	0.031	.54	0.015	0.015	.33	0.015	0.024	.53
			$R^2 = 0.064$			$R^2 = 0.043$			$R^2 = 0.080$			$R^2 = 0.056$			$R^2 = 0.024$			$R^2 = 0.065$
			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Friend support as the moderator, Life satisfaction as the outcome																		
Friend	0.263	0.026	< .0001***	0.249	0.023	< .0001***	0.169	0.020	< .0001***	0.273	0.022	< .0001***	0.063	0.010	< .0001***	0.343	0.021	< .0001***
PSMU	−0.026	0.418	.95	−1.007	0.482	.038*	−1.106	0.413	.007**	−1.981	0.413	<.0001***	−0.328	0.197	.096	−0.455	0.306	.14
PSMU * Friend	−0.109	0.073	.13	0.101	0.088	.25	0.103	0.073	.159	0.235	0.077	.002**	−0.080	0.040	.046*	−0.066	0.067	.32
			$R^2 = 0.099$			$R^2 = 0.094$			$R^2 = 0.097$			$R^2 = 0.132$			$R^2 = 0.049$			$R^2 = 0.132$
			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.002$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$
Models: Friend support as the moderator, Sleep difficulty as the outcome																		
Friend	0.084	0.020	< .0001***	0.100	0.019	< .0001***	0.092	0.023	< .0001***	0.115	0.018	< .0001***	0.028	0.009	.002**	0.122	0.017	<.0001***
PSMU	−1.161	0.321	.0003***	−0.897	0.382	.019*	−0.040	0.459	.93	−1.156	0.349	<.001***	−0.417	0.169	.014*	-0.740	0.245	.003**
PSMU * Friend	0.090	0.056	.11	0.078	0.070	.264	−0.076	0.082	.35	0.065	0.065	.32	−0.030	0.034	.39	0.029	0.053	.59
			$R^2 = 0.069$			$R^2 = 0.038$			$R^2 = 0.025$			$R^2 = 0.054$			$R^2 = 0.032$			$R^2 = 0.049$
			$\Delta R^2 = 0.001$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$			$\Delta R^2 = 0.000$

(*continued on next page*)

Table 4
Continued

	Finland			Germany			Belgium			Estonia			Czech Republic			Poland		
	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*	Coeff	SE	*P*



Regression formula (e.g., in the PSMU group, the estimated effect of family support on self-rated health is $B_{\text{family support}} + B_{\text{PSMU*family support}} = 0.141 + 0.070 = 0.211$ in Estonia).
Controlled for gender, age, and family affluence.
Graphic representations of the moderations.
HL = health literacy.

(B) and the explained variance in the outcomes (Tjur's R^2 and Adjusted R^2) were often small despite being statistically significant. This was most evident in the effect sizes and variation changes due to moderation effects (i.e., interaction terms and ΔR^2 values). This leaves room to question how far some of the results can be interpreted as practically meaningful. As regards the missing data, the CCA is known to be susceptible to bias, although this was taken into consideration by conducting the analyses also via imputation. Finally, the overall findings on negative effects should be balanced with the potential benefits of social media use, including opportunities for social connection [2].

The list of moderators in our study was not exclusive, and other variables may also play a role in the studied relationships (RQ1 and RQ2). For the future, we suggest research on the moderation provided by digital literacy given that digital literacy is not fully captured by the health literacy instrument. Furthermore, more research is needed to explain the moderations and their direction (e.g., the reasons why in some instances, adolescents in vulnerable situations were the persons who gained greater benefit from the resources, while, in some cases, the improvements in resources actually widened the disparities between groups). It is also important to consider that the interpretation of the moderations can go multiple ways. Hence, interpretation of the resources as moderator variables can significantly influence recommendations for policy-making and intervention. The role of the resources as moderator variables was based on the theoretical foundation applied and on previous literature. However, longitudinal research is needed to verify such an interpretation. Moreover, research is needed to explain the reasons behind the country-level differences. For such research, socio-ecological, life course, and multilevel approaches could be appropriate.

Finally, one should consider the benefits and risks of using simpler regression models to investigate the moderations (i.e., with one resource variable and one interaction term in a model). The selection of the regression models was based on consistency in the country-level analyses (i.e., between-country consistency at the analytical level), which became important in pooling and weighting the results for the random-effects models. Furthermore, the simpler models behaved more consistently, were easier to interpret, were less prone to overfitting, and took account of the shared underlying construct of the two social support variables (i.e., family support and friend support). The risks in using the simpler regression analyses included potentially biased results, as the simpler models may not account for possible confounding variables. Furthermore, accuracy may be reduced due to underfitting, and there is the possibility of missing out on important data.

In conclusion, this study found that higher health literacy, family support, and friend support have the potential to moderate the association between individual characteristics and PSMU and between PSMU and health outcomes. Altogether, our results indicate a need for both universal and targeted interventions, with efforts to ensure that the impact of the resources is proportionately greater among adolescents in vulnerable situations. The interventions should also consider the cross-national and regional differences indicated in our study.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2023.07.026.

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