

# Adverse Teenage Behavior and its Indicators

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## **Abstract**

I aim to identify indicators of various adverse behavioral traits in teenagers to gain a better understanding for how such behavioral traits are correlated with typical teenage activities and habits. In doing so, I leverage a comprehensive set of Norwegian survey data covering a broad array of categories of teenage life, from social interactions and family dynamics, to physical and mental health, and expectations about the future, all to get an understanding for how different habits and lifestyles correlate with different types of adverse behaviour.

The problem is approached in two parts. Firstly, I conduct a purely correlative study of which teenage habits correlate with proven adverse elements of teenage life, in which I find that activities like physical activity, out-of-school employment, gaming, and extracurricular involvement all are significantly correlated with outcomes like depression, substance use, violence, and more. Secondly, I turn to a causal study of how shocks to society can affect the teenage behavior in question, in which I focus on behavioral changes over the pandemic. In this part, I find strongly significant results of increased county-level Covid prevalence increasing depression, substance use, and non-productive screentime, and decreasing elements of teenage life like physical activity, social connections, and life quality.

All source code to duplicate the below graphs and regressions can be found at [https://github.com/madsgroholdt/Econ1425\\_term\\_project](https://github.com/madsgroholdt/Econ1425_term_project).

# 1 Introduction

There has in the past been found strong evidence of teenage behaviour predicting adult outcomes (1). Among many papers written on the topic, (McCambridge, 2011) shows that elevated levels of teenage alcohol consumption leads to life-long elevated levels of alcohol consumption, which has been long proven to lead to substantial physical and mental health costs, among other things(2). Not only does such behavior negatively impact the individual, but decreased standards of health have proven to have substantial costs to society as well (Santos, 2022)(3). This is one of many examples of adverse teenage behavioral traits that have been proven to spill over to adult life and have both individual and societal costs.

Because of these dynamics, it should be an essential task for policymakers to find new ways of identifying adverse behavioral traits in both individual and groups of teenagers early, and thereby be able to employ preventative measures early enough to avoid spillovers into adult life, as this not only would benefit the individuals being saved from a life of sub-optimality, but it would in many cases also save the government future capital that would have gone into supporting said individuals.

In this paper, I wish to explore potential indicators of various adverse teenage behaviours in an effort to identify groups of teenagers that could use particular attention and preventative measures toward mitigating potential sub-optimal lifelong outcomes. In doing this I will first reference previous literature identifying adverse teenage behavioral traits, and then proceed to conduct a correlative study on those traits against indicators of teenage behavior. Mainly, I will look at the correlative relationship of physical activity, video gaming, religious involvement, and extracurricular involvement, and identify how these different activities might indicate different levels of sub-optimal behavior in an individual or a group. I will also address how different variables correlate with an individual's ability to confide in those around them, which has been proven to be important in mitigating adverse behavior(4).

Additionally to the correlative investigation, I will conduct a causal investigation into how a shock to society, in this paper proxied by the Covid-19 pandemic, can affect adverse teenage

behavioral traits, and how such shocks might affect some demographics and communities more extremely than others. The goal of the paper is to provide guidance for policymakers, parents, and others that are invested in the later-in-life outcomes of teenagers, to hopefully allow them to more easily identify adverse behaviour among the teenagers in their life and begin mitigating such behaviour when appropriate.

The paper will be structured as follows. Firstly, in section 2, I will summarise relevant literature that justifies my choices of adverse behavioral traits as dependent variables. Then, section 3 will present and describe the main survey data and other data sources used in both the correlative and the causal study. In presenting the findings of my research I will first describe the structure and results of the correlative study in section 4, before building on the correlative study with a causal investigation of Covid-19 and teenage behavior in section 5. Lastly, I will tie the findings of my correlative and causal investigations together in the conclusion of the paper, found in section 6.

## 2 Literature Review

An adverse behavioral trait among teenagers that has increased in prevalence over time, and subsequently become a popular area of research, is depression. Among the many articles written on the topic, (Maughan, 2013)(5) presents evidence toward elevated levels of adolescent and teenage depression increasing later-in-life adverse outcomes like suicidality, decreased social functionality, and worsened physical and mental health. Additionally, they find that depression shows signs of familial transmission across generations, thereby making it particularly important to mitigate as it potentially could lead to generations of sub-optimal outcomes.

As mentioned in the introduction, teenage consumption patterns of alcohol have proven to solidify themselves into adulthood (McCambridge, 2011)(2), for which there also has been presented strong evidence that elevated levels of lifelong alcohol consumption has a

significant impact on physical and mental health (U.S. govt, 2023)(6). In addition to alcohol consumption, other articles like (Haller, 2010)(7) show that adolescent drug abuse lead to even more adverse adult outcomes than alcohol consumption, with drugs like marijuana, cocaine, and LSD all showing strong decreases in adult performance and health. Because of this coherent pattern of alcohol- and substance-use among teenagers leading to adverse adult outcomes, the investigation of indicators related to an aggregate substance use variable seems appropriate.

Violent behaviour is another youth behavioral trait that has proven to continue cascading into an individual's adult life. (Juon, 2006) presented evidence of adolescent aggression being associated with a higher probability of adult incarceration and conflict(8). Similarly, (Harding, 2009) shows that violence has a negative impact on high school graduation rates(9), providing a strong incentive for understanding how one can mediate teenage violent behavior, outside of the physical harm typically involved in violent altercations.

In addition to depression being found to have adverse consequences in regard to both physical and mental health, teenage loneliness has been shown to lead to similar adult outcomes. (Goosby, 2013) shows that higher levels of teenage loneliness has been shown to lead to early-adulthood outcomes like poorer mental health, higher risk of cardiovascular disease, and adult depression(10). This implies that one would want to mitigate teenage loneliness and ensure that as many individuals have a functioning social life that, at the least, is satisfactory on their own scale. Because of this it could be useful to understand which activities lead to friendship and social bonds among teenagers as they in a way represent the inverse of loneliness.

Aside from literature tying different adolescent behavioral traits to adult outcomes, there has been little literature attempting to uncover indicators or patterns of adverse adolescent behavior in the way this paper attempts to. Current literature, like (Chimchenga, 2009)(13) and (Muna, 2020)(14), focuses mainly on small samples and qualitative analysis of specific communities rather than the large-sample, multi-region quantitative approach taken in this

paper.

### 3 Data

The main source of data used in the article is "Ungdata"(11), a Norwegian survey administered to teenagers in middle- and high-schools around the country. It has been completed with strong geographical coverage since 2010 and covers a vast array of aspects from teenage life like social- and parental relationships, school enjoyment and performance, extracurricular activities, mental and physical health, and substance use. The survey is administered and maintained by NOVA(12), which is the leading community for research on youth and teenagers in Norway.

The data set issued by NOVA is comprehensively cleaned to ensure response samples that correspond well with the population they are intended to provide insight about. Some of the methods employed include pattern recognition in answers, meaning that an individual's response is deemed as unrealistic if they answer, for example, "6+ times per week" for all 10+ options of extracurricular activities given in a section. Additionally to such pattern recognition for individual segments of the survey to be excluded, an individual's survey will be deleted completely if their responses are concluded to be unrealistic or non-serious across multiple segments. Formally, it will be deleted if  $\sum_{i=1}^N \mathbb{1}\{C_i = \text{non-serious}\} > 2$ , where  $C_i$  represents one of the  $N$  total categories of questions where non-serious responses can be detected. This, together with other measures taken by the issuing entity ensures that most of the responses in the final data set are made with good intent and not simply motivated by finishing the survey quickly or answer non-seriously.

The survey is anonymous, meaning that it is not possible to obtain panel data with individually tagged responses over time. The survey responses are however tagged with the county the individual belongs to, which I leverage in the causal analysis of Covid-19 and its affects on teenage behavior later in the paper. Additional informative data in the data

set aside from the survey responses include the individual’s grade level, gender, and general parental information related to socioeconomic and marital status, among other things.

The responses of the data set can be broken down as follows, with number of responses, number of counties represented, and the minimum per-county number of responses per year as:

Table 1: Survey Response Information

<b>Year</b>	<b># responses</b>	<b># counties</b>	<b>min. sample</b>
2010	16,941	24	92
2011	10,112	16	102
2012	21,102	22	122
2013	72,133	69	93
2014	36,559	29	112
2015	60,255	50	93
2016	57,652	55	101
2017	88,708	62	89
2018	57,826	39	134
2019	105,794	75	196
2020	18,264	25	286
2021	116,788	73	286

As can be observed from the response-sizes, the survey has consistently increased in popularity both in terms of the number of counties participating and the number of total respondents. It can be observed that 2020 has an anomalously low response count, which is due to the fact that surveys no longer were completed after the onset of the pandemic in March 2020. Additionally, despite the low sample size in the 2020 survey submissions, it has much larger county overlap with 2021 than 2019, with 19 counties completing the survey in both 2020 and 2021, while only 7 counties completed it in 2019 and 2021. This fact is utilized in the causal study in section 5, as it makes for a very accurate pre-pandemic sample.

The data set has a total of  $N = 793,879$  responses over 11 years of survey data and has a total of 1190 variables. This is however somewhat of a misrepresentation of the number of questions asked students, as the main module of the survey consists of 174 questions, with all 1016 additional questions being optional extra categories the counties each can

choose to administer at their own will. In addition to using the standard survey variables, I have created various aggregate variables to represent different types of adverse behavior, like depression or physical activity.

Aside from the "Ungdata"-survey, I have stitched various other data sources to the survey data at a county level, which are mostly utilized as controls, as well as in creating a Covid-prevalence regressor. These data include:

- **County-level # of Covid infections:** Total number of Covid-cases detected in 2020 and 2021 in each Norwegian county. Obtained from the Norwegian Health Institute.
- **County Population:** Citizens per county. Obtained from Norwegian Statistical Bureau.
- **County-level population density:** Average number of citizens per sq. km in the county. Obtained from Norwegian Statistical Bureau.
- **County-level median income:** Measure of 2021 median income among working population in county. Obtained from Norwegian Statistical Bureau.
- **County-level Unemployment:** Percentage of county population defined as unemployed by the Norwegian Statistical Bureau, for each year and county in the survey. Obtained from Norwegian Statistical Bureau.

## 4 Adverse Behavior and its General Indicators

For the initial part of the paper, my motivation is to uncover the correlative relationship of different types of teenage behavior and attempt to understand to what extent such behavior or habits can be used as a way of understanding whether an individual is more likely to struggle with different types of adverse teenage behavior. As previously mentioned, this section is not intended to be causal, but rather focuses on how a teenager doing a certain activity or having a certain hobby might be more likely to also struggle with a specific issue.

In exploring this, I focus on four main types of teenage habits or activities, which make up the main regressors in my analysis:

- **Physical Activity:** Aggregate measure of physical activity. Defined as the un-weighted sum of
  - "How often are you so physically active that you get sweaty or out of breath?". Answered at a range of 1 (Never) to 6 (At least 5 times a week).
  - "How often do you do other organized training (dance, martial arts, etc.)?". Answered at a range of 1 (Never) to 6 (At least 5 times a week).
  - "In the last 7 days, how many times where you so physically active that you got sweaty or out of breath?". Answered at a range of 1 (No days) to 5 (7 days). (This variable is multiplied by 1.2 in the sum to ensure the same scale as the other 2 variables.)
- **Playing video games:** Single question defined as: "How much time per day do you typically spend on playing TV- or computer-games?". Answered at a range of 1 (No time) to 6 (> 3 hours).
- **Religious Involvement:** Single question defined as: "How important is religion in your day-to-day life?". Answered at a range of 1 (Very important) to 4 (No meaning in my life). This value has been negated in all regressions to account for the fact that higher religious involvement corresponds to a lower response value.
- **Extracurricular involvement:** Single question defined as: "Are you, or have you previously, been part of an extracurricular organization, team, or club after turning 10 years old?" Answered as of 1 (Yes, I am in one), 2 (No, but I have been in one), or 3 (No, I have never been in one). This variable has been negated in all regressions to account for the fact that higher EC involvement corresponds to a lower response value.



All the above-defined variables, along with the various dependent variables I address, have been standardized to have a max value of 100. The above defined variables are used as regressors for each of the dependent variables, together with a number of fixed effects. The regression run for each dependent variable can be defined as

$$Y_i = \beta_0 + \beta_1 \text{Phys. Activity}_i + \beta_2 \text{Gaming}_i \\ + \beta_3 \text{Religion}_i + \beta_4 \text{EC}_i + \delta_t + \alpha_i$$

Where  $\delta_t$  represents time fixed-effect (survey submission year), and  $\alpha_i$  is a vector of individual fixed-effects consisting of: County of residence, socioeconomic status, school grade, gender, and level of neighborhood amenities.

## 4.1 Results

Turning to the results from the above-defined regression, some interesting results can be found. Below are the various dependent variables representing adverse aspects of teenage life and their correlative relationship with the previously mentioned teenage habits. All standard errors in the regressions have been clustered at a county level. All of the regressors have also been standardized on a scale from 0 - 10 to allow for accurate comparisons of the coefficients, while each dependent variable is standardized to be between 0 and 100, to allow for more easily readable coefficients as well as cross-table comparisons. Many of the correlations show extremely strong significance, which is intuitive as the relationships often are logical and the results in this section of the paper are intended to provide empirical evidence for whether or not certain biases and societal beliefs hold true.

### 4.1.1 Depression

The dependent variable representing depression is an aggregate variable created as an un-weighted sum of the following series of depression-related survey questions: "How bothered have you been by ...?":

- Feeling like everything is a struggle
- Having trouble sleeping
- Feeling unhappy, sad, or depressed
- Feeling lonely
- Feeling stiff or tense
- Feeling worried about things
- Feeling hopelessness about the future

These are all answered at a range of 1 (Not bothered at all) to 4 (Very bothered). These are all classified as "depression-related survey questions" by NOVA, the issuing entity of the survey, and I therefore chose to combine them to get a robust measure of an individual's level of depression.

In the regression table on the following page we can see that level of depression is significantly positively correlated with more time spent playing video games, as well as lower levels of physical activity and less involvement in extracurricular activities. This suggests that if elevated levels of gaming, or decreased levels of EC-involvement or physical activity are observed for individuals or at an aggregate school- or county-level, preventative measures against depression could prove effective in improving teenage life quality in the region. As can be observed from the coefficients, physical activity is strongly negatively correlated with depression compared to the other variables, while more video gaming conversely is strongly positively correlated with higher levels of depression.

Although this shows no causal relationship, it provides evidence toward elements of life that are quite easily detectable, like physical activity, video gaming, and extracurricular involvement, can prove useful in detecting depression, which often can be much more difficult to identify. The findings suggest that if it is observed that an individual is lacking physical activity and is spending vast amounts of time playing video games, it may be fitting to pay particular attention to the individual's mental health.

Table 2: Dependent Variable: Aggregate Level of Depression Indicators

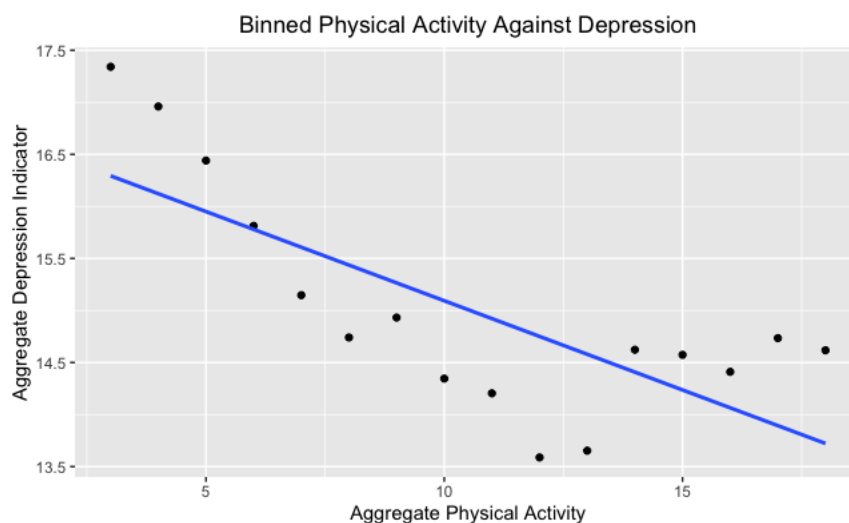
	Model 1	Model 2	Model 3	Model 4	Model 5
Physical Activity	−0.74*** (0.04)	−1.05*** (0.03)			
Gaming	0.72*** (0.03)		0.63*** (0.02)		
Religious Involvement	−0.43** (0.16)			−0.39** (0.13)	
EC Involvement	−0.29*** (0.03)				−0.31*** (0.03)
Num. obs.	104000	107422	434518	304559	441610
Num. groups: Year	2	2	8	6	8
Num. groups: County	77	77	171	166	171
Num. groups: Socioec. Status	11	11	11	11	11
Num. groups: School Grade	6	6	6	6	6
Num. groups: Gender	2	2	2	2	2
Num. groups: Neigh. Amenities	17	17	17	17	17
R <sup>2</sup> (full model)	0.18	0.11	0.13	0.13	0.17
Adj. R <sup>2</sup> (full model)	0.18	0.10	0.13	0.13	0.17

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

Although physical activity is correlated with lower levels of depression overall, it is not to say that all increased levels of physical activity are correlated with lower levels of depression across its entire domain. From the below binned scatter plot, it can be observed that the downward trend in depression with physical activity actually seems to turn around at approximately the 90th percentile, where higher levels of physical activity actually turns to be positively correlated with higher levels of depression. This could perhaps represent

the proportion of teenagers doing elite level sports, which compared to more recreational levels of physical activity comes with substantial sacrifices in terms of lifestyle. Particularly elements of teenage life like social interaction (through parties etc.) come at an opportunity cost for elite athletes, which likely could contribute to higher levels of depression together with elements like high stress, pressure on oneself and from others, among with other factors elite athletes deal with.

Aside from elite athletes, elevated depression levels among teenagers enduring excessive exercise could also arise from the fact that this is prevalent among individuals suffering from various eating disorders and other cases of body dysmorphia, which are proven to have a causal relationship with depression.



#### 4.1.2 Substance Use

The dependent variable for substance use is defined as an unweighted sum of questions related to frequency of use of various substances. The aggregate variable is constructed from question responses to the 4 survey questions "Do you ...?":

- Drink alcohol
- Use chewing tobacco
- Smoke cigarettes
- Smoke marijuana

All of the above questions are answered at a range of 1 (Never done it) to 5 (Do it every day).

The below regression table shows that substance use is significantly decreasing with all the independent variables. The decrease with religious involvement was expected, considering that many religions have a negative consensus toward use of various substances. It is also not particularly surprising that extracurricular involvement and physical activity decreases substance use, as one can view individuals with lower EC-involvement or physical activity as having lower opportunity costs of spending time consuming various substances. With substance use being one of the most proven adverse behavioral traits of teenagers, knowledge of these elements could prove useful in perhaps funnelling teenagers with little athletic, religious, or extracurricular engagement into one or more of such categories.

Table 3: Dependent Variable: Aggregate Level of Substance Use

	Model 1	Model 2	Model 3	Model 4	Model 5
Physical Activity	−0.24** (0.07)	−0.35*** (0.07)			
Gaming	−0.38*** (0.05)		−0.14*** (0.03)		
Religious Involvement	−1.11*** (0.12)			−1.20*** (0.05)	
EC Involvement	−0.50*** (0.03)				−0.43*** (0.06)
Num. obs.	105568	109207	452059	311686	462218
Num. groups: Year	2	2	8	6	8
Num. groups: County	77	77	171	166	171
Num. groups: Socioec. Status	11	11	11	11	11
Num. groups: School Grade	6	6	6	6	6
Num. groups: Gender	2	2	2	2	2
Num. groups: Neigh. Amenities	17	17	17	17	17
R <sup>2</sup> (full model)	0.24	0.22	0.23	0.24	0.23
Adj. R <sup>2</sup> (full model)	0.24	0.22	0.23	0.24	0.23

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

### 4.1.3 Violence

The dependent variable for violence is defined from a single question as "How many times have you been in a physical fight?". It is answered on a range of 1 (Never) to 5 (11 times or more). Regressing it on the variables related to teenage habits we find that lower levels of EC-involvement increases violent behavior with strong significance. This could similarly

to the results about substance use in section 4.1.2 be eluding to the fact that individuals with low levels of EC-involvement have less to spend their time on, which leads them into more situations where violent situations could arise. It could also be correlated with the fact that teenage violence often happens in a period where substances are used, meaning that violent behaviour likely also could be correlated with the fact that the group consumes more substances. We can also see that playing video games increases violence, which has been a long-lasting debate around violent video games, which likely is the reason for the relationship.

Interestingly, physical activity is positively correlated with higher levels of violence, which perhaps eludes to individuals being physically active feeling more comfortable stepping into a physical altercation, as they may be more confident in their ability to come out "victorious". Religiousness also shows a significant relationship with increased levels of historical violence. Although it has been proven that countries with higher religious affiliation also see higher levels of violence (16), this may also elude to previously violent individuals turning to religion to improve on their ways, which has been a popular path. Additionally, it may reflect religious individuals having a lower tolerance for what is described as "violence", leading their values to be inflated. In either case, the author believes it is a stretch to state that a higher level of religious involvement is correlated with being more violent in nature, as there also are differences both between religions and within-religion with certain extremist groups perhaps leading the way in making the correlation positive.

Table 4: Dependent Variable: Historical Levels of Violence

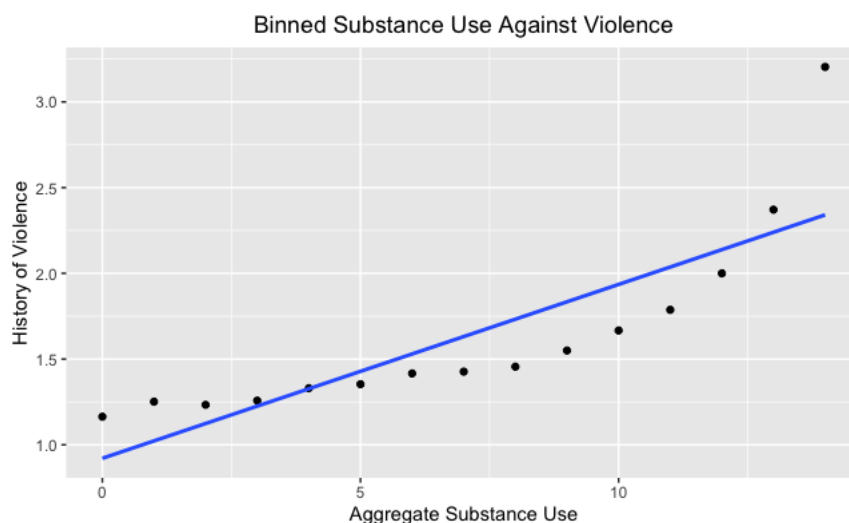
	Model 1	Model 2	Model 3	Model 4	Model 5
Physical Activity	0.45*** (0.03)	0.32*** (0.04)			
Gaming	0.22*** (0.02)		0.26*** (0.01)		
Religious Involvement	0.19*** (0.03)			0.12*** (0.02)	
EC Involvement	-0.19*** (0.02)				-0.12*** (0.02)
Num. obs.	105996	109700	323472	308022	332509
Num. groups: Year	2	2	5	5	5
Num. groups: County	77	77	165	165	165
Num. groups: Socioec. Status	11	11	11	11	11
Num. groups: School Grade	6	6	6	6	6
Num. groups: Gender	2	2	2	2	2
Num. groups: Neigh. Amenities	17	17	17	17	17
R <sup>2</sup> (full model)	0.08	0.07	0.08	0.08	0.08
Adj. R <sup>2</sup> (full model)	0.08	0.07	0.08	0.08	0.08

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

The relationship between two of the adverse behaviors, substance use and history of violence, can be explored further through the below binned scatter plot, in which it can be observed that the relationship is partially driven by the outliers in both substance use and violent behavior, showing an exponential trend in violence with extreme substance use. This could as mentioned above both have to do with the type of individuals that indulge in excessive substance use, but also with the increased potential for finding oneself in a violent



situation when consuming intoxicating substances.



#### 4.1.4 Social Life

The variable of social life is defined through the unweighted sum of two questions: "Do you have anyone to spend time with outside of school?" and "Do you have anyone to spend time with during breaks at school?". They are both answered at a range of 1 (Yes, always) to 4 (No, never), but the dependent variable has been negated in the table so that a higher value reflects a more robust social life.

From the below table, we can see that physical activity and extracurricular involvement are both correlated with higher levels of social life. This can likely be connected to the fact that many forms of physical activity among teenagers are conducted in groups or teams and similarly to extracurricular involvement expose individuals to people with similar interests, leading to a higher likelihood of acquiring a "social circle" of people with which one has things in common. We can see that gaming is negatively correlated with social life, which could be a combination of opportunity costs of time, meaning that to be social the video gaming individuals give up additional time playing video games, which they clearly value. Additionally, this could be correlated with video gaming individuals acquiring friends in the online universe rather than in real life, leading to fewer friends to hang out with in person and in school.

Historically, a social life highly dependent on online friendship has proven to not improve on social vulnerabilities (15), and may thereby provide a lesser value to an individual compared to building friendship in real life. Regardless of this, one may also want to mediate a teenager’s reliance on online friendships as it likely leads to stronger dependence on screen-based devices, which as mentioned in the literature review has been proven to have negative effects on teenagers and later-life outcomes.

Table 5: Dependent Variable: Feeling of Friendship and Social Life

	Model 1	Model 2	Model 3	Model 4	Model 5
Physical Activity	0.78*** (0.06)	0.96*** (0.06)			
Gaming	−0.31*** (0.03)		−0.40*** (0.03)		
Religious Involvement	−0.03 (0.07)			0.00 (0.07)	
EC Involvement	0.21*** (0.02)				0.41*** (0.03)
Num. obs.	105260	108928	110690	110480	113478
Num. groups: Year	2	2	2	2	2
Num. groups: County	77	77	77	77	77
Num. groups: Socioec. Status	11	11	11	11	11
Num. groups: School Grade	6	6	6	6	6
Num. groups: Gender	2	2	2	2	2
Num. groups: Neigh. Amenities	17	17	17	17	17
R <sup>2</sup> (full model)	0.07	0.06	0.06	0.05	0.05
Adj. R <sup>2</sup> (full model)	0.07	0.06	0.05	0.05	0.05

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

#### 4.1.5 Confiding in Parents

Aside from the above adverse variables, a variable that can prove to be important when paying attention to teenagers is their ability to share problems in their life with those close to them. As mentioned in the introduction, the ability to share ones problems has proven effective in mitigating personal issues. This is particularly important in cases of depression and other mental health struggles, where it routinely has been shown that confiding in those around you can prove useful in improving ones condition. In this case, I categorize into 2 different groups, confiding in parents, and confiding in other individuals (friends, sibling, teachers, and others).

As can be seen from the below table, increased levels of videogaming leads to lower levels of confiding in both parents and others, even when controlling for "family dynamics" through parental satisfaction. It can also be seen that increased substance use is correlated with lower interest in cofiding in those around you. The parental part of this may arise from parents disapproving of the problems that come up in a substance user's life, while the "other" aspect may arise from those who consume more substances potentially having more of a need to "look tough" to those around them, and therefore do not wish to share their problems.

It can also be seen that depression has a strong impact on confiding in others, with those having higher levels of depression seeing strong decreases in willingness to share their problems with others. Interestingly, this change is much stronger in confiding in parents compared to confiding in others, perhaps suggesting that the closeness of parents may lead to difficulties in revealing particularly deep problems to them.

Table 6: Dependent Variables: Confiding in Parents and Confiding in Others

	Confiding in Parents			Confiding in Others		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Gaming	−0.22*** (0.03)	−0.42*** (0.03)		−0.08*** (0.02)	−0.14*** (0.01)	
Substance Use	−0.74*** (0.05)	−1.60*** (0.06)		−0.28*** (0.02)	−0.51*** (0.02)	
Satisfaction With Parents	1.94*** (0.05)			0.54*** (0.02)		
Depression	−2.32*** (0.05)		−3.11*** (0.05)	−0.69*** (0.03)		−0.94*** (0.02)
Num. obs.	76406	100437	80340	72706	93080	74392
Num. groups: Year	5	6	5	5	6	5
Num. groups: County	92	94	92	94	94	92
Num. groups: School Grade	6	6	6	6	6	6
Num. groups: Gender	2	2	2	2	2	2
R <sup>2</sup> (full model)	0.15	0.04	0.09	0.04	0.02	0.04
Adj. R <sup>2</sup> (full model)	0.15	0.04	0.09	0.04	0.02	0.04

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ 

## 5 Covid-19 and Adverse Teenage Behavior

Aside from the general correlations presented above, it is useful to understand how shocks to society can affect teenage behavior, and especially whether or not it affects different groups of people in different ways. The following section is focused on a causal investigation of how a shock to society, in this case the Covid-19 pandemic, changed different teenage behavioral

traits. Because panel data is not available for the "Ungdata"-survey, all analysis is done at a county-level to allow for a causal interpretation of the results. The sample used consists of 19 Norwegian counties with strong geographical spread, with a minimum county sample-size of 286.

The main regressor used in the analysis is Covid prevalence, but others are included as well to account for different aspects of county heterogeneity. The complete set of regressors consists of

- **Covid Prevalence:** Percentage of county population infected by Covid. Calculated for county  $i$  as

$$\text{Covid Prevalence}_i = 100 \cdot \frac{\# \text{ infected by Covid}_{2020,2021}^i}{\text{Population}_{2021}^i}$$

- **Median Income, Population Density, and  $\Delta$ Unemployment<sub>2021–2020</sub>:** As defined at the end of section 3.

The above regressors are used in the following regression on each county-level dependent variable as

$$\begin{aligned} \Delta Y_{2021-2020}^i \cdot \log \left( \frac{\text{sample size}_i \cdot 100}{\sum_{i=1}^{19} \text{sample size}_i} \right) = & \beta_0 + \beta_1 \text{Covid Prev}_i + \beta_2 \text{Income}_i \\ & + \beta_3 \text{Pop. Dens}_i + \beta_4 \Delta \text{Unemployment}_{2021-2020}^i \end{aligned}$$

As can be observed, each county-level dependent variable observation is scaled by its relative sample size. This is done to account for potential small-sample outliers and assure that any strong homogeneous results from a large sample size county are valued more than those of a smaller sample size. All the results remain significant without the sample size adjustment, but I believe it is more representative to scale the dependent variables, as county sample sizes vary from 286 to 5433, thereby allowing for small county samples to skew the overall result if they are not adjusted for their relative size. Additionally, before scaling relative to

sample size, all dependent variables are standardized to have a maximum value of 100 and a minimum value of 0. The regressors have not been standardized, as their values provide valuable interpretation themselves. Summaries of the quantiles for the regressors are as follows

Table 7: Regressor Quantile Summary

Variable	Min.	1st	2nd	3rd	Max
Covid Prevalence (in %)	3.1	4.0	4.8	6.4	9.2
log(Median Income)	13.3	13.42	13.46	13.50	13.64
log(Population Density)	1.1	3.1	3.6	4.3	6.2
$\Delta\text{Unemployment}_{2021-2020}$	-3.0	-2.1	-1.8	-1.3	-0.2

## 5.1 Results

The above regression has been run for all the below sections of dependent variables, uncovering some quite interesting results. The intention of the below results is to show the causal effect the Covid-19 pandemic and the consequences it had on Norwegian teenage behavior, as well as how the pandemic affected some counties differently than others depending on county properties like population density and median income.

### 5.1.1 Depression

The depression dependent variable as defined in subsection 4.1.1 showed a 5% significance level in increasing in counties with higher Covid prevalence, as can be seen in the below regression table. Interestingly, one can also observe that median income is strongly significant as well, suggesting that individuals from wealthier counties saw a larger increase in depression over the pandemic period. This is perhaps eluding to that higher-income teenagers saw more sources of joy lost over the pandemic than those with lower income, as activities like travelling, festivals and music concerts, in-person shopping, and restaurant visits all became restricted, which likely impacted life enjoyment much more for wealthier individuals.

Table 8: Dependent Variable:  $\Delta\text{Depression}_{2021-2020}$ 

Controls	All Controls	Income	Pop. Dens.	$\Delta$ Unemployment	None
Covid Prevalence	2.74*	1.89*	3.25**	2.61**	2.61**
	(1.01)	(0.82)	(1.07)	(0.84)	(0.81)
log(Median Income)	39.21*	34.36			
	(16.68)	(16.44)			
log(Pop. Dens.)	-1.83		-1.23		
	(1.27)		(1.32)		
Unemployment	-0.13			0.22	
	(1.64)			(1.78)	
R <sup>2</sup>	0.58	0.51	0.41	0.38	0.38
Adj. R <sup>2</sup>	0.46	0.45	0.34	0.30	0.34
Num. obs.	19	19	19	19	19

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

### 5.1.2 Life Quality

In addition to the depression variable somewhat representing an individual's life quality, I have constructed a variable representing aggregate life quality, constructed as an unweighted sum from 6 different individual questions as "How often do you find yourself being ...?":

- Happy
- Engaged/motivated
- Energetic
- Optimistic about the future
- Useful
- Accomplishing things

Each of the above questions is answered at a range from 1 (All the time) to 5 (Not at all).

Looking at the below regression table, we can see that higher Covid prevalence decreased life quality. Interestingly, we find no significant differences in county heterogeneity in this case, as opposed to the aggregate depression variable in 5.1.1, where we saw increased changes in depression among wealthier counties there is little evidence of heterogeneous change in life quality between counties. This could potentially be attributed to the elements of the variable responding to being "optimistic about the future", as an individual likely is optimistic about the non-Covid future ahead, potentially even particularly so in areas with higher Covid prevalence.

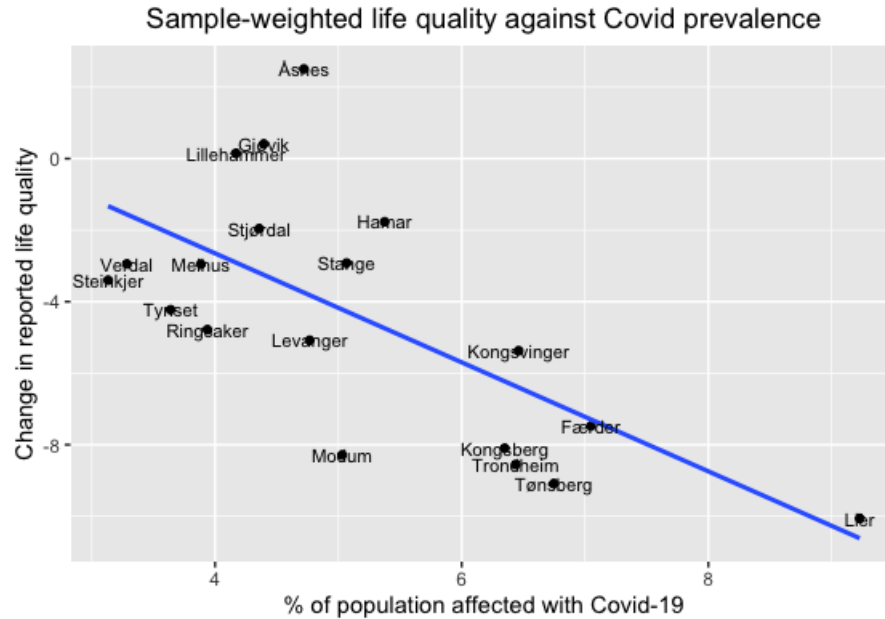
Table 9: Dependent Variable:  $\Delta\text{Life Quality}_{2021-2020}$

Controls	All Controls	Income	Pop. Dens.	$\Delta$ Unemployment	None
Covid Prevalence	-1.21* (0.54)	-1.24* (0.43)	-1.39* (0.55)	-1.53** (0.42)	-1.52** (0.41)
log(Median Income)	-13.22 (9.50)	-13.43 (8.71)			
log(Pop. Dens.)	-0.07 (0.72)		-0.27 (0.68)		
Unemployment	0.00 (0.93)			0.14 (0.89)	
R <sup>2</sup>	0.52	0.52	0.45	0.45	0.45
Adj. R <sup>2</sup>	0.38	0.46	0.39	0.38	0.42
Num. obs.	19	19	19	19	19

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

In understanding the changes in behavior in different counties, it can be conceptually useful to plot the various counties' Covid Prevalence against the change in life quality. In the below plot the relationship between the two can be observed, showing a strong negative trend in life quality as Covid prevalence increased. Looking at the different counties, there is no significant trend in terms of geography or urbanity, as counties like Trondheim and F  rder are in opposite areas of the country, but very closely together in the scatter plot, while counties like Trondheim and Lillehammer both are highly population dense, but far apart on the plot.





### 5.1.3 Substance Use

The dependent variable for substance use is defined exactly the same as the variable used in section 4.1.2. I believe the changes observed in the dependent variable in the below regression table are particularly worrisome, considering that a lot of social life was restricted during the pandemic, meaning that there in general should be fewer opportunities for teenagers to meet and consume substances like drugs and alcohol. Although outside gatherings became prevalent during the "lockdown" times of the pandemic, the change could suggest that consumption of drugs and alcohol by oneself became more prevalent, which is something that would be interesting to investigate further as it should be regarded as particularly worrisome.

Interestingly regarding the above, we can see that the increase in substance use with Covid prevalence was strongly decreased by increased population density, suggesting that urban counties saw a higher increase in substance use over the period than urban counties. This is consistent with the above-mentioned element of outside social gatherings and substance use, as such gatherings likely were more prevalent in rural counties than the urban ones.

Table 10: Dependent Variable:  $\Delta$ Substance Use<sub>2021–2020</sub>

Controls	All Controls	Income	Pop. Dens.	$\Delta$ Unemployment	None
Covid Prevalence	18.04* (6.11)	8.03 (5.87)	19.31** (5.60)	8.57 (5.25)	8.66 (5.18)
log(Median Income)	89.30 (100.57)	29.78 (117.64)			
log(Pop. Dens.)	−21.71* (7.65)		−20.54** (6.93)		
Unemployment	0.60 (9.86)			7.95 (11.12)	
R <sup>2</sup>	0.48	0.14	0.45	0.17	0.14
Adj. R <sup>2</sup>	0.33	0.04	0.38	0.06	0.09
Num. obs.	19	19	19	19	19

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ 

#### 5.1.4 Physical Activity

Although it is far from an adverse behavior itself, I found in 4.1 that physical activity was correlated with various adverse teenage traits, like depression and social life. Additionally to this, numerous studies have found physical activity to be causally positive for a number of aspects related to both physical and mental health, making it an interesting variable to look into when attempting to understand how teenage behavior changed over the pandemic. The dependent variable in this case is an aggregate variable identical to the physical activity variable described as a regressor at the top of section 4.

As we can see from the below table, counties with higher Covid prevalence showed a significant decline in overall physical activity. Additionally, the significance of population density in a positive direction perhaps suggests that urban areas were able to keep up their levels of physical activity to a higher degree than rural ones. This could perhaps be correlated with the results found about substance use in section 5.1.3, where it is observed that substance use saw a much stronger positive change in rural rather than urban areas. Since substance use and physical activity are reasonable to be considered substitutes rather than compliments, this could likely be part of the explanation for the importance of population

density in the heterogeneous affect of the pandemic on physical activity.

Table 11: Dependent Variable:  $\Delta$ Physical Activity<sub>2021–2020</sub>

Controls	All Controls	Income	Pop. Dens.	$\Delta$ Unemployment	None
Covid Prevalence	−5.32* (1.83)	−2.94 (1.66)	−5.70** (1.66)	−2.95 (1.47)	−2.98 (1.46)
log(Median Income)	−17.28 (30.12)	−1.96 (33.29)			
log(Pop. Dens.)	5.24* (2.29)		5.25* (2.05)		
Unemployment	−1.19 (2.95)			−3.00 (3.10)	
R <sup>2</sup>	0.45	0.20	0.43	0.24	0.20
Adj. R <sup>2</sup>	0.29	0.10	0.36	0.15	0.15
Num. obs.	19	19	19	19	19

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$

### 5.1.5 Non-productive Screentime Usage

Another element of teenage behavior that has been described as sub-optimal by numerous psychologists and social scientist in later years is the increased reliance teenagers have showed on devices with digital screens. In this section, I investigate the effect of Covid on a variable related to non-productive screentime, asking "Outside of school, how much time do you typically spend on screen-based activities?". It is answered at a range of 1 (No time) to 7 (More than 6 hours).

From the below regression table, we can see that counties with a higher Covid prevalence saw a strongly significant (1% level) increase in screentime usage. It can also be observed that the increase was surprisingly homogeneous across different counties, as neither population density, median income, or change in unemployment are significant in the change in screentime usage. This should be regarded as quite worrisome for policymakers, considering that increased screentime has proved causal in obesity, depression, sleep apnea, and other problems harmful at both the individual and societal level.

Table 12: Dependent Variable:  $\Delta \text{Screentime}_{2021-2020}$ 

Controls	All Controls	Income	Pop. Dens.	$\Delta$ Unemployment	None
Covid Prevalence	3.15** (0.87)	2.53** (0.70)	2.98** (0.82)	2.58*** (0.62)	2.56*** (0.62)
log(Median Income)	3.58 (14.31)	1.83 (14.12)			
log(Pop. Dens.)	-1.23 (1.09)		-0.80 (1.01)		
Unemployment	-1.76 (1.40)			-1.33 (1.31)	
R <sup>2</sup>	0.57	0.50	0.52	0.53	0.50
Adj. R <sup>2</sup>	0.45	0.44	0.46	0.47	0.47
Num. obs.	19	19	19	19	19

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ 

### 5.1.6 Social Life

The last adverse teenage behavioral trait development I was interested in investigating over the pandemic was change in teenage social life. I hypothesized beforehand that this may not change as much as one might expect, since the millennial teenagers have such a strong reliance on technology and therefore would be able to maintain their social circles despite physical interaction and contact being restricted. As can be observed from the below table, I was mistaken in this as Covid prevalence proved significant at the 1% level in decreasing social life, a variable defined in the same way as it was in section 4.1.4.

An interesting aspect of the below table is the positive coefficient on population density, indicating that urban teenagers maintained social life better than rural ones. This is particularly interesting considering that rural teenagers saw an increase in substance use, which I hypothesized may be due to a smaller slowdown in social gatherings. However, this may indicate that such hypothesis is false and points toward rural teenagers consuming substances like drugs and alcohol more by themselves than in a social setting, which should be considered severely worrisome.

Table 13: Dependent Variable:  $\Delta\text{Social Life}_{2021-2020}$ 

Controls	All Controls	Income	Pop. Dens.	$\Delta$ Unemployment	None
Covid Prevalence	-1.51** (0.41)	-0.90* (0.38)	-1.52** (0.41)	-1.03** (0.34)	-1.02** (0.34)
log(Median Income)	-8.73 (6.81)	-6.04 (7.55)			
log(Pop. Dens.)	1.28* (0.52)		0.96 (0.51)		
Unemployment	0.85 (0.67)			0.45 (0.73)	
R <sup>2</sup>	0.57	0.38	0.47	0.37	0.35
Adj. R <sup>2</sup>	0.45	0.30	0.40	0.29	0.31
Num. obs.	19	19	19	19	19

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ 

## 6 Conclusion

From the above-presented results, I have uncovered that there are strong correlations between various adverse behavioral traits and different teenage lifestyle choices, even when employing a wide array of heterogeneity controls. In the correlative investigation, it was uncovered that increasing physical activity is significantly correlated with lower levels of depression and an improved social life. On the other side of the spectrum I found that someone who plays more video games is expected to have a worse in-person social life and higher prevalence in feelings related to depression. This does not however suggest that a correct policy to decrease depression is to increase average teenage physical activity, as it was uncovered that extreme levels of physical activity are correlated with higher levels of depression. Instead, the

results can be used in thinking about habits like physical activity and gaming as indicators of perhaps paying more attention to other signs of depression in an individual or population.

One can think about extracurricular or religious involvement in the same way. Although EC involvement is correlated with lower levels of depression and religious involvement is correlated with lower levels of substance use, the solution to improving on those metrics is certainly not to force teenagers into one or both. Rather, they can be used as indicators of certain adverse behavioral tendencies that similar youth may partake in, or indicators of a teenager being less likely to partake in some aspect of adverse behavior.

In the causal investigation, numerous connections were found in terms of a "shock" to society changing teenage behavior. It was uncovered that higher Covid prevalence caused higher levels of adverse teenage behaviors like depression, screentime usage, and substance use, as well as decreased feeling of social life and life quality. Although this part of the paper is causal, it is not my intention to state that the disease Covid-19 leads to higher levels of depression and higher dependence of digital devices. Rather, the disease prevalence is used as a proxy for the changes that were introduced into societies with the disease, like increased social isolation and geographical restriction. It can also be thought of as a proxy for any general "shock" as mentioned above, meaning that one likely can expect negative shocks like the pandemic to have similar effects on adverse elements of behavior.

Although this part of the paper is intended to be causal and we saw shifts in behavior that were predominantly negative, it is naturally not possible to implement some policy solution that would grant us immunity from something like a pandemic. Rather, it is my intention that the results serve as evidence to that in periods of societal shock it is important to pay particular attention to changes in behavior to ensure that any potential spillover effects from the shock are limited as much as possible.

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