

A nationwide study of adolescent psychosocial well-being one year after the outbreak of the COVID-19 pandemic

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Abstract

The COVID-19 pandemic has dramatically restricted adolescents' lives. We used nationwide Norwegian survey data collected from 2014–2021 ($N = 227,258$; ages 13–18) to address three essential questions: What are the psychosocial consequences of the pandemic? Are disadvantaged adolescents disproportionately affected by the pandemic? Do pandemic effects vary with geographical variations in infection rates and restrictions? Multilevel models revealed higher depressive symptoms and lower optimism during the pandemic than before the pandemic, even when accounting for the measures' time trends. Further, alcohol and cannabis use decreased, and screen time increased. Social relationships and conduct problems remained stable. Girls, younger adolescents, and adolescents from low socioeconomic backgrounds were disproportionately affected by the pandemic. The pandemic's effects varied little with municipality infection rates and restrictions. These findings can inform means and interventions to reduce negative pandemic effects and identify groups that need particular attention during and after the pandemic.

Introduction

On March 11, 2020, the World Health Organization declared the COVID-19 outbreak a pandemic. Since then, drastic measures to prevent the spread of the pandemic have been implemented worldwide. Imposed restrictions, such as school closures, physical distancing, and restrictions on recreational activities raise concerns about adolescents' well-being^{1,2}. Understanding how the pandemic has affected psychosocial aspects in key arenas of adolescents' lives is a fundamental step towards supporting adolescents during and after the pandemic. Moreover, it is crucial to obtain knowledge of whether disadvantaged groups suffer disproportionately from the consequences of the pandemic. Here, to address these issues we use nationwide, large-scale, repeated cross-sectional data from more than 200,000 adolescents in Norway that were assessed comprehensively on key psychosocial aspects before the COVID-19 outbreak and one year into the pandemic. We examine: (1) potential psychosocial consequences of the pandemic, (2) whether disadvantaged groups are particularly vulnerable to the effects of the pandemic, and (3) whether the effects of the pandemic vary with geographical variations in infection rates and restrictions.

Despite the growing interest in studying the psychosocial consequences of the COVID-19 pandemic on the general population, our knowledge about its impact on adolescents is still limited. First, there is a lack of studies providing comprehensive and comparable assessments of a variety of psychosocial factors before and during the pandemic. Second, some recent longitudinal studies that compared adolescents' responses before and during the pandemic did not disentangle the effects of COVID-19 from normative development during the teenage years^{3,4}. Repeated cross-sectional studies comparing same-aged adolescents before and after the pandemic can account for developmental trends during adolescence. Third, most studies so far have been based on small-sized or convenience samples^{4,5}, whereas there is a lack of large-scale, population-based studies that include information about geographical variations in infection rates and restriction measures and their association to adolescent psychosocial well-being. Fourth, although some studies examined adolescents' psychosocial well-being during the initial months of the pandemic^{4,6,7}, the long-term effects are unknown.

Using nationwide Norwegian data from adolescents assessed with the same procedure in 157 municipalities before and one year into the pandemic, we provide knowledge about the psychosocial consequences of the pandemic in key arenas of adolescents' lives. We disentangle the sudden consequences of the pandemic from long-term time trends using multilevel societal growth curves⁸ and additionally examine the role of geographical variations in infection rates and restrictions. This study utilizes the by-far largest sample of teenagers to examine psychosocial consequences of

the pandemic up to now. The results provide information that will better inform intervention and prevention measures to reduce the adverse psychosocial effects of the pandemic among adolescents.

Previous research on the impact of the pandemic on adolescents

In this article, we aim to examine how the pandemic has affected adolescents' lives in five key life domains. These life domains include social relationships, mental health, conduct problems and substance use, physical activity and screen time, and future life expectations. Concerning social relationships, we know that adolescent social life has substantively changed during the pandemic, due to infection control measures such as school closures and physical distancing⁹. Consequently, peer relationships may be disrupted in a time of social deprivation such as the present. In fact, one of the greatest concerns related to the pandemic reported by adolescents is not feeling connected to their friends⁴. In addition to peer relationships, the pandemic may also have affected relationships within the family: Financial insecurity, caregiving burden, and confinement-related stress may adversely affect parent-child relationships¹⁰. Indeed, in the early stage of the pandemic, many parents reported experiencing increased levels of distress¹¹. Such stress, in turn, has been shown to increase the practice of harsher parenting styles, resulting in more conflicts and worsening relationships between parents and their children¹². However, it has also been posited that changes in family routines and the increased amount of time and attention spent within the family may have had positive effects for some children and adolescents¹³. This study will examine how peer relationships and parental relationships have changed from before to during the pandemic.

In the domain of mental health, it has been suggested that the pandemic leads to increasing mental health problems in children and adolescents because of the unique combination of social isolation, economic recession, and disruptions in mental health care services for adolescents^{1,2}. Moreover, large-scale studies in several countries have indicated that early in the pandemic, mental health problems increased among adults¹⁴⁻¹⁸. However, research on adolescents has not been conclusive. For example, data from 12 longitudinal studies primarily conducted in North America found that adolescent depressive symptoms increased significantly from before to during the first six months of the pandemic, whereas symptoms of anxiety remained stable³. However, these longitudinal studies do not disentangle effects of the pandemic from normative aging processes in adolescence. To illustrate, a Norwegian longitudinal study indicated that increases in depression and anxiety during the pandemic were caused by adolescents getting older, rather than by effects of the pandemic⁶. Large-scale repeated cross-sectional studies are therefore important to provide more information about the effect of the pandemic on adolescent mental health.

The effect of the pandemic on substance use and conduct problems is another field where research is scarce. The pandemic limits situations where adolescents consume alcohol and other drugs, such as unsupervised gatherings and parties with peers¹⁹. Research with five longitudinal adult samples in the UK showed that alcohol use decreased during the pandemic, and the largest reduction was found in the youngest cohort, born in 2001²⁰. In contrast, a study in Canada assessing drug consumption in adolescents retrospectively indicated increased alcohol and cannabis use⁵. Regarding conduct problems, crimes committed by young people in the United States seemed to decrease during the pandemic²¹. Here, we follow this line of research by examining changes of substance use and conduct problems from before to one year into the pandemic.

There have been concerns that restrictions during the pandemic may lead to a decrease in physical activity for children and adolescents, which, in turn may have long-term negative health consequences²². A multi-wave survey in China seems to confirm these concerns by finding reduced physical activity in children and adolescents due to the pandemic²³. However, a longitudinal study on children and teens aged 4–17 in Germany found that even though sports activity declined in the beginning of the pandemic, habitual physical activities increased, thereby leading to an overall

increase in physical activity⁷. Both studies also found that recreational screen time increased^{7,23}. Consequently, while taking time trends into account, in this study we examine the effects of the pandemic on physical activity and screen time among Norwegian adolescents.

Finally, the pandemic may have an impact on adolescents' expectations concerning their future life opportunities. The pandemic may have challenged adolescents' basic beliefs about living in a controllable world and about their physical safety and economic security. Moreover, the economic recession triggered by the COVID-19 pandemic is expected to hit those who are in the initial phase of their labour market career the hardest, such as young people²⁴. Thus, adolescents might be more pessimistic about their future prospects. To our knowledge, the pandemic's impact on adolescents' future expectations has not been examined up to now; we expect it to influence adolescents' expectations negatively.

Are marginalized groups disproportionately affected by the pandemic?

Poverty and low education are consistently associated with social ills, lifetime problems, and higher morbidity and mortality, both among adults^{25,26} and adolescents²⁷. Social disparities typically increase in times of crisis²⁸, and European and US research have documented that the less educated and the poor are economically more severely affected by the COVID-19 pandemic^{29,30}. However, less is known about whether the pandemic disproportionately affects disadvantaged adolescents in a variety of life domains and thereby widens social disparities. According to the literature, adolescents from a low socioeconomic background may be disproportionately affected by the pandemic, with a higher risk of living in crowded households, increasing family stress, and adverse economic and health effects of the pandemic^{11,31}.

The adverse effects of the pandemic may also vary with other sociodemographic factors. For example, adolescent girls show more symptoms of anxiety and depression and ruminative coping styles than boys³² and may be affected more by the pandemic psychosocially. Two longitudinal studies have provided first evidence that the pandemic has led to increasing gender disparities in mental health problems in adolescents⁴ and adults¹⁴. However, to our knowledge, studies examining whether girls are more severely affected by the pandemic in psychosocial domains other than mental health are lacking. Finally, pandemic effects may differ according to age. Research on adults has shown that mental health problems have disproportionately increased in young adults (18-24 olds)¹⁴, but no studies have been conducted as yet on age differences in adolescents. Over the course of adolescence, multiple significant developmental changes occur progressively that correlate with the age and timing of pubertal maturation. These developmental changes may affect the ways in which individuals understand and respond to significant life stressors³³. The effect of the pandemic may therefore differ according to age during adolescence; however, the nature of such potential differences is unknown.

Do changes from before to during the pandemic vary with regional differences in infection rates and restriction measures?

COVID-19 infection rates and the extent of the restrictions imposed vary considerably both across countries and across smaller geographical units within a country, such as municipalities³⁴. It would therefore be important to examine to what degree higher infection rates and stricter restrictions affect adolescents' psychosocial well-being. A study on adults has found that people who predominately physically distanced themselves report higher levels of mental health problems¹⁷, thereby indicating that mental health problems may be higher in areas with more extensive distancing measures. However, there is a lack of studies that directly examine the association between infection rates, restriction severity on the regional level, and psychological well-being in adolescents. Thus, the present study will provide novel

information on how infection rates and infection control measures at the municipality level predict changes in psychosocial variables from before to during the pandemic.

The COVID-19 pandemic in Norway

Despite the relatively low COVID-19 related death rate in Norway, infection control measures in Norway have been similar to those in other European countries³⁴ and include closure of schools, mandatory physical distancing, and severe restrictions on recreational activities. Also in Norway, working from home has been the rule since March 2020. Moreover, during the recent data collection for the present study in 2021 (January to March), COVID-19 infection rates in Norway were of the same magnitudes as in Portugal, Ireland, Iceland, Finland, Denmark, Germany, Belgium, and Italy³⁴.

The present study

In summary, there is an urgent need for methodologically sound, large-scale population-based studies examining consequences of the long-lasting COVID-19 pandemic for adolescents. Using a unique, nationwide dataset comprising 227,258 adolescents, we examine the following three questions: What are the psychosocial consequences of the pandemic for adolescents, one year after its onset? Are adolescents from a disadvantaged background disproportionately affected by the pandemic? Do pandemic effects vary according to geographical variations in infection rates and restrictions? We expect that the pandemic has adverse effects on social relationships (friends, families), mental health, and outlook for the future. And in contrast, we expect to find a decrease in substance use and conduct problems. We expect screen time to have increased, whereas the effect of the pandemic on physical activity is unclear. Despite limited evidence for adolescents, we expect that the pandemic disproportionately affects girls, adolescents in poor families, and adolescents with low parental education. Finally, we expect the effects of the pandemic to vary with the infection rates and restriction measures on the municipality level.

Results

We used data from 227,258 adolescents from 157 municipalities in Norway, collected between 2014 and 2021. Table 1 presents information about the sample according to year of participation. In 2021, 86,597 adolescents participated. Because municipalities typically participate every third or fourth year in the data collection scheme, the number of municipalities included before 2021 was highest in 2018, 2017, and 2015. Response rates were high and ranged from 77% in 2021 to 85% in 2017, except of the year 2020. The response rate in that year was considerably lower (65%) because some school classes did not succeed to participate before schools were closed on March 12 due to the pandemic.

Table 2 presents descriptive statistics for all outcome variables and sociodemographic characteristics across all data collection years. All psychosocial outcomes were scaled as percent of maximum possible (POMP) scores, which can be interpreted as the percentage of the maximum possible scores achievable on the scale³⁵. On average, adolescents were highly satisfied with their social relationships, as they indicated satisfaction above 80% of the maximum score possible. They scored on average on the lower end of the scale for indicators of mental health, substance use, and conduct problems. Moreover, adolescents scored relatively high on physical activity and daily screen time (67%), and 70% of the adolescents reported expecting a happy life in the future. Concerning socioeconomic status, 19% of the adolescents indicated that neither of their parents had higher education, and 5% perceived their family's economic status to be poor.

In a first set of analyses, we examined the effect of the pandemic for each outcome variable by using multilevel regression analyses to construct societal growth curves for all municipalities. Moreover, to estimate the effect of the pandemic, we included a dummy variable indicating participation in 2021, expressing the deviation of the outcome variable during the pandemic over and above the general trend as represented by the societal growth curves. Parental education, gender, and age were included as covariates. We did not include perceived family poverty as a covariate, because parts of the potential adverse effects of the pandemic may be due to increasing financial difficulties in some families. Table 3 presents growth parameters of the societal growth curves and the estimated effect of the pandemic; Fig. 1 presents the results graphically and shows rather stable levels of satisfaction with peer and parental relationships across the years from 2014 to 2021. Moreover, analyses revealed no significant effect of the pandemic in 2021 on either peer or parental relationships, as the dummy variable assessing the average deviation in 2021 from the general trend line was not significant for peer or parental relationships. Depressive symptoms increased substantially from 2014 to 2018 and levelled out thereafter. Depressive symptoms were 2.13 POMP scores higher than expected in 2021, thereby indicating a significant adverse effect of the pandemic on depressive symptoms (see Table 3 and Fig. 1). Loneliness increased linearly from 2014 and thereafter, and increased as such also under the pandemic in 2021. However, no additional adverse effect of the pandemic on loneliness was observed. Concerning substance use, smoking behaviour did not change significantly as a result of the pandemic. In contrast, adolescents reported significantly decreased levels of alcohol intoxication and less use of cannabis in 2021, relative to what would have been expected according to the trend line (a decrease of 2.58 and 0.87 POMP scores, respectively). Physical activity decreased slightly through all years, and we did not see an effect of the pandemic. However, the pandemic had an effect on screen time, as with 1.69 POMP scores in 2021 it increased over and above an already increasing general time trend. Finally, adolescents were less optimistic about their own future during the pandemic, compared with what would be expected according to the general time trend (a decrease of 2.36 POMP scores).

Next, we examined whether adolescents from a disadvantaged background were disproportionately affected by the pandemic. For this purpose, we tested whether the pandemic effect dummy variable indicating changes over and above the general time trend was moderated by low parental education and perceived poverty. Fig. 2 shows the results of the interaction analyses from multilevel models by graphically presenting point estimates of pandemic effects according to sociodemographic characteristics. The results show that adolescents with low parental education were more affected in several domains: The pandemic had greater adverse effects on peer and parental relationships, depressive symptoms, and loneliness, as satisfaction with these relationships decreased more and depressive symptoms and loneliness increased more. There were no significant moderation effects of parental education on drug use and conduct problems; however, both physical activity and screen time decreased more among those with low parental education. Also, the decline in optimism about their future was greater in adolescents with low parental education. Similar results were found when examining perceived family poverty, with more severe adverse effects in the domains of social relationships and mental health for those who perceived the family's economic situation to be difficult. Additionally, adolescents who perceived their family to be poor showed a comparatively smaller decrease in smoking, cannabis use, and conduct problems. As was found for perceived family poverty, physical activity declined more with low parental education, whereas no differences between adolescents in poor families and other adolescents were found for screen time and optimism about their future.

When examining moderator effects for gender and age, we found girls and younger adolescents to be disproportionately affected by the pandemic as compared to boys and older adolescents (Fig. 2). Peer relationships and parental relationships decreased more for girls than boys, whereas depressive symptoms increased more. Moreover, smoking, alcohol intoxication, and conduct problems decreased less for girls relative to boys. Further, physical activity increased less, and screen time increased more for girls, compared to boys. Only loneliness showed an opposite trend, with boys

more affected than girls by the pandemic. Finally, for all variables but cannabis use, older age was related to less adverse effects of the pandemic.

In a final set of multilevel analyses, we examined whether infection rates at the municipality level and the number of weeks with strict local restrictions moderated the effect of the pandemic by including cross-level interaction with these two municipality level variables in the model. Results showed no interaction effects for infection rates ($p > .05$), indicating that municipality level infection rates were not related to changes from before to during the pandemic for any of the assessed psychosocial variables. When we examined restrictions, we found a significant interaction effect only for smoking, indicating that for each week with additional restrictions in schools in a municipality, smoking behavior decreased with 0.15 POMP scores more during the pandemic than in municipalities without such restrictions ($p < .01$).

Discussion

By using a nationwide sample of 227,258 adolescents with measures before and one year into the COVID-19 pandemic, this study provides unique data on the potential effects of the pandemic on key psychosocial aspects in adolescents' lives. By using multilevel societal growth curves to adjust for general time trends, we show that depressive symptoms and screen time increased. Moreover, alcohol intoxication and cannabis use decreased, and adolescents were less optimistic about their future. Most strikingly, we see a consistent association between low parental education/perceived family poverty and adverse effects of the pandemic in several domains of adolescents' lives. In addition, girls and younger adolescents were more affected by the pandemic than boys and older adolescents. Finally, COVID-19 infection rates on the municipality level were not related to how adolescents were affected by the pandemic. Stricter restrictions on the municipality level were related only to a greater reduction in smoking and were not related to the other ten measures of psychosocial well-being assessed in this study.

The effect of the COVID-19 pandemic on adolescents

The results reveal that peer and parental relationships did not change substantially as an effect of the pandemic. These results are in contrast to concerns that peer relations and relationships within the family may suffer during the pandemic¹⁰⁻¹². Instead, the results support voices suggesting that the pandemic, in addition to negative effects on social relationships, may also lead to positive changes, including increased amount of time and attention spent within the family¹³. The combination of these negative and positive changes may lead to no substantial overall changes in satisfaction with peer and parental relationships during the pandemic.

In the domain of mental health, the present study shows that the pandemic seems to have a negative effect on depressive symptoms. The results may be explained by the adverse effects of social isolation, the economic recession, and disruptions in mental health care services due to the pandemic^{1,2}. The results are in line with research on adults showing substantial increases in mental health problems among adults early in the pandemic¹⁴⁻¹⁸. However, the increase of about 2.13 units on a scale from 0 to 100 shows that the effect is of a moderate magnitude and seems to be considerably smaller than what has been found in studies on adults. The rather moderate increases are in accordance with findings from longitudinal studies on adolescents from the beginning of the pandemic that observed rather small changes in mental health problems^{3,6}. Interestingly, contrary to expectations, we found no adverse effect of the pandemic on adolescents' loneliness. This is possibly because adolescents' relationships with peers and parents did not deteriorate during the pandemic. This finding is also in line with a longitudinal study among Norwegian adults that observed stable or even falling loneliness trends during the pandemic³⁶.

From a public health perspective, the pandemic may have affected substance use in a positive way, indicated by the decline in adolescent alcohol intoxications and cannabis use during the pandemic. Physical distancing measures probably reduced the frequency of occasions where adolescents would have used drugs, such as parties and unsupervised meetings with other adolescents. The pandemic may also have forced adolescents to stay at home under parental supervision more frequently, thereby reducing the opportunities to use drugs. Research on adolescents' drug use during the pandemic is scarce; however, our results are in accordance with longitudinal research on adults in the UK²⁰.

Physical activity did not change significantly as a result of the pandemic, whereas screen time increased. It may seem surprising that physical activity did not decrease, because adolescents' opportunities to participate in organized sports activities were severely restricted during the pandemic. However, we may see similar mechanisms as have been found in children and adolescents in Germany, where decreasing organized sports activities were counterbalanced by a substantial increase in recreational physical activities⁷. This potential mechanism is in accordance with evidence from Norway showing that recreational use of urban green space increased substantially during the pandemic³⁷. Increased screen time outside school is in accordance with other studies measuring the effect of the pandemic on adolescents^{7,23} and may be explained by more leisure time spent online and more frequent use of digital media to socialize in times of restricted opportunities for organized leisure time activities and physical distancing measures.

Finally, this is the first study to show that adolescents are now less optimistic about their own future than before the pandemic. We suggest that the pandemic may have challenged adolescents' feelings concerning physical safety and future economic security, which in turn may have increased worries about the future and decreased optimism.

In sum, the findings show negative effects of the pandemic on adolescents' mental health and expectations about their future, but the pandemic has also led to decreased substance use. The observed effect sizes seem to be rather small, with typical increases and decreases of few percentage points.

Disproportional effect of the pandemic on disadvantaged adolescents

The results show that the pandemic has hit disadvantaged adolescents the hardest. Adolescents with low parental education and those from poor families were more negatively affected in several domains, including peer and parental relationships, mental health, and physical activity. Poverty was additionally related to a smaller decrease in smoking, cannabis use, and conduct problems. Our results are in line with research showing that the poor and underprivileged suffer the most in times of crisis²⁸. Other studies have demonstrated that the less educated and the poor are economically more severely affected by the COVID-19 pandemic^{29,30}. Building on these findings, our findings show that adolescents from families with low education and poor economic backgrounds are also affected in a variety of other life domains. The results clearly indicate the need for societal means and measures to reduce the negative impact of the pandemic for underprivileged groups.

Moreover, the results indicate that sociodemographic factors such as gender and age are additional sources of disparities in how the pandemic has affected adolescents' lives. The disproportional adverse effects on mental health for girls are in line with the notion that adolescent girls are more reactive and more likely to become depressed as a consequence of significant stress exposure than boys³⁸. Our results are also in line with two studies demonstrating widening gender disparities for mental health during the pandemic in adolescents and adults^{4,14}. We extend the literature by showing that the pandemic affects girls more severely than boys in other psychosocial domains as well, thereby indicating that gender disparities in the impact of the pandemic extend beyond the mental health domain.

This study is among the first to find that younger adolescents are more affected by the pandemic than older adolescents. These results might be partially explained by the multiple changes associated with puberty that younger adolescents must have undergone; after all, puberty is characterized by dramatic changes in hormone levels that alter adolescents' sensitivity to exogenous stressors³⁹ and as such, younger adolescents might be more sensitive to the negative impact of the pandemic. In contrast, older adolescents might have completed the majority of pubertal changes and acquired increased self-regulatory capacity³³, which may make them less vulnerable to the effects of the pandemic than younger adolescents. It seems reasonable that as young people mature over the course of adolescence (i.e. acquire more cognitive, social, and emotional capacities), they may become better equipped to deal with the impact of the pandemic on psychosocial aspects of their lives.

Few municipality level interaction effects

The results indicated no effect of municipality level variations in infection rates, and also the extent of the imposed restriction measures was only related to smoking behaviour. We believe that such effects were largely not observed because infection rates varied only moderately in Norway. Moreover, by far the most restriction measures in Norway were implemented on the national level, and local variations may therefore have been of minor importance for adolescents' psychosocial well-being. An important future focus of research may be to examine the effects of infection rates and restrictions measures when comparing areas with larger variations in such figures, such as examining cross-country differences.

Strengths and limitations

The study's strengths include the very large sample of adolescents and the repeated cross-sectional design with data collections before and during the pandemic using identical procedures and measures. Moreover, the comprehensive assessment of psychosocial factors in different life domains and the stringent adjustment for overall time trends are additional strengths. However, the results have to be interpreted in light of several limitations. First, concerning measurement issues, we assessed some of the variables (e.g. peer and parental relationships) with one-item instruments only. Future studies should include more comprehensive measures. We operationalized family poverty by an item on perceived family economic situation, and a more objective measure of family income would have been preferable. Moreover, the study did not conduct more extensive assessments of disadvantage, such as ethnic minority status or non-heterosexual orientations. Also, we did not directly assess age but only based on school grade. However, previous Norwegian studies found nearly perfect correlations between age and school grade⁴⁰. Second, compared to other years of data collection, response rates were considerably lower in 2020, because some school classes did not succeed to participate before the lockdown. However, the risk of bias due to the lower response rate in 2020 is low because non-participation was primarily due to random factors such as when the survey was planned to be conducted. Third, generalizability of the results to other countries may be limited, because Norway has had comparably fewer COVID-19 related deaths than many other countries. However, restriction measures and infection rates have been similar to those in other European countries. Fourth, even though our analyses provide sound knowledge about changes in a variety of psychosocial variables about one year after the onset of the pandemic while accounting for general time trends, the study does not provide definite evidence of causal effects of the pandemic. We acknowledge that deviations from the general trend during the pandemic in 2021 may partly be caused by societal changes in this year that are unrelated to the COVID-19 pandemic.

Conclusion

This study provides solid evidence that as a result of the pandemic, adolescents' depressive symptoms and time spent in front of a screen increased, whereas adolescents' optimism about their future decreased. Alcohol intoxication and

cannabis use decreased. The effects were of only moderate size and may in themselves not indicate alarming adverse effects of the pandemic. However, of concern is the consistent finding that girls, young adolescents, and adolescents with a low socioeconomic background seemed to be affected more by the pandemic. This finding indicates that the pandemic, in line with other crises, disproportionately affects the disadvantaged. And similar to other crises, the disproportionately negative effects may be long-lasting and affect the disadvantaged negatively far beyond the duration of the pandemic²⁴. It is therefore imperative to develop and implement measures such as economic support and public health interventions that are aimed at buffering the effects of the pandemic for adolescents and their families with low socioeconomic resources. Moreover, the particular vulnerability of girls and the youngest adolescents have to be taken into account when developing interventions. Norway is a typical social democratic welfare state⁴¹, characterized by rather extensive social welfare services and benefits, including a universal health insurance system, which may buffer the economic, health, and psychosocial effects of the pandemic on the disadvantaged. Arguably, the COVID-19 pandemic may therefore lead to even larger social disparities among adolescents in other countries that have less generous social security systems. Research on the effect of the pandemic on social disparities in other countries will therefore be an important research focus in the future.

Methods

Data and participants

The present study used data from Norwegian nationwide *Ungdata* surveys. *Ungdata* is a national data collection scheme designed to conduct youth surveys at the national and municipal levels in Norway. It is regarded as the most wide-ranging source of data on adolescent health and well-being in Norway, and adolescents in almost all municipalities are regularly assessed, typically every third year. The *Ungdata* data collection scheme was started in 2010 but has been fully implemented for all junior and senior high school students (grades 8 to 13, students aged 13 to 18) since 2014. Participating students were invited to complete an electronic questionnaire in class, covering various aspects of young people's lives, including social relationships, mental health, substance use, health behaviour, norm-breaking behaviour, exposure to negative life events, and leisure activities.

Data collection was conducted each spring. Also in 2020, data collection started in January but was discontinued when schools were closed in Norway on March 12. At that time, only some of the participating municipalities had finished considerable parts of the data collection. In 2021, 204 municipalities participated in *Ungdata* from January to the end of March. Of those, data from 43 municipalities were not used because one or several of outcomes, predictors, or controls were not assessed in these municipalities. Furthermore, four municipalities that had not conducted any *Ungdata* surveys before 2021 were excluded. Of the remaining 157 municipalities, 43, 70, 41, and three municipalities had conducted one, two, three, and four data collections before 2021, respectively. In total, we used data from $N = 227,258$ adolescents in 157 municipalities who had participated in *Ungdata* in 2021 and at least at one previous data collection. All participants and their parents were informed that participation in *Ungdata* is voluntary. Parents had the possibility to reserve their children from participation. All relevant ethical regulations were followed, and the study was recommended by the Department of Psychology's internal research ethics committee at the University of Oslo (reference # 13710027).

Measures

Social relationships. Peer relationships were assessed by one item asking how satisfied the respondents were with their friendships with peers. Parental relationship was assessed in a similar way by asking how satisfied the respondents were with their parents. Both items were measured by a 5-point scale ranging from *very unsatisfied* to *very satisfied*.

Mental health. Depressive symptoms were measured by Kandel and Davies' 6-item Depressive Mood Inventory⁴². This measure was derived from the widely used Hopkins Symptom Checklist⁴³ and assesses depressive symptoms during the preceding week on a 4-point scale from *affected not at all* to *affected extremely*. In the present study internal consistency was $\alpha = .89$. Loneliness was assessed by one item on feelings of loneliness in the last week, with the same response options.

Substance use and health behaviour. Adolescents' smoking behaviour was assessed, which we categorized into those who did not smoke (1), smoked less than once a week (2), smoked every week but not daily (3), and daily smokers (4). Alcohol intoxication was assessed by asking how often over the past year participants had consumed so much alcohol that they clearly felt intoxicated. We also assessed cannabis use in the past year. Conduct problems were assessed by a 5-item instrument on the frequency of stealing, vandalism, tagging, truancy, and not paying at public transportation or events. A composite score of the five items was computed. Response options for alcohol intoxication, cannabis use, and conduct problems items were on a 5-point scale ranging from *never* to *more than 10 times*.

Physical activity and screen time. Respondents' physical activity was assessed by asking how often they engaged in physical activity that caused them to breathe harder or break a sweat, on a scale ranging from 1 (*never*) to 6 (*at least five times a week*). Screen time was assessed by asking respondents about their daily use of screens outside of school with response options ranging from 1 (*no time*) to 6 (*more than 3 hours*).

Future life expectations. Future life expectations were assessed by one item about whether respondents expected to live a good and happy life. Response options were *yes*, *no*, and *don't know*. We contrasted those who responded that they expected to live a good and happy life (*yes*) with all other adolescents (*no* and *don't know*).

Indicators of socioeconomic status and other demographics. Low parental education was operationalized by whether at least one of the parents had a university or college education or not. Perceived family poverty was measured by asking "Has your family's economic situation been good or bad during the past two years?", with five response options ranging from *always good* to *always bad*. We contrasted those who perceived the family's economic situation as *mostly bad* or *always bad* with all other adolescents. Gender was assessed. For anonymity concerns, only school grade (Grades 8 to 13) but not age was assessed. In the Norwegian school system, attendance in school grades is strictly organized by birth cohorts, and staying back (repeating a grade) due to poor academic performance is generally not practiced. Therefore, we used school grade as an indicator of age, where Grade 8 corresponds to age 13 and Grade 13 corresponds to age 18.

Municipality level variables. Municipality level data on total COVID-19 infection rates per 100,000 residents from the onset of the pandemic to March 31, 2021 were obtained from the Norwegian Surveillance System for Communicable Diseases. Because restrictions to control the spread of the COVID-19 pandemic varied across municipalities, we used a database of all restrictions on the municipality level that is operated by one of the largest national newspapers in Norway, *Verdens Gang*. The database is continuously updated by direct contact with the municipalities and by monitoring municipality webpages, official documents, and official announcements. We identified all registered restrictions that were directed towards junior and senior high schools in the municipalities, as they were the only restrictions that were specifically directed towards adolescents, and we calculated the number of days with stricter restrictions in municipalities than what had been imposed by national authorities.

Analyses

To provide a scaling of all psychosocial outcome variables that is easily interpretable and allows comparison across measurements, we transformed all dependent variables into POMP scores³⁵. Thus, in line with the POMP score

approach, variables were rescaled with minimum and maximum possible scores of 0 and 100, respectively. Scores can be interpreted as the percentage of the maximum possible score achievable on the scale³⁵.

Due to the hierarchical structure of the data, with individuals nested within municipalities observed repeatedly over time, we used multilevel regression models in all analyses. In particular, we applied the ‘societal growth curve’ approach to multilevel modelling, as introduced by Fairbrother⁸. This approach was specifically developed for designs such as *Ungdata*, where multiple geographical units (e.g. municipalities) are observed across time, but at each point of observation, a different representative cross-sectional sample of individuals is drawn from the population^{44,45}. The method thus allows assessment of how aggregated individual characteristics develop over time within repeatedly sampled higher-level units (i.e. municipalities). More specifically, using multilevel linear regression analyses, we constructed growth curves for each municipality to model time trends on the municipality level from 2014 to 2021 for indicators of psychosocial well-being. All models were estimated as random-intercept multilevel linear regressions with individuals at the lowest level, clustered within municipality years at the middle level, and municipalities at the highest level. The inclusion of random intercepts at the municipality-years level and municipality level was also supported empirically, since variability in the random intercepts at the higher levels was found to be significantly different from zero for all outcomes ($p < .05$).

The overall pattern of change over time was modelled as a curvilinear trend, through inclusion of both linear and quadratic terms for number of years that had passed since the first included survey wave in 2014. Additionally, we measured the effect of the pandemic in 2021 over and above the curvilinear development by including a dummy variable for the 2021 wave (coded 1 for participating in the 2021 data wave and 0 for participation in all other data waves; for another application of this approach, see⁴⁴). Due to convergence issues, societal growth curve slope parameters and the pandemic effects were fixed to be the same across all municipalities. More specifically, the societal growth model was specified by means of the following equation

$$Y_{itj} = \beta_0 + \beta_1 time_{tj} + \beta_2 time_{tj}^2 + \beta_3 dummy_{tj} + v_{0j} + u_{0tj} + \varepsilon e_{itj}$$

$$\text{with } e_{itj} \sim N(0, s_e^2)$$

$$u_{0tj} \sim N(0, s_u^2)$$

$$v_{0j} \sim N(0, s_v^2)$$

where Y_{itj} represents a psychosocial characteristic for adolescent i at data collection wave t in municipality j . β_0 represents the grand intercept across all municipalities, and β_1 and β_2 represent the linear slope and quadratic slope of the societal growth curve, respectively. β_3 is the coefficient for the dummy, indicating the deviation of the dependent variable in the pandemic year of 2021 over and above the general trend as expressed by the growth curve. Moreover, the model includes random intercepts for the municipality (v_{0j}) and municipality-year level (u_{0tj}). The two, together with the individual-level error term (e_{itj}), are assumed to be distributed normally, with a mean of 0.

Because all dependent variables were recoded into POMP scores, the pandemic effect can be interpreted in terms of percentage-point change of the percentage of the maximum possible score achievable on the scale³⁵. We controlled for parental education, gender, and age (not shown in the equation) to adjust for individual-level compositional differences that may have affected the societal growth curves or the estimated effect of the pandemic⁴⁶.

To examine whether the pandemic disproportionately affected particular groups of adolescents, we included interaction terms of the pandemic effect variable with the individual-level predictors of parental educational background, perceived

family poverty, gender, and age. We then calculated point estimates of these conditional effects for specific values of moderator variables⁴⁷. We also explored whether the impact of the pandemic varied with municipality infection rates and extent of imposed restrictions. For this purpose, we included cross-level interactions of the pandemic effect with infection rates and extent of restriction measures.

In line with best practices for multilevel modelling⁴⁸, all predictors and controls were grand-mean centred to facilitate interpretation of the estimates. We used R version 4.0.3 for all analyses. All multilevel regressions were conducted using the *lme4* package for R, version 1.1.26⁴⁹. The *interplot* package for R, version 0.2.3⁵⁰ was used to estimate conditional effects for interaction analyses.

Declarations

Data availability

The data that support the findings of this study are available from Norwegian Social Research (NOVA) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Norwegian Social Research (NOVA).

Code availability

The code for all analyses reported in the manuscript is available on request.

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Tables

Table 1

Sample characteristics according to data collection year

	2014	2015	2016	2017	2018	2019	2020	2021	Total
Number of individual observations	11,719	24,694	10,555	44,103	30,246	8,792	10,552	86,597	227,258
Number of participating municipalities	31	61	33	75	66	16	36	157	157
Average response rate (%)	80	81	78	85	81	81	65	77	79

Note. Data from 2020 were collected before the lockdown due to the COVID-19 outbreak (i.e. before March 12, 2020).

Table 2

Descriptive statistics and intercorrelations for variables under study

	<i>M</i>	<i>SD</i>	Range	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Social relationships																	
(1) Peer relationships	84.85	25.08	0-100														
(2) Parental relationship	85.66	26.93	0-100	0.55													
Mental health																	
(3) Depressive symptoms	35.80	26.65	0-100	-0.23	-0.23												
(4) Loneliness	28.34	33.34	0-100	-0.31	-0.21	0.68											
Substance use and conduct problems																	
(5) Smoking	5.09	16.52	0-100	-0.03	-0.11	0.13	0.08										
(6) Alcohol intoxication	21.05	32.95	0-100	0.01	-0.07	0.18	0.08	0.41									
(7) Cannabis use	3.38	14.89	0-100	-0.04	-0.10	0.12	0.08	0.44	0.35								
(8) Conduct problems	8.25	13.04	0-100	-0.07	-0.18	0.24	0.16	0.38	0.40	0.39							
Physical activity and screen time																	
(9) Physical activity	71.54	24.27	0-100	0.10	0.11	-0.14	-0.15	-0.09	-0.04	-0.05	-0.05						
(10) Screen time	67.02	23.04	0-100	-0.05	-0.07	0.21	0.17	0.07	0.09	0.07	0.16	-0.16					
Future expectations																	
(11) Expecting a happy future	70.40	45.65	0-100	0.18	0.19	-0.42	-0.37	-0.07	-0.04	-0.07	-0.13	0.17	-0.15				
Sociodemographics																	
(12) % with low parental education	19 %			-0.04	-0.06	0.04	0.05	0.08	0.08	0.03	0.04	-0.13	0.03	-0.05			
(13) % with perceived family poverty	5 %			-0.10	-0.16	0.17	0.15	0.08	0.05	0.07	0.11	-0.08	0.05	-0.13	0.12		
(14) % girls	50 %			-0.04	-0.04	0.32	0.21	-0.06	0.02	-0.07	-0.07	-0.11	-0.04	-0.07	-0.10	0.03	
(15) Age	15.30	1.60	13-18	0.00	-0.02	0.15	0.08	0.18	0.53	0.15	0.16	-0.08	0.07	-0.04	0.13	0.05	0.03

Note. Intercorrelations of $r = |.01|$ or above are statistically significantly different from zero at $p < .001$. Continuous measures (except for age) are scaled as percent of maximum possible (POMP) scores, with a minimum score of 0 and a maximum achievable score of 100. *M* = mean; *SD* = standard deviation.

Table 3

Societal growth curve estimates from 2014 to 2021 and estimated effects of the pandemic for 11 indicators of psychosocial well-being

	Societal growth curve estimates of time trends			Estimated effects of the pandemic	
	Intercept (β_0)	Linear slope (β_1)	Quadratic slope (β_2)	β_3	95% confidence interval
Social relationships					
Peer relationships	84.83***	-0.16	0.02	-0.55	[-1.45; 0.35]
Parental relationships	85.88***	0.31**	0.01	-0.48	[-1.40; 0.45]
Mental health					
Depressive symptoms	36.08***	0.38**	-0.21***	2.13***	[0.99; 3.27]
Loneliness	27.93***	0.77***	-0.02	0.70	[-0.62; 2.02]
Drug use and conduct problems					
Smoking	4.94***	0.03	0.04	-0.42	[-1.26; 0.43]
Alcohol intoxication	20.42***	0.64**	0.26***	-2.58**	[-4.41; -0.74]
Cannabis use	2.78***	0.26***	0.03	-0.87**	[-1.52; -0.22]
Conduct problems	7.29***	0.24**	0.04	0.61	[-0.09; 1.30]
Physical activity and screen time					
Physical activity	71.22***	-0.26*	-0.01	0.57	[-0.61; 1.75]
Screen time	66.47***	1.70***	0.07*	1.69**	[0.65; 2.73]
Future expectations					
Expecting a happy future	69.25***	-0.18	0.26***	-2.36**	[-4.12; -0.60]

Note. * $p < .05$, ** $p < .01$ *** $p < .001$. Due to mean centering, the intercept of societal growth curves (β_0) can be interpreted as the estimated value between 2018 and 2019 (2018.5). Linear and quadratic slope parameters represent change from one year to the next.

Figures

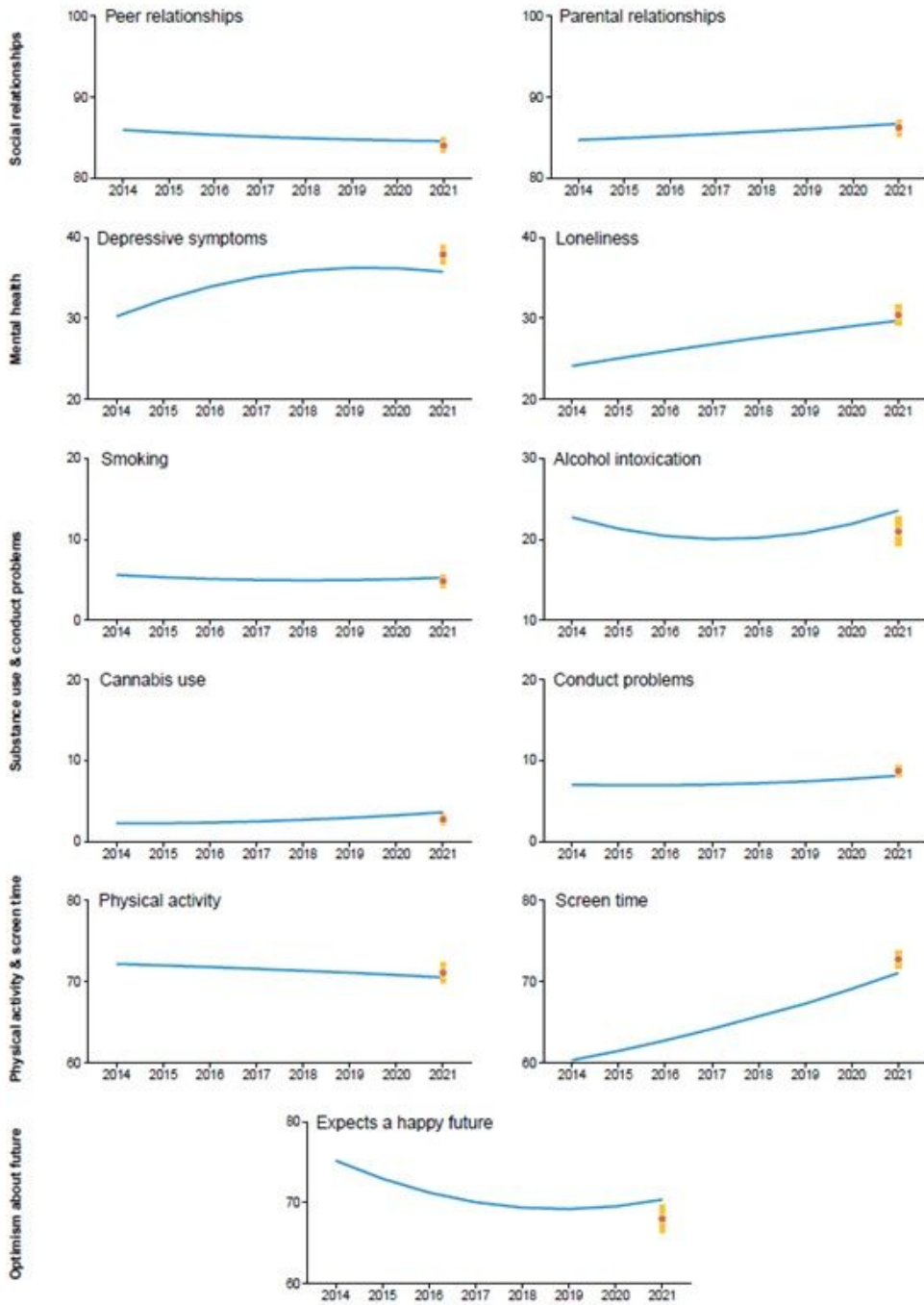


Figure 1

Time trends in psychosocial aspects of adolescents' lives from 2014 to 2021 and the estimated effect of the pandemic. Note. The blue line indicates the time trends in adolescent psychosocial well-being from 2014 to 2021 as estimated by societal growth curves. The red dot represents the average estimated value during the pandemic in 2021, and the 95% confidence interval is represented by orange bars. Data from 2020 were collected before the lockdown due to the COVID-19 outbreak (i.e. before March 12, 2020).

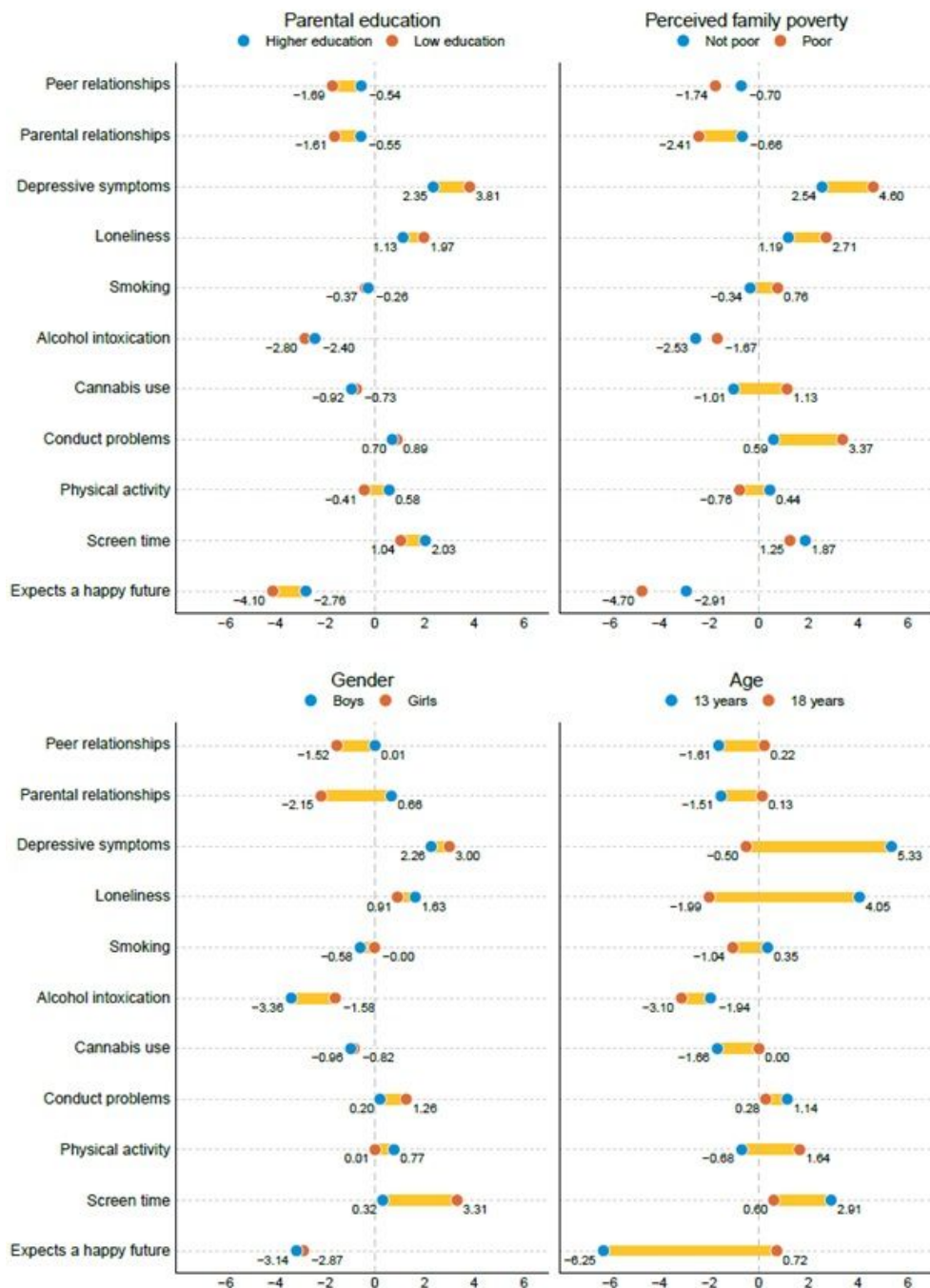


Figure 2

The effect of the pandemic according to indicators of disadvantage, gender, and age. Note. Blue and red dots indicate point estimates of the effect of the pandemic for specific groups of adolescents, as estimated by conditional effects analysis. The orange bars represent statistically significant differences ($p < .05$) of the pandemic effects for different groups of adolescents. Tests of significance were provided by interaction analyses in multilevel models.

Supplementary Files

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