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TITLE: Secular trends in depressive symptoms among Norwegian adolescents from 1992 to 2010

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Abstract

Several survey studies among adolescents have shown increasing rates of depressive symptoms over the last two to three decades. We know however little about mechanisms that might explain this increase. The present study uses data from three nationwide representative surveys of 16-17 year-old Norwegian adolescents that were conducted according to identical procedures in 1992, 2002, and 2010 (response rates 97.0, 91.0, 84.3 %, respectively). At each time point, approximately 3,000 adolescents participated (48.8 % girls and 51.2 % boys). Questionnaire data on depressive symptoms and a variety of potential risk and protective factors that might explain time trends in such symptoms were assessed at all time points. The results showed that the prevalence of high scores on depressive symptoms increased significantly between 1992 and 2002 among both boys and girls. No significant changes were observed between 2002 and 2010. The increase from 1992 to 2002 among girls and boys could be partially attributed to increases in eating problems and cannabis use, while reduced satisfaction with own appearance among girls contributed as well. Although the study does not provide information about the causal direction between putative risk factors and depressive symptoms, the results provide some indication that eating problems, cannabis use, and appearance related factors may contribute in explaining secular trends in depressive symptoms.

Keywords: Secular trends, adolescence, youth, depression, risk factors.

Secular trends in depressive symptoms among Norwegian adolescents from 1992 to 2010

Knowledge about shifting rates in mental health problems over time is of importance as such shifting rates may imply need for change in mental health services and preventive efforts (Rutter & Smith, 1995). Information may be obtained by using official statistics, data on mental health service use, successive epidemiological studies using diagnostic interviews, and successive population-based survey studies (Collishaw, 2009; Maughan, Collishaw, Meltzer, & Goodman, 2008). In recent years, several publications have examined time trends in psychological problems among adolescents, particularly using survey data, since such information is less vulnerable to changes in recording practices, in diagnostic systems, and in the routines of public mental health services (Collishaw, 2009). The present study uses such data collected in 1992, 2002, and 2010 to provide information about time trends in depressive symptoms among Norwegian adolescents. Moreover, putative causes of potential trends are examined as well.

Research from the UK based on survey data has shown that rates of depressive symptoms have increased among adolescents during the past two to three decades (Collishaw, Maughan, Natarajan, & Pickles, 2010; Sweeting, West, Young, & Der, 2010). Survey studies have also shown increasing levels of internalizing symptoms in other countries, including Greece (Fichter, Xepapadakos, Quadflieg, Georgopoulou, & Fthenakis, 2004), the Netherlands (Tick, van der Ende, & Verhulst, 2007), and the US (Achenbach, Dumenci, & Rescorla, 2003). However, there are also some contradictory findings. For instance, one meta-analysis based on prevalence reports of depression diagnoses did not find increased prevalence of depression between 1965 and 1996 (Costello, Erkanli, & Angold, 2006). Moreover, recent research from the UK indicates that while increasing rates of psychosocial problems among adolescents were observed in the 1980s and 1990s, the incidence of such problems appears to have stabilized or even declined since about the

year 2000 (Maughan et al., 2008). Research from the Nordic countries indicates the same time trends as in other Western societies, as studies from Iceland and Sweden show emotional symptoms to have increased among adolescents over recent decades (Sigfusdottir, Asgeirsdottir, Sigurdsson, & Gudjonsson, 2008; Swedish Ministry of Education and Culture, 2006). To date, no data on time trends in depressive symptoms in Norway have been published, where the present study originates.

If time trends are indeed found, they need then to be explained. One possible account that has been forwarded relates to changes in parental factors and family structure (Rutter & Smith, 1995). Specifically, the rising number of children raised by one parent alone may be related to increases in psychosocial problems. However, two British studies did not find evidence for an association between the lower number of adolescents living with both biological parents and the higher rate of emotional problems and psychological distress seen between the 1980s and 2006 (Collishaw et al., 2010; Sweeting et al., 2010). On the other hand, time trends in other family variables, such as a growing number of reported arguments with parents and increased maternal stress, were associated with greater psychological distress in the UK from the 1980s through 2006 (Schepman et al., 2011; Sweeting et al., 2010).

Factors related to school and education have also been suggested to be related to time trends in psychosocial problems (Rutter & Smith, 1995). Initial support for this notion has been provided by a study showing that increased disengagement from and worries about school were connected to changes in students' level of psychological distress over the period from 1987 to 2006 (Sweeting et al., 2010). Another explanation focuses on economy and the labor market, as changes in family finances and parents' participation in the work force may be related to adolescents' mental health (Rutter & Smith, 1995). However, in one British study, a series of indicators of family economy were not found to be related to time trends in psychological distress

among adolescents (Sweeting et al., 2010). Finally, changes in adolescents' lifestyle, self-concept and values have been put forward as potential explanatory factors (Rutter & Smith, 1995; Sweeting et al., 2010). Thus far, one study has examined several such factors, including changes in religious behavior, youth culture, computer gaming, obesity, and worries about weight and looks (Sweeting et al., 2010). Aside from time trends in worries about weight and looks, which were moderately related to changes in psychological distress, none of the other factors contributed to explain time trends on this count.

Research has thus so far suggested that parental conflict and mental health, school factors, and worries about weight and appearance may serve in part to explain time trends in emotional problems. However, studies on this issue are rare and almost exclusively conducted in the UK; moreover, only one study (Sweeting et al., 2010) included a comprehensive number of explanatory factors from different domains in their analyses. The study was nonetheless limited by the fact that several of the factors used to explain time trends were not identically measured at the two time points, thereby potentially confounding the results (Sweeting et al., 2010). There is as such a lack of studies where identical procedures and measures are used at different time points to examine a variety of potential predictors of time trends in depressive symptoms.

The present study builds on and extends previous research by complying with this methodological requirement, and by including a wide range of social and psychological factors that may explain secular changes in depressive symptoms. Explanations of changes in depressive symptoms should be sought among co-occuring secular changes in possible risk and protective factors for depressive symptoms. Longitudinal studies among adolescents and young adults show several variables to be prospectively related to depressive symptoms. These include a variety of psychological problems, including disordered eating (Marmorstein, von Ranson, Iacono, & Malone, 2008; Stice & Bearman, 2001), conduct problems (Nock, Kazdin, Hiripi, & Kessler,

2006), and substance abuse (Marmorstein, Iacono, & Malone, 2010). Moreover, studies have indicated that variables related to appearance, such as appearance dissatisfaction and body mass index (BMI), may be risk factors for depressive symptoms (Bearman & Stice, 2008; Needham & Crosnoe, 2005; Paxton, Neumark-Sztainer, Hannan, & Eisenberg, 2006). Likewise, there is some support for that lack of exercise is increasing the likelihood for experiencing depressive symptoms (Biddle & Asare, 2011). Finally, as noted above, family structure variables, and particular single parenthood, may be risk factors for depressive symptoms (Jablonska & Lindberg, 2007).

It should, however, be noted that although prospective associations between potential risk and protective factors and depressive symptoms have been found, their causal status is far from clearly delineated. Several alternative explanations of the prospective relationships are possible, and these are presented in the discussion part of the article.

Changing Trends in Norway

We have indication that some putative risk factors addressed above have changed in Norway over the past two decades, which is a second requirement for inclusion as an explanatory factor for secular changes in depressive symptoms. Annual surveys in Norway show that both alcohol consumption and use of illicit drugs increased distinctively in the 1990s, whereas they have gradually subsided since 2000 (Vedøy & Skretting, 2009). Time trends in smoking clearly indicate a gradual decline in the percentage of adolescents who smoke (Vedøy & Skretting, 2009), which most likely relates in part to the Norwegian tobacco legislation implemented in 2004, prohibiting smoking in bars and restaurants. In line with other Western populations, Norwegians are getting heavier. A Norwegian nationwide survey among eighth-graders in junior high-school showed a marked increase in the prevalence of overweight from 1993 to 2000 (Andersen et al., 2005). Repeated survey studies of physical activity show the amount of time spent on physical activity to be relatively stable for adolescents of both genders from 1985 to 2001, with a slight

increase from 2001 to 2005 (Samdal et al., 2009). Concerning single parenthood, national Norwegian statistics show that the percentage of children under the age of 18 living with both parents has decreased from 82% in 1989 to 75% in 2010 (Statistics Norway, 2012). Moreover, the percentage of Norwegian adolescents having been charged for crimes increased during the 1990s until 2001, whereas the figures have decreased since 2001 (Thorsen, Lid, & Stene, 2009). These figures may indicate a similar trend for the rate of conduct problems among adolescents.

Methodological Issues

When examining time trends in depressive symptoms, there are several methodological issues to be considered. First, in previous time trend studies, psychological symptoms have been commonly measured by continuous variables with emphasis on changes in mean level of symptom scores (Maughan et al., 2008; Sigfusdottir et al., 2008; Sweeting et al., 2010). Other studies reported changes in both mean score and in the proportion of adolescents with high symptom loads (Collishaw et al., 2010; Schepman et al., 2011). Few studies have however examined changes in variance of psychological problems over time. For instance, increasing variance over time, combined with a relatively stable mean, may be indication of a polarization whereby an increased rate of adolescents with high symptom loads might be accompanied by a simultaneous increase in adolescents with markedly few symptoms of depression. This issue is examined in this study by looking at both mean symptom scores, variation of mean symptom scores, and the proportion of those with low and high depressive symptomatology over time.

Second, a potential rise in depressive symptoms may not be solely explained by increases in the frequency of risk factors; it may as well be accounted for by an increased vulnerability to risk factors (Sweeting et al., 2010). An increased vulnerability implies that even if levels of a risk factor remain constant, the association between the risk factor and depressive symptoms becomes stronger with time, thereby leading to a rise in depressive symptoms. Two studies showed just

such increased vulnerability to some risk factors, such as worries about school and family relationships (Sweeting et al., 2010) and income (Langton, Collishaw, Goodman, Pickles, & Maughan, 2011), when examining possible causes for a rise in psychological distress and emotional problems over time; however, vulnerability was not found to differ for a variety of other factors (Sweeting et al., 2010). In the study at hand we will extend this research by examining potential changes in vulnerability for a variety of psychosocial factors that have not been investigated yet.

Third, one limitation of repeated survey studies is the possibility that adolescents may have changed their view and conception of depressive symptoms over time. It has in particular been suggested that adolescents may talk more frankly about mental health issues today than in earlier times (Collishaw, 2009); in this case, the threshold for reporting mental health problems may have lowered, such that these symptoms are more frequently reported even if no real increase may indeed have occurred. One way to address the issue of changes in reporting is to test whether the factor structure of the instrument assessing depressive symptoms is invariant across time points. Such measurement invariance would indicate that symptoms of depression are perceived in similar ways across time. Moreover, other researchers have suggested inspecting time trends of specific symptoms assessed by self-report. Collishaw and colleagues (2010) found for instance increasing time trends in some symptoms of emotional problems, whereas others remained stable. This result was regarded as indicating a real change in emotional problems, as the authors argued that a lowered threshold for reporting symptoms would imply an increased prevalence of all symptoms of emotional problems, rather than just some. In the present study, we will conduct construct validation analyses to test for factorial time invariance as well as analyses of specific symptoms of depression to provide indications of potential changes in the conception and thresholds of depressive symptoms.

Finally, several studies have examined whether time trends in psychological problems vary according to socio-demographic factors. Some studies indicate gender differences in time trends of depressive symptoms (Sigfusdottir et al., 2008; West & Sweeting, 2003), while others do not (Collishaw, Maughan, Goodman, & Pickles, 2004). Moreover, no variations in time trends were found in relation to families' socio-economic status or family structure (Collishaw et al., 2010; Maughan et al., 2008), whereas one study did find time trends to vary according to number of children in the family (Maughan et al., 2008). Given the paucity of studies, the possibility of different time trends in different socio-economic strata and different family structures will be examined. Moreover, we will test for possible gender differences in time trends, and should such gender differences be found, analyses will be conducted separately for boys and girls.

The Present Study

In the present study, data from three population-based samples collected with identical procedures in 1992, 2002, and 2010 are used to provide information about secular trends in depressive symptoms. More specifically, the main objectives of this study are to examine i) whether self-reported depressive symptoms have changed among Norwegian adolescents over the period between 1992 and 2010 and, if such changes are in fact found, ii) whether changes in alleged risk or protective factors can account for increased or decreased symptoms of depression. Moreover, we aim to study iii) whether the threshold for reporting depressive symptoms has shifted over time; iv) whether any association between risk factors and depressive symptoms vary over time, thereby indicating variations in vulnerability; and v) whether time trends differ according to gender and other socio-demographics.

Methods

Participants and Procedure

Data from the Young in Norway studies were used. These cross-sectional studies were conducted to obtain comprehensive information about social and psychological issues in Norwegian adolescents' lives. In 1992, students from 28 senior high-schools comprised the study sample (Wichstrøm, 1999). Every school in the country was included in the register from which they were selected. Schools were drawn with probability according to size (proportional allocation). In 2002, the study was replicated and new senior high-schools were selected according to the same procedures as in 1992. A new data collection was performed in 2010, where the same schools were asked to participate as in 2002. Four schools declined to participate; one in 1992, one in 2002, and two in 2010. These schools were replaced by back-up schools with similar geographic location and size.

Every student gave informed consent according to the standards prescribed by the Norwegian Data Inspectorate. The regional committee for medical research ethics endorsed the surveys. Parents' consent was not required because the Data Inspectorate and the ethics committee evaluated such consent as unnecessary for adolescents in this age group. The students completed the questionnaires in class and those not present at the time of data collection were asked to complete the survey at a later occasion. Only students aged 16 and 17, attending the first or second year of senior high-school, were included since the data collected in 2010 did not include the third and final year of senior high-school. In 1992, data from 2,994 students were obtained, whereas 3,438 and 2,813 students partook in 2002 and 2010, respectively. The response rate for students included in the study was 97.0% in 1992, 91.0% in 2002, and 84.3% in 2010. Response rates at the school level varied from 53.2% to 100.0%.

With 48.8 % of respondents being female, no significant gender differences between the three samples were seen ($\chi^2[2] = 1.46$, $p = .48$). Of all participants, 13.3% reported to have at least one parent being unemployed or receiving occupational disability pension, with no differences detected between time points ($\chi^2[2] = 5.51$, $p = .06$). However, slight but significant age

differences between the three samples were found (mean age 1992 = 16.52, *SD* = .50; mean age 2002 = 16.59, *SD* = .49; mean age 2010 = 16.55, *SD* = .50; $F = 16.14$, $p < .01$). Likewise, the percentage of adolescents who reported to be born in other countries than Norway differed significantly from time point to time point (1992: 3.8%; 2002: 5.1%; 2010: 6.4%; $\chi^2[2] = 21.57$ $p<.01$). As a result, age and country of birth (Norway versus other countries) were included as covariate in all analyses.

Measures

Depressive symptoms. Kandel and Davies' (1982) Depressive Mood Inventory was used as a measure of depressive symptoms, with internal consistency of $\alpha = .83$. This measure was derived from the Hopkins Symptom Checklist (SCL; Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974) and asks for ratings of depressive symptoms during the preceding year on a 3-point scale. In the present version, the response format was changed back to the original format in the SCL, restricting the ratings to the preceding 14 days and applying a 4-point scale with the response options *1 – not at all, 2 – a little bit,* 3 *– quite a bit* , and *4 – extremely*. The students were asked about how often they had "been bothered or troubled" by each of the following states: "feeling too tired to do things"; "having trouble going to sleep or staying asleep"; "feeling unhappy, sad, or depressed"; "feeling hopeless about the future"; "feeling nervous or tense"; and "worrying too much about things". Mean scores were computed, ranging from 1 to 4, whereby high scores indicated high levels of depressive symptoms. In order to capture more serious depressive symptoms, a dichotomous variable of depressive symptoms was used when analyzing time trends, where the cut-off was set at 3.0 (the average score of *quite a bit distressed*). The prevalence of adolescents scoring above this cut-off is within the range of prevalence rates of depressive disorders commonly found in adolescent community samples, also in Norway (Sund, Larsson, & Wichstrøm, 2011; Wichstrøm, 1999). For additional analyses, we constructed a dichotomous variable contrasting adolescents who

did not report any depressive symptoms (i.e. those who responded *not distressed at all* for all six symptom items) with all others. In analyses where specific symptoms of depression were examined, each item was dichotomized whereby those who reported to be *extremely distressed* were contrasted with those with lower scores. The present measure of depressive symptoms has previously be shown to correlate highly with the Anxious/Depressed scale of the Youth Self Report (YSR) in Norwegian adolescents (Heyerdahl, Kvernmo, & Wichstrøm, 2004), and the YSR has been found to be an effective screen for adolescent depressive disorder (Dingle et al., 2010).

Potential explanatory variables. The five-item Physical Appearance subscale of a revised version of the Self-Perception Profile for Adolescents (Wichstrøm, 1995) was included to measure appearance satisfaction. The internal consistency was high (α = .89), and previous studies have shown that the scale correlates highly with other measures of appearance satisfaction (Wichstrøm, 1995). BMI (kg/m^2) was based on self-reports of weight and height, which have previously been found to correlate highly among adolescents with measured values (Goodman, Hinden, & Khandelwal, 2000). Exercise was tapped by an additive index of whether the participants had over the previous week "trained or exercised on their own", "visited a health-club, work-out center etc.", or "exercised or trained in a team or sports club" (range 0 – 14). Single item measures on physical activity such as those used in the present study show good test-retest reliability and fairly good concurrent validity, especially when one-week recall is used (Milton, Bull, & Bauman, 2011).Whether or not participants were living with both biological parents was assessed as well. Eating problems were measured by the first eight items of the Eating Attitude Test-12 (EAT) developed by Lavik and colleagues (1991), tapping the dimensions Dieting and Bulimia-Food Preoccupation. Internal consistency was α = .94.

A 15-item measure of conduct problems over the past 12 months approximating the diagnostic criteria for conduct disorders in DSM-III-R was employed (Wichstrøm, Skogen, &

Øia, 1996). All respondents were categorized into having or not having conduct problems according to procedures described by Wichstrøm and colleagues (1996). Internal consistency was $\alpha = .77$. The respondents were asked to indicate on a 6-point scale how often during the preceding 12 months they had "drunk so much that [they] felt clearly intoxicated". The students were also asked if they ever had used cannabis and whether or not they currently smoked cigarettes daily. Country of birth was assessed by asking the respondents whether they were born in Norway or not (yes/no). Finally, as a proxy of low socio-economic status, a dummy variable (yes/no) was constructed indicating whether at least one of the respondent's parents was unemployed or received occupational disability benefits.

Statistics

To examine the factor structure of the depressive symptoms measure, confirmatory factor analyses were conducted on depressive symptoms as a continuous measure, using a robust maximum likelihood estimator. The Confirmatory Fit Index (CFI), Tucker-Lewis-Index (TLI), and Root Mean Square Error of Approximation (RMSEA) were used to evaluate model fit. Moreover, to investigate whether the factor structure was invariant over gender and time points, multiple group analyses were performed; fits between models in which factor loadings were constrained to be equal over gender or time were compared to models without such constraints. For these comparisons, χ^2-difference tests as suggested by Satorra and Bentler (2001) were used. Differences in means and variances in depressive symptoms across time points were as well tested by multiple group analyses.

Analyses of depressive symptoms' time trends using the dichotomized measure were conducted in two steps. First, changes in depressive symptoms and potential risk and protective factors were examined by means of logistic regression analyses where period was dummy-coded and included as independent variable. Logistic regressions were also used to examine time trends

in specific symptoms of depression and investigate changes in the rate of those not reporting any depressive symptoms. In all analyses, age and country of birth were entered as covariates. The "repeated" contrast coding schedule was employed, which has been described as an adequate coding scheme for such studies as the present one (Wendorf, 2004). This scheme provides information about the change in odds from one time point to the next (i.e. from 1992 to 2002 and from 2002 to 2010). An overall period effect on the dependent variable was also computed. Potential differences in the time trend of depressive symptoms according to gender and socio-demographics were tested by including interaction terms in logistic regression analyses. For continuous potential risk factors, Analyses of Covariance (ANCOVA) were conducted with additional Scheffé post hoc tests, controlled for age and country of birth, to examine which time points differed significantly from each other. Second, potential risk and protective factors were entered into multiple logistic regression analyses along with dummy variables representing the time points. In a first model, each factor was included one by one. In a second model, only factors that could function as potential explanations of the period effect were included in one multiple regression. More specifically, factors were only included when they showed time trends consistent with the secular trend of depressive symptoms and when the period effect for depressive symptoms decreased after adjusting for the factor in Model 1. In a third model, other potential risk and protective factors were included as well, also when they showed secular trends not in accordance with those of depressive symptoms. Age and country of birth was included in all analyses as covariate. The statistical program Mplus 6.12 was used for confirmatory factor analyses and tests of differences in means and variances of depressive symptoms. SPSS 19 was used for all remaining analyses.

Results

Factor Structure of Depressive Symptoms across Gender and Time

Confirmatory factor analysis was conducted for all three time points separately for each gender to examine the factor structure of the measure of depressive symptoms. The results showed acceptable fits for all six factor models, with CFI values ranging from .96 to 1.00, TLI values from .93 to .99, and RMSEA values from .029 to .077. Moreover, multiple group analyses showed no gender differences in the factor loadings of depressive symptoms at any time point (all $p>.05$). Data for girls and boys were then combined and factorial invariance across time was tested, showing significant differences in factor loadings (corrected χ^2-difference[10]=66.59, $p<.01$). However, since the χ^2-value depends on sample size, and a large sample was used in this analysis ($N>9{,}000$), statistically if not substantially significant differences between models might have been obtained. Model fit indices with values not influenced by sample size were therefore compared for the models with and without restricting the factor loadings to be invariant over time. The results showed that two of three fit indices were literally equal between the models, whereas one index performed slightly better in the time invariant model (time invariant model: CFI=.98; TLI=.97; RMSEA=.050; model without constraints: CFI=.98; TLI=.97; RMSEA=.053). The results thus confirm the factor structures at all time points to be similar.

Secular Changes in Depressive Symptoms

Mean values for depressive symptoms for boys, with standard deviations in parenthesis, were 1.65 (.49) in 1992, 1.75 (.59) in 2002, and 1.71 (.61) in 2010; for girls, the corresponding values were 1.96 (.57), 2.02 (.63), and 2.00 (.68). No significant overall mean difference in depressive symptoms at the three time points were found for girls (corrected χ^2-difference[2] = 1.07, $p>.05$), though such a difference was detected among boys (corrected χ^2-difference[2] = 12.32, $p<.01$). Post-hoc analyses for boys showed a significant mean increase from t1 to t2 (corrected χ^2-difference[1] = 10.43, $p<.01$), whereas no other significant differences were found. When examining the differences in standard deviations over time, the results revealed such

differences for both genders (girls: corrected χ^2-difference[2] = 29.50, $p<.01$; boys: corrected χ^2-difference[2] = 28.08, $p<.01$). Post-hoc tests showed that the standard deviation increased significantly from 1992 to 2002 and again from 2002 to2010 for girls, whereas it only increased from 1992 to 2002 for boys, with no significant difference between 2002 and 2010.

The increasing variance over time may be an indication of a rising number of adolescents with high scores on depressive symptoms, even if an increase in the level of depressive symptoms was only found among boys between 1992 and 2002. Time trend analyses were thus repeated by using the dichotomized depressive symptom variable. As displayed in Table 1, logistic regression analyses with dichotomized indicators of depressive symptoms as outcome showed a significant overall period effect for both girls and boys. Moreover, analyses revealed that this was due to a symptom increase between 1992 and 2002 for both boys and girls, whereas no significant change was observed between 2002 and 2010. A significant interaction effect between time point and gender was found between 1992 and 2002 ($p=.02$), indicating a greater increase in depressive symptoms for boys compared to girls. No such interaction effect was found between 2002 and 2010 ($p=.11$). Interaction analyses were conducted to examine whether time trends differed between adolescents with parents of low socio-economic status and adolescents whose parents had higher socio-economic status. Likewise, adolescents living with both biological parents were compared to those not living with both biological parents. For both measures, no significant interaction effects were found for either girls or boys ($p>.05$).

The increasing variance in depressive symptoms over time may be indication of increased polarization, where the rise in frequency of adolescents with high symptom scores is accompanied by a simultaneous increase in the rate of adolescents with no symptoms. We examined as such the rate of boys and girls without any symptoms of depression. Rates of boys without any symptoms of depression were 12.5%, 10.5%, and 14.9% in 1992, 2002, and 2010, respectively. Logistic

regression analyses showed that there was a significant overall effect of time point ($p<.01$), and more specific analyses showed no significant difference in the proportion of boys without any symptoms between 1992 and 2002 ($p=.09$), while a significant increase was observed between 2002 and 2010 ($p<.01$). The proportion of girls without symptoms was 3.2%, 4.1%, and 5.4% in 1992, 2002, and 2010, with a significant overall effect of time point ($p=.02$). However, the observed changes in prevalence between adjacent time points, i.e. 1992 and 2002 ($p=.15$) and 2002 and 2010 ($p=.14$), were not significant.

Finally, time trends for all six symptoms of depression were examined separately to provide information about changes on item level. For this purpose, time trends were again examined by logistic regression analyses, where dichotomous measures of specific symptoms were used as dependent variables. The results showed significantly increasing percentages of boys with high symptom loads between 1992 and 2002 for all symptoms of depression ($p<.05$), with the exception of "feeling hopeless about the future", where no changes were observed. For girls, rates of three symptoms increased in the same time frame ("having trouble going to sleep or staying asleep"; "feeling nervous or tense"; and "worrying too much about things"). Two symptoms ("feeling too tired to do things" and "worrying too much about things") showed a significant decrease from 2002 to 2010 for boys, with no significant changes in any of the six symptoms for girls over the same time span.

Secular Changes in Putative Risk and Protective Factors

Time trends in risk and protective factors that could serve as potential explanations of the secular changes were examined. Table 1 shows that the frequency of adolescents not living with both of their biological parents increased gradually over the 18-year period. Moreover, the proportion of boys and girls exercising increased, particularly between 2002 and 2010. Eating problems increased for both genders from 1992 to 2002, and remained stable thereafter. Conduct

problems remained stable over all three time points in girls, whereas boys' scores showed a marked decrease from 2002 to 2010. Daily smoking rates remained rather constant between 1992 and 2002, but were greatly reduced in 2010. Moreover, there was a strong rise in cannabis use between 1992 and 2002 and an almost equally marked decrease between 2002 and 2010 for both genders. A similar trend was observed for alcohol intoxication, as seen in Table 2. The table shows further that general perception of physical appearance scores remained stable between 1992 and 2002 and increased in 2010 among boys, whereas girls showed similar scores in 1992 and 2010, but had lower physical appearance evaluation levels in 2002. Finally, BMI increased for both boys and girls from 1992 to 2010, although the increase for girls from 2002 to 2010 was not significant.

Examining Potential Explanations of the Secular Increase in Depressive Symptoms

A correlation matrix of all explanatory variables and depressive symptoms is depicted in Table 3 for girls and boys, separately. The table shows relatively similar correlational patterns for both genders.

We examined whether a potential increased vulnerability to depressive symptoms could explain increases in secular trends between 1992 and 2002. For this purpose, interaction analyses were conducted for boys and girls separately to examine whether the strength of the association of each predictor variable with depressive symptoms varied between 1992 and 2002. Results showed no such interaction effects for boys ($p>.05$); for girls, the only significant interaction effect was found for alcohol intoxication ($p=.02$), with a positive association with depressive symptoms in 1992 (OR =1.17, 95% CI: 1.04-1.31, $p=.01$) and no significant relationship in 2002 (OR=0.98, 95% CI: 0.90-1.08, p =.72). We tested in addition for different relationships between predictors and depressive symptoms when comparing 2002 and 2010, and 1992 and 2010, but no significant interaction was found for any predictor for either gender ($p>.05$).

We then examined whether changes in the level of putative risk and protective factors might contribute to changed rates of high symptom loads. For this purpose, potential risk and protective factors that might explain the time trends in depressive symptoms were entered together with time period, age, and country of birth in logistic regression analyses. First, factors were entered one by one to estimate separately each variable's relation to trends in depressive symptoms. The boys' results, as presented in Model 1 in Table 4, show eating problems, conduct problems, daily smoking, cannabis use, physical appearance, and alcohol intoxication to be significantly related to depressive symptoms. However, only the inclusion of some of these factors was accompanied by a substantial reduction of the period effect for depressive symptoms between 1992 and 2002. More specifically, only the inclusion of eating problems, cannabis use, and alcohol intoxication reduced the original *OR* of the period effect of 2.15, which was obtained when no potential explanatory were included (see Baseline Model in Table 4). The same three variables also showed significant time trends between 1992 and 2002 in accordance with trends in depressive symptoms.

Model 2, Table 4, presents a multiple logistic regression analysis where these three variables were included simultaneously. In this analysis, eating problems and cannabis use remained significant predictors of depressive symptoms, whereas alcohol intoxication did not. The *OR* for the period effect of depressive symptoms between 1992 to 2002 decreased from the unadjusted *OR* of 2.15 to an *OR* of 1.67, but remained significant. Finally, we estimated a third model where all potential explanatory factors were included, independent of whether they showed time trends in accordance with secular trends in depressive symptoms. The results, as presented in Table 4, Model 3, show that when all variables were included, the boys' secular trends in both time periods increased compared to results in Model 2, but remained lower than the unadjusted *OR* value in the Baseline Model.

The girls' results, presented in Table 5, showed that all potential explanatory variables with the exception of BMI were significantly related to depressive symptoms when these variables were included one by one in the analyses (Model 1). Again, only those variables that were related to a substantial reduction of the time effect between 1992 and 2002 – eating problems, cannabis use, physical appearance, and alcohol intoxication – were included in the multiple analysis in Model 2. The results showed all the included variables but alcohol intoxication to be related to depressive symptoms. The *OR* of the period effect in depressive symptoms from 1992 to 2002 decreased from 1.30 in the unadjusted analysis (see Baseline Model in Table 5) to a non-significant *OR* of 1.00 in the multiple analysis. Moreover, the *OR* of the depressive symptom period effect from 2002 to 2010 increased to a significant 1.51. Finally, when all variables, independent of whether or not they were in accordance with time trends in depressive symptoms, were included in Model 3 the secular time trends were similar to those observed in Model 2, with no significant period effect between 1992 and 2002 and a significant increase between 2002 and 2010. In all analyses conducted the overall period effect remained significant for both genders.

Discussion

Three nationwide and representative surveys of Norwegian senior high-school students were conducted according to identical procedures over an 18-year time span, showing that the prevalence of boys with high scores on depressive symptoms more than doubled between 1992 and 2002. Likewise, the percentage of girls with high symptomatology increased significantly between the two time points, though to a lesser extent than boys' scores. No significant changes for boys or girls were observed between 2002 and 2010. Eating problems and cannabis use partially explained the increase in depressive symptoms between 1992 and 2002 for both genders, whereas physical appearance was an additional explanatory factor of the time effect between 1992 and 2002 for girls. However, the overall effect of time period remained significant for both

genders even when potential explanatory variables were included. The results of this study therefore provide only a partial explanation of the secular trend in depressive symptoms. Moreover, as described below, no firm conclusions can be drawn since the causal direction of the relationship between depressive symptoms and risk factors cannot be conclusively delineated.

When all putative risk and protective factors were accounted for, including those not showing time trends in congruence with depressive symptom trends, all variables taken together did only explain a minor part of the time trends in depressive symptoms among boys. This finding indicates that though some variables may be of explanatory value for the time trend of depressive symptoms, other potential risk and protective factors operate in a contrary manner by increasing the period effect when adjusted for these factors. These results can be interpreted as a suppressor effect, indicating that if there had not been certain positive time trends in adolescents' behavior and psychological well-being between 1992 and 2002, the increases in depressive symptoms would have been even greater. Particularly, smoking may have such effects, since smoking rates decreased between 1992 and 2002. A similar tendency could be found for girls' depressive symptoms: Although the inclusion of potential explanatory factors was related to a diminishing time trend between 1992 and 2002, adjustment for those same factors led as well to an emerging increase in depressive symptoms between 2002 and 2010. This emerging period effect for girls between 2002 and 2010 may be particularly due to the fact that the use of drugs such as alcohol, tobacco, and cannabis decreased during this period. Without such reductions in drug use between 2002 and 2010, girls would probably have experienced a greater increase in depressive symptoms between 2002 and 2010.

Increased vulnerability for depressive symptoms as an explanation for increased rates of depressive symptoms between 1992 and 2002 could not be supported by the data: Of all predictors, only alcohol intoxication's association with depressive symptoms changed

significantly between 1992 and 2002, and solely among girls. Moreover, increased vulnerability would imply the relationship between alcohol intoxication and depressive symptoms to become stronger over time, whereas we found a diminished relationship between 1992 and 2002. The non-findings in the present study contrast in part to findings from one study showing increased vulnerability to several predictors of psychological distress from 1987 to 2006 (Sweeting et al., 2010). However, vulnerability increased primarily in relation to educational factors, which were not assessed in the present study. Parts of the observed time trends might, therefore, be explained by changed vulnerability to factors that were not assessed in the present study.

Several of the predictor variables showed considerable change in prevalence over time, and particularly changes in drug use and BMI were in accordance with other research conducted in Norway (Andersen et al., 2005; Vedøy & Skretting, 2009). Likewise, time trends for other variables, including single parenting, exercise, and conduct problems emerged more or less as expected based on other Norwegian research and official statistics.

The present study's finding of an increase in depressive symptoms during the 1990s is in congruence with those from survey studies conducted in other Western countries showing similar increases. The study is as well in accordance with research where no differences have been found in time trends in emotional problems according to socio-economic status and family structure. As such, there is to date no indication that time trends vary across certain socio-demographic groups, with the exception of gender. Our study further suggests that particularly those with high symptom loads show an increase, whereas the mean level increase in depressive symptoms remained non-significant for girls between 1992 and 2010. This finding, in combination with a tendency toward an increased proportion of adolescents reporting no symptoms of depression from 1992 to 2010, indicates a polarization whereby the percentage of those with both low and high symptom loads increases. The rather stable prevalence of depressive symptoms between

2002 and 2010 is in accordance with research from the UK indicating that rates of psychosocial problems in adolescents have stabilized or even declined since about the year 2000 (Maughan et al., 2008). As described above, one reason for the stable trend over this time period may be the decrease in prevalence of several risk factors between 2002 and 2010, particularly for girls, since the analyses actually showed an increase in depressive symptoms during this period when controlling for all explanatory variables. Why such an effect was only found for girls remains however an open question.

Limitations

The current study provides information about depressive symptom time trends and indication of explanations for these trends between 1992 and 2010 through representative nationwide surveys using identical procedures. There are, meanwhile, several possible methodological explanations for the present findings.

Lowered thresholds for reporting emotional symptoms. As already noted above, the increase in depressive symptoms may reflect a potential rise in social acceptance of mental health problems among adolescents, and thus a greater willingness over time to express such symptoms. In the present study, validation analyses showed that the factor structure of the depressive symptoms measure was similar across time points, thereby providing some evidence of measure comparability over time. Moreover, time trends in specific symptoms showed an increase in some but not all symptoms between 1992 and 2002 for girls, thereby not indicating any general shift across time in how adolescent girls respond to questions about depressive symptoms (Collishaw et al., 2010). For boys, all but one symptom increased between 1992 and 2002, which may also be in accordance with a generally decreased threshold to report such symptoms. The possibility of a lowered threshold for reporting emotional problems over time can thus not be completely dismissed.

Response rates. Studies of selective attrition show that mood disorders to some degree predict non-response in epidemiological studies (Knudsen, Hotopf, Skogen, Øverland, & Mykletun, 2010). Since the response rate decreased by 6% from 1992 to 2002 and by an additional 7% between 2002 and 2010, the level of depression may have been somewhat under-estimated in 2002 and even more so in 2010 if non-participation indeed was related to higher levels of depressive symptoms. The stable trend in depressive symptoms between 2002 and 2010 observed in this study may to some extent, then, be a result of the lower response rate in 2010.

Reversed order of cause and effect. The direction of the relationship between depressive symptoms and time period can on logical grounds be unquestionably determined as period is not influenced by the outcome variables. However, the cross-sectional nature of the data does not provide information on the causal order between the outcome variable and the putative risk factors. Although, as described above, there is an indication that several of the variables included in this study function as risk factors, this could as well be an effect of changes in depressive symptoms, rather than the cause of them. For instance, a causal relationship to cannabis use for boys could not be delineated, and no strong evidence for such a relationship is found in the scientific literature (Moore et al., 2007). As for eating problems, while some prospective research indicates a causal effect of eating pathology on depressive symptoms (Marmorstein et al., 2008; Stice & Bearman, 2001), other studies reveal prospective reciprocal effects of these two variables (Presnell, Stice, Seidel, & Madeley, 2009), indicating a partial reverse causal relationship. As such, the current knowledge of risk factors for such symptoms does not provide the possibility to draw strong conclusions about factors that causally explain such changes.

Spurious relationships. Although a wide range of potential explanations for the period effect were included in the study, the model is clearly not definitive. Thus, when changes in depressive symptoms were not fully accounted for, the inclusion of additional risk factors might

have altered this. In particular, more information on quality of family interaction and parents' mental health would have been valuable (Schepman et al., 2011; Sweeting et al., 2010). Moreover, factors such as potentially higher academic pressure at school (West & Sweeting, 2003) and increased exposure to the Internet may be of importance to explain time trends in depressive symptoms.

Measurement of explanatory variables. Several variables in the study were assessed with one item only (e.g. smoking and alcohol use), conceivably resulting in an underestimation of their relationship to depressive symptoms due to potentially low reliability. Moreover, measures such as cannabis use were constructed based on life-time use whereas only the last 14 days of depressive symptoms were addressed, again possibly contributing to an attenuation of the relationships examined. Likewise, dichotomization of the dependent variable may have artificially deflated relationships between explanatory variables and depressive symptoms.

Conclusion

The current study is one of few to examine how secular trends in depressive symptoms among adolescents might be explained by controlling for a variety of putative risk and protective factors on an individual level. The results provide some indication that eating problems and cannabis use may constitute risk factors to be addressed in population-based interventions for both genders, whereas self-concept related to physical appearance may be of specific importance for girls. However, since the causal direction between depressive symptoms and putative risk factors could not be established, further research is needed to obtain more definitive information about preventive measures that could be implemented to reduce the rate of depressive symptoms in the adolescent population.

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Table 1

Prevalence of High Levels of Depressive Symptoms and Potential Explanatory Variables in 1992, 2002, and 2010 by Gender

	Boys						Girls					
	1992	2002	2010	Change from 1992 to 2002	Change from 2002 to 2010	Overall change	1992	2002	2010	Change from 1992 to 2002	Change from 2002 to 2010	Overall change
	%	%	%	OR [95% CI]	OR [95% CI]	p	%	%	%	OR [95% CI]	OR [95% CI]	p
Depressive symptoms[+]	2.9	6.1	5.5	2.15*** [1.49-3.10]	0.90 [0.66-1.22]	<0.01	8.8	11.4	13.4	1.30* [1.02-1.65]	1.22 [.98-1.52]	<0.01
Not living with both biological parents	28.1	32.3	40.0	1.22* [1.05-1.41]	1.39*** [1.20-1.61]	<0.01	29.3	36.8	44.2	1.40*** [1.21-1.63]	1.36*** [1.18-1.58]	<0.01
Exercise 8+ times per week	32.6	38.3	50.3	1.29** [1.12-1.49]	1.61*** [1.39-1.86]	<0.01	26.2	28.6	40.6	1.16 [0.99-1.36]	1.68*** [1.45-1.96]	<0.01
Eating problems	1.3	3.4	4.4	2.67*** [1.60-4.47]	1.28 [0.88-1.85]	<0.01	11.2	17.7	16.1	1.71*** [1.39-2.10]	.89 [0.73-1.08]	<0.01
Conduct problems	7.0	6.4	2.9	0.90 [0.68-1.19]	0.44*** [0.31-0.64]	<0.01	0.7	0.6	0.8	0.93 [0.39-2.21]	0.80 [0.47-2.65]	0.97
Daily smoking	23.8	22.9	7.0	0.93 [0.79-1.10]	0.25*** [0.20-0.32]	<0.01	23.4	24.6	7.0	1.06 [0.90-1.25]	0.23*** [0.18-0.30]	<0.01
Cannabis use	7.2	20.0	9.6	3.10*** [2.46-3.91]	0.43*** [0.34-0.53]	<0.01	4.8	12.5	5.6	2.77*** [2.09-3.69]	0.42*** [0.32-0.55]	<0.01

Note. OR = odds ratio. 95% CI = 95% confidence interval of OR. All OR adjusted for age an country of birth.

[+]A dichotomized variable of depressive symptoms was used, where the cut-off was set at 3.0 (the average score of *quite a bit distressed*)

*$p < .05$; *$p < .01$; ***$p < .001$.

Table 2

Means (Standard Deviations) of Potential Explanatory Variables in 1992, 2002, and 2010 by Gender

	Boys					Girls				
	1992	2002	2010	F	Post hoc	1992	2002	2010	F	Post hoc
Physical appearance	2.80	2.84	3.03	43.48***	23, 13	2.39	2.31	2.44	14.30***	12, 23
	(0.60)	(0.68)	(0.67)			(0.65)	(0.74)	(0.73)		
Body mass index	21.42	22.29	22.71	51.38***	all	20.67	21.44	21.57	34.51***	12, 13
	(2.47)	(3.33)	(4.31)			(2.43)	(3.52)	(3.51)		
Alcohol intoxication	2.78	3.45	2.68	80.48***	12, 23	2.65	3.25	2.72	63.89***	12, 23
	(1.75)	(1.79)	(1.69)			(1.62)	(1.69)	(1.59)		

Note. Scheffé post-hoc tests are used. all = significant differences between all three measures, 12= significant difference between measures in 1992 and 2002, 23= significant difference between measures in 2002 and 2010, 13 = significant difference between measures in 1992 and 2010

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3

Inter-Correlations between Depressive Symptoms and all Explanatory Variables with Girls' Values Below and Boys' Values Above the Diagonal (Data from all Three Data Collections Combined)

	1	2	3	4	5	6	7	8	9	10
1 Depressive symptoms	-	0.08**	-0.03	0.08**	0.14**	0.13**	0.18**	-0.31**	0.01	0.10**
2 Not living with both biological parents	0.08**	-	-0.01	0.03*	0.10**	0.11**	0.09**	0.00	0.03	0.08**
3 Exercise 8+ times per week	-0.05**	-0.02	-	0.08**	0.00	-0.14**	-0.04**	0.12**	0.06**	-0.04*
4 Eating problems	0.22**	0.02	0.12**	-	0.12**	0.02	0.08**	-0.06**	-0.13**	0.00
5 Conduct problems	0.05**	0.04**	-0.01	0.01	-	0.25**	0.34**	-0.03*	0.02	0.21**
6 Daily smoking	0.15**	0.13**	-0.12**	0.02	0.13**	-	0.36**	-0.04**	0.00	0.33**
7 Cannabis use	0.14**	0.13**	-0.06**	0.04*	0.18**	0.32**	-	-0.01	0.03*	0.35**
8 Physical appearance	-0.32**	-0.03	0.01	-0.29**	0.00	-0.08**	-0.01	-	-0.10**	-0.01
9 Body mass index	0.02	0.06**	0.00	0.14**	0.00	0.01	-0.01	-0.24**	-	0.08**
10 Alcohol intoxication	0.08**	0.11**	-0.02	0.10**	0.09**	0.32**	0.29**	-0.07*'	0.00	-

Note. *$p < .05$. **$p < .01$.

Table 4

Association between Potential Explanatory Variables and Depressive Symptoms for Boys. Logistic Regression Analyses

	Predictor	Change in depressive symptoms		
		1992 to 2002	2002 to 2010	overall
	OR [95% CI]	OR [95% CI]	OR [95% CI]	p
Baseline Model				
Without predictors, controlled for age and birth country		2.15*** [1.49-3.10]	0.90 [0.66-1.22]	<0.001
Model 1 (separate analysis for each predictor, controlled for age and birth country)				
Not living with both biological parents	1.21 [0.92-1.61]	2.12*** [1.47-3.06]	0.86 [0.63-1.17]	<0.001
Exercise 8+ times per week	0.81 [0.60-1.08]	2.13*** [1.48-3.08]	0.91 [0.66-1.25]	<0.001
Eating problems	3.51*** [2.15-5.74]	2.08*** [1.44-3.01]	0.84 [0.61-1.14]	<0.001
Conduct problems	4.53*** [3.09-6.63]	2.23*** [1.53-3.23]	0.94 [0.69-1.29]	<0.001
Daily smoking	2.42*** [1.78-3.31]	2.26*** [1.55-3.29]	0.99 [0.71-1.37]	<0.001
Cannabis use	3.12*** [2.30-4.28]	1.80** [1.24-2.62]	1.00 [0.72-1.37]	<0.01
Physical appearance	0.41*** [0.34-0.50]	2.14*** [1.48-3.09]	1.07 [0.78-1.47]	<0.001
Body mass index	1.03 [1.00-1.07]	2.02*** [1.40-2.93]	0.85 [0.62-1.18]	<0.01
Alcohol intoxication	1.16** [1.07-1.26]	1.96*** [1.35-2.85]	0.96 [0.70-1.32]	<0.01
Model 2 (analysis including all variables with time trends in accordance with trends in depressive symptoms)				
Eating problems	3.04*** [1.83-5.05]			
Cannabis use	2.80*** [1.98-3.96]			
Alcohol intoxication	1.07 [0.97-1.17]	1.67** [1.14-2.45]	1.03 [0.74-1.42]	0.01
Model 3 (analysis including all variables)				
Not living with both biological parents	0.98 [0.72-1.35]			
Exercise 8+ times per week	0.90 [0.66-1.24]			
Eating problems	2.14* [1.18-3.87]			
Conduct problems	2.56** [1.55-4.22]			
Daily smoking	1.46 [0.99-2.16]			
Cannabis use	2.00** [1.32-3.03]			
Physical appearance	0.41*** [0.33-0.51]			
Body mass index	0.99 [0.96-1.03]			
Alcohol intoxication	1.03 [0.94-1.14]	1.86** [1.24-2.80]	1.37 [0.96-1.96]	<0.001

Note. OR = odds ratio. 95% CI = 95% confidence interval of OR. All analyses controlled for age and birth country.
*$p < .05$. *$p < .01$. ***$p < .001$

Table 5

Association between Potential Explanatory Variables and Depressive Symptoms for Girls. Logistic Regression Analyses

	Predictor	Change in depressive symptoms		
		1992-2002	2002-2010	overall
	OR [95% CI]	OR [95% CI]	OR [95% CI]	p
Baseline Model				
Without predictors, controlled for age and birth country		1.30* [1.02-1.65]	1.22 [.98-1.52]	<0.01
Model 1 (separate analysis for each predictor, controlled for age and birth country)				
Not living with both biological parents	1.37** [1.13-1.66]	1.29* [1.01-1.64]	1.18 [0.95-1.47]	<0.01
Exercise 8+ times per week	0.74** [0.60-0.92]	1.29* [1.01-1.63]	1.29* [1.03-1.61]	<0.001
Eating problems	3.18*** [2.57-3.93]	1.18 [0.93-1.51]	1.25 [1.00-1.56]	<0.01
Conduct problems	3.94*** [1.84-8.47]	1.30* [1.02-1.65]	1.21 [0.97-1.50]	<0.01
Daily smoking	2.31*** [1.86-2.88]	1.31* [1.03-1.66]	1.42** [1.13-1.78]	<0.001
Cannabis use	2.52*** [1.91-3.33]	1.18 [0.93-1.51]	1.31* [1.05-1.64]	<0.01
Physical appearance	0.37*** [0.32-0.43]	1.16 [0.91-1.49]	1.41** [1.13-1.77]	<0.001
Body mass index	1.02 [0.99-1.05]	1.29* [1.01-1.65]	1.19 [0.95-1.49]	<0.01
Alcohol intoxication	1.07* [1.01-1.14]	1.24 [0.97-1.58]	1.23 [0.99-1.54]	<0.01
Model 2 (analysis including all variables with time trends in accordance with trends in depressive symptoms)				
Eating problems	1.96*** [1.55-2.48]			
Cannabis use	2.70*** [1.98-3.70]			
Physical appearance	0.42*** [0.36-0.49]			
Alcohol intoxication	0.98 [0.92-1.04]	1.00 [0.78-1.29]	1.51** [1.19-1.91]	<0.01
Model 3 (analysis including all variables)				
Not living with both biological parents	1.17 [0.94-1.45]			
Exercise 8+ times per week	0.71** [0.56-0.90]			
Eating problems	2.18*** [1.69-2.80]			
Conduct problems	2.34 [0.94-.5.83]			
Daily smoking	1.80*** [1.37-2.36]			
Cannabis use	2.03*** [1.44-2.88]			
Physical appearance	0.42*** [0.36-0.50]			
Body mass index	0.96* [0.93-0.99]			
Alcohol intoxication	0.92** [0.85-0.98]	1.11 [0.85-1.45]	1.64** [1.27-2.12]	<0.001

Note. OR = odds ratio. 95% CI = 95% confidence interval of OR. All analyses controlled for age and birth country.

*$p < .05$. **$p < .01$. ***$p < .001$.