

# Did self-reported tobacco smoking, alcohol consumption, and physical activity change during the COVID-19 restrictions in Germany in spring 2020? Findings from a population survey (the DEBRA study)

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## Research Article

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# Abstract

## Background

Broad nationwide restrictions of social life and contacts were implemented in Germany on March 22nd, 2020, to reduce the spread of the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2). It is unclear how these restrictions affected peoples' health behaviour.

## Objective

To: i) examine changes in self-reported health behaviour of the German population regarding tobacco smoking, alcohol consumption, and physical activity during the restrictions compared with the time prior to these restrictions; ii) explore associations between potential changes and socioeconomic and sociodemographic characteristics.

## Methods

We used data from two waves (June-August 2020) of the German Study on Tobacco Use (DEBRA): a cross-sectional, representative, face-to-face household survey in people aged  $\geq 14$  years (N = 4078). Associations between socioeconomic and sociodemographic characteristics and changes in each health behaviour were analysed using multinomial logistic regression analyses (categories of the dependent variable: increase, no change, decrease).

## Results

People reported changes in their health behaviour: **smoking** increase = 24.0% (95% confidence interval (CI) = 21.5–26.7), decrease = 12.2% (95%CI = 10.4–14.4); **alcohol consumption** increase = 12.9% (95%CI = 11.7–14.1), decrease = 19.9% (95%CI = 18.4–21.3); **physical activity** increase = 18.5% (95%CI = 17.3–19.7); decrease = 29.4% (95%CI = 28.0–31.0). People with a lower level of education and younger age were more likely to report a harmful change in health behaviour.

## Conclusion

The majority of people in Germany did not change their health behaviour during the 2020 corona restrictions. Among those who changed, relatively more increased their smoking and decreased their alcohol consumption and physical activity. Public health interventions in this context should particularly target people with lower socioeconomic status and younger age e.g., by offering more online courses.

## Introduction

At the end of January 2020, the novel, severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2), which leads to coronavirus disease 2019 (COVID-19), reached Europe. The first reported case in Germany was on January 27th [1]. Around one month later, the Federal Ministry of Health and the Federal Ministry of the Interior, Building and Community set up a crisis committee to combat the outbreak of the virus in Germany [2]. By the beginning of March, cases of COVID-19 infection were already reported in all 16 federal states of Germany [3].

Following the example of other European countries (e.g., Belgium, the Netherlands, Italy, Spain [4]) who decided in early March to cut back on public, working, and private life, Germany implemented nationwide restrictions on March 22nd, aiming at reducing the spread of the virus [5]. This entailed broad restriction of social life and contacts, which strongly affected the personal privacy. Schools and day-care centres for children were closed, and an entry ban from some neighbouring countries of Germany was imposed [6]. Many parts of economic life were shut down. Some service sectors had to close completely (e.g., restaurants, hairdressers, sports centres) and many employees were sent on short-time work [5]. There were also substantial restrictions within the health care system, e.g., routine surgeries were cancelled, and psychotherapy and psychosocial consultations had to switch to digital formats or were offered with reduced capacity. The latter affected the treatment of addictive disorders, including individual and group courses for smoking cessation or alcohol abstinence interventions [7].

It is quite likely that these massive restrictions on personal liberty and the accompanying feelings of uncertainty (both job-related and health-related) also had an impact on the health behaviour of people [8]. The World Health Organization (WHO) already warned at the beginning of the pandemic that the risk of increasing alcohol consumption due to isolation is possible [9, 10]. Besides, mental health problems, such as depression or anxiety disorders, which are also associated with increased alcohol and tobacco consumption, could be triggered or aggravated by these conditions [11–14].

Other health behaviours such as physical activity might have changed as well since sporting habits could not be pursued during this time for many areas of activity (e.g., fitness studios, club sports, or active commuting [15]). This poses a risk, especially for people with pre-existing chronic diseases, such as cardiovascular diseases, diabetes or mental illness, for whom physical activity has positive effects [16–25]. On the other hand, the pandemic-related reduction of commuting and working hours (short-time work) might have offered more time to pursue physical outdoor activities for some people.

In Germany, the number of cigarettes sold increased markedly during the first comprehensive restrictions in March 2020 (number of cigarettes sold: February 2020 = 4,949,032,692; March 2020 = 8,174,948,907) [26]. For comparison: the relative increase in sales from February to March 2020 was 65%, whereas it was only 14% from February to March 2019.

Visiting bars or restaurants was severely or completely restricted during the aforementioned period, and these establishments were thus not eligible as a place for alcohol consumption. First data from other countries (e.g., United States [27], Belgium [28, 29], Australia [30], England [31, 32], Pakistan [33], Italy [34], Scotland [35]) report changes in tobacco smoking, alcohol consumption and/or physical activity during

the first national COVID-19 restrictions. Whereas data from United States, England, and Belgium indicate a substantial increase in alcohol consumption [27, 28, 32], further data from England and Australia showed mixed results with a proportion of respondents who reported increased alcohol consumption and roughly the same proportion who drank less during this time [30, 31]. According to these studies certain person characteristics are associated with alternated consumer behaviour: women, people with a higher socioeconomic status, symptoms of anxiety, depression and stress were associated with increased alcohol consumption [30, 31].

As for tobacco consumption, findings are also mixed. While a study from Belgium (web-based survey) and a longitudinal study conducted in Pakistan found an increase [28, 33] in tobacco smoking, web-based surveys from Australia and England, as well as a cross-sectional study from England reported no changes in smoking behaviour [30, 32, 36], or even a strong reduction in tobacco smoking during the COVID-19 restrictions [33].

Concerning physical activity, a decrease and therefore negative effect has been observed in the majority of the 66 articles (N = 86.981) included in a systematic review [37]. A representative study from Belgium, as well as further web-based studies from Italy and England showed a reduction in moderate to vigorous physical activity but an increase in strength training [29, 34, 38]. The representative (cross-sectional) population survey (N = 13,515) from Belgium showed that the change in physical activity behaviour seems to be dependent on the age of the respondents, their previous physical activity behaviour (before) and habits [29]. A reduction of the physical activity was particularly evident in people who previously had a high level of physical activity, were less educated, and were more used to training in groups or in a sports club [29].

The current evidence shows that specific groups of the society are more likely to be affected by health behaviour changes during the first COVID-19 restrictions. As the level of the restrictions differed substantially between countries, there is a need to obtain data from different countries to get an overview and a solid data basis on health behaviour changes related to COVID-19 restrictions and associations with personal characteristics. We are still in an exceptional situation worldwide. In Germany, only few data are available so far, and these data indicate an increasing trend in self-reported alcohol consumption as well as tobacco consumption during restrictions at the beginning of the pandemic [39]. These data are important for public health to understand the effects of these restrictions and to be able to counteract them with targeted health policy/care measures. In addition, these data help to measure the health economic relevance of these restrictions; and, if appropriate, to detect a worsening of the deprivation of people from more disadvantaged groups in terms of health behaviour.

The present study therefore aims to examine whether there was a change in self-reported health behaviour regarding tobacco smoking, alcohol consumption, and physical activity during the first COVID-19 restrictions in Germany in spring 2020, compared with the time prior to these restrictions. Furthermore, this study aims to explore potential associations between changes in health behaviour, if any, and

socioeconomic and sociodemographic characteristics. A sample of the nationwide, representative German Study on Tobacco Use (DEBRA) serves as data basis to answer these questions.

## Methods

We used data from the German Study on Tobacco Use (DEBRA: “Deutsche Befragung zum Rauchverhalten”, [www.debra-study.info](http://www.debra-study.info)), an ongoing representative household survey [40]. The DEBRA study collects bi-monthly data by means of computer-assisted, face-to-face household interviews in a new sample of about 2000 people aged 14+ each survey wave. People are interviewed about their use of tobacco and of alternative nicotine delivery systems, as well as on sociodemographic characteristics. Additional questions on self-reported health behaviour changes in tobacco smoking, alcohol consumption, and physical activity during the nationwide COVID-19 restrictions in spring 2020 (March 22<sup>nd</sup> to June 5<sup>th</sup>) were added to two waves of the DEBRA study: wave 24 (June/July 2020) and wave 25 (July/August 2020). For the present analysis, data on both waves were aggregated resulting in a total sample of 4078 respondents (N wave 24: 2038 respondents, N wave 25: 2040 respondents).

Up to January 2020, respondents of the DEBRA study were selected through multistage, multi-stratified random probability sampling. In January 2020, the market research institute Kantar, which conducts the survey, switched to a dual frame design of data collection: random stratified sampling (50% of the sample) and quota sampling (50% of the sample). The COVID-19 pandemic substantially affected the possibility and willingness of the general public to participate in face-to-face household surveys, leading to lower response rates during the pandemic than before. As consequence, the proportion of the quota sampling had to be increased up to 100% during the study waves 24 and 25 to further balance expected non-response effects. Details on these changes in the sampling design of DEBRA have been published elsewhere: <https://osf.io/s2wxc/>.

The study was approved by the ethics committee of the Heinrich-Heine-University Duesseldorf (HHU 5386R) and was registered at the German Clinical Trials Register (DRKS00011322 and DRKS00017157).

## Measurements

### *Measuring sociodemographic characteristics*

We collected self-reported data on age, sex, education, and on monthly net household income of respondents. The level of education was categorised into three groups: low (no qualification or junior high school equivalent (“Hauptschulabschluss”)), middle (secondary school equivalent (“Realschulabschluss”)), and high level of education (advanced technical college equivalent

("Fachhochschulreife") or high school equivalent ("Allgemeine Hochschulreife")). We used an equalisation technique provided by the Organisation for Economic Co-operation and Development (OECD-modified equivalence scale) to adjust the net household income for household size and composition. In order to have the distribution of income in the German population reflected in our data in the best possible way, we assigned the monthly net income to the following categories: low=approximately <20<sup>th</sup> income percentile, middle=approximately 20<sup>th</sup> to 80<sup>th</sup> income percentiles, and high= approximately >80<sup>th</sup> income percentile (details: <https://osf.io/387fg/>).

### *Self-reported changes in health behaviour*

Behaviour changes in the German population during the time of the first COVID-19 restrictions in spring 2020 were collected for three health behaviours of interest by using the following answer categories:

#### **Tobacco smoking:** *"During the time of corona restrictions, I ...*

1. *smoked much more than before*
2. *smoked somewhat more than before*
3. *smoked the same amount than before*
4. *smoked somewhat less than before*
5. *smoked much less than before*
6. *don't smoke tobacco at all*
7. *no answer"*

#### **Alcohol consumption:** *"During the time of corona restrictions, I ...*

1. *drank much more alcohol than before*
2. *drank somewhat more alcohol than before*
3. *drank the same amount of alcohol than before*
4. *drank somewhat less alcohol than before*
5. *drank much less alcohol than before*
6. *I don't drink alcohol at all*
7. *no answer"*

**Physical activity:** *“During the time of corona restrictions, I was*

1. *much more active than before*
2. *somewhat more active than before*
3. *just as active as before*
4. *slightly less active than before*
5. *much less active than before*
6. *I can't move around*
7. *no answer”*

Answers were classified into “increase” (answer options 1 and 2), “no change” (answer option 3) and “decrease” (answer options 4 and 5). People who reported that they do not smoke, drink or cannot move around (answer option 6), and those who did not provide an answer (answer option 7) were excluded for the analyses.

## **Statistical analyses**

A protocol of the present analyses, including a pre-specified analysis plan, was published prior to the statistical analyses (<https://osf.io/emaq2/>).

Before we aggregated the data from the two waves, we carried out a preparatory analysis to test if the data from both survey waves differ significantly regarding reported health behaviour changes (see **Supplemental Table I**).

Prevalence data on self-reported health behaviour changes (increase, no change and decrease) were analysed using descriptive statistics and presented as percentages together with 95% confidence intervals (CI). Data were weighted (reported as: “ $w$ ”) to be representative of the German population accounting for personal and household characteristics. Details on the weighting technique are described in the study protocol [40].

Three separate multinomial logistic regression analyses (three categories: increase, no change, decrease) were used to analyse associations between each health behaviour and the following socioeconomic and

sociodemographic characteristics: age, sex, monthly net household income, and education level of the respondents. All regression analyses used unweighted data.

Age in years was used as a continuous variable for the regression analyses, and as categorical variable (14-17, 18-24, 25-39, 40-64, 65+ years) for descriptive statistics. Monthly net household income was used as a continuous variable in € among over 18-year-olds (€0-€7000 or more) for the regression analyses, and as categorical variable (low, middle, high income) for descriptive statistics. Education was analysed as a categorical variable (low, middle, high level of education) for all analyses. Data were analysed using IBM SPSS version, 25.

Regarding the total sample (N=4078), 69.6% (n=2838) of the respondents reported not to smoke tobacco, 25.4% (n=1035), not to drink alcohol, and 1.4% (n=56) reported not to move around at all. Of the remaining samples for each health behaviour, missing data on health behaviour change was  $\leq 1\%$  (smoking: 1.0% (n=39); alcohol consumption: 0.3% (n=12); physical activity: 0.2% (n=7)). These persons were excluded from the regression analyses. Missing values of predictor and outcome variables were sparse (because this was a face-to-face survey) and assumed to be “missing at random”.

## Results

The preparatory analysis showed that survey waves 24 and 25 did not differ significantly with regard to reported changes in smoking and drinking behaviour. However, a small difference was observed in self-reported changes in physical activity (Chi square test (4)=13.173,  $p=.010$ ,  $n=4015$ ; Cramers V=0.57).

Sociodemographic and socioeconomic characteristics of the total sample of 4078 respondents are presented in **Table 1** (unweighted data). The mean age of the sample was 49.3 years (SD (standard deviation) =  $\pm 18.6$  years) and 51.1% (n=2084) of the respondents were female.

**Figure 1** presents prevalence data on reported health behaviour changes for each health behaviour. With regard to changes in smoking behaviour around one quarter of the respondents reported an increase during COVID-19 restrictions compared to the time before (24.0%<sub>w</sub>, 95%CI=21.5-26.7  $n_w=264$ ), whereas the majority (63.7%<sub>w</sub>, 95%CI=60.8-66.5;  $n_w=700$ ) reported no change and 12.2%<sub>w</sub> (95%CI=10.4-14.4;  $n_w=135$ ) reported a decrease in smoking during this time.

Regarding changes in alcohol consumption 12.9%<sub>w</sub> (95%CI=11.7-14.1; n<sub>w</sub>=384) of the respondents reported an increased consumption, 67.3%<sub>w</sub> (95%CI=65.6-69.0; n<sub>w</sub>=2006) no change, and around one out of five persons (19.9%<sub>w</sub>, 95%CI=18.4-21.3; n<sub>w</sub>=592) reported to drink less alcohol than during the time before the first strict COVID-19 restriction in spring 2020.

An increase of physical activity was reported by 18.5%<sub>w</sub> (95%CI=17.3-19.7; n<sub>w</sub>=727) of the respondents, no change in physical activity by 52.1%<sub>w</sub> (95%CI=50.5-53.6; n<sub>w</sub>=2048), and 29.4%<sub>w</sub> (95%CI=28.0-31.0; n<sub>w</sub>=1158), of the respondents were less active than before.

The results of the three multinomial ordinal regression analyses are presented in **Table 2**.

### *Tobacco smoking*

We found that increasing age was associated with reduced odds of increasing or decreasing tobacco consumption (increase: OR=0.98, 95%CI=0.97-0.99; decrease: OR=0.99, 95%CI=0.98-1.00). Respondents with lower educational level also had lower odds of reporting a decrease in tobacco smoking (middle educational level: OR=0.61, 95%CI=0.40-0.95; low educational level: OR=0.49, 95%CI=0.28-0.85) compared to people with a high level of education. As income rises, the odds of reporting a change in tobacco consumption rises in the direction of increase (OR=1.30, 95%CI=1.08-1.58).

### *Alcohol consumption:*

Similar associations were found when comparing increase, respectively decrease, of alcohol consumption. The associations were more pronounced here, especially between age and low educational level and a decrease in alcohol consumption. As age rises, the odds of a change in alcohol consumption also rises in the direction of increase (OR=0.98, 95%CI=0.97-0.98) or decrease (OR=0.99, 95%CI=0.98-0.99) compared to no change.

### *Physical activity:*

The associations regarding physical activity showed a quite similar pattern. Men have lower odds than women to change their behaviour regarding physical activity towards decrease (OR=0.80, 95%CI=0.70-0.93). Again, the analyses show that people with lower educational level also had lower odds of changing their physical activity during the strict restrictions, and this applies to both decrease (middle educational

level: OR=0.83, 95%CI=0.70-0.99; low educational level: OR=0.71, 95%CI=0.58-0.87) and increase (middle educational level: OR=0.63, 95%CI=0.51-0.77; low educational level: OR=0.40, 95%CI=0.30-0.52) compared to people with a high level of education.

## Discussion

Overall, the majority of the German population (around 52%-67%) did not report changes in their health behaviour with regard to smoking, alcohol consumption, and physical activity during the first COVID-19 restrictions in spring 2020 compared to the time immediately before. Nevertheless, significantly more respondents reported having smoked more than having smoked less. A comparable negative effect was seen concerning physical activity: more people reported having exercised less than more. About alcohol consumption, the result is different: here, slightly more respondents said they had reduced their alcohol consumption instead of increasing it. It seems that these behavioural changes are associated with socioeconomic and sociodemographic characteristics such as education, age, gender and income of the respondents.

Our results are comparable with the current figures of the Federal Statistical Office: in the "corona year" 2020, the per capita consumption in Germany for various alcoholic beverages decreased (-5.4% for beer, -2.1% for sparkling wine and -0.9% for spirits). As possible reasons, the experts cite a lack of drinking opportunities due to closed gastronomy and the absence of many festivities [41]. On the other hand, a total of €28.8 billion worth of tobacco products were taxed, 5.0% more than in the previous year (2019). Differentiated by the various tobacco products (cigarettes, cigars, pipe tobacco, fine cut), only for conventional cigarettes a small decrease of -1.1% was observed. The strongest increase was observed in pipe (+44.3%) and fine cut tobacco (+10.6%). The strong increase regarding fine cut is assumed to be due to the lack of availability of alternative low-priced cigarettes from other countries and the fact that people roll their own cigarettes [42].

We found associations between changes in all analysed health behaviours (smoking, alcohol drinking, and physical activity) and specific person characteristics, such as higher age, lower education level, and higher net household income. Comparable associations have also been found by other international research groups [28, 29, 31, 43]. As previous studies suggested, aspects such as stress, boredom and anxiety seem to negatively influence health behaviour change during country-specific COVID-19 restrictions [27, 28, 30, 31, 43].

Current studies report heterogeneous results about the change in smoking, drinking behaviour, and physical activity [27–34, 43–45]. Many of these studies were conducted as online surveys, and data were reported as being not representative for the general population of the respective countries. The objective was often to get an initial overview on trends in pandemic-related health behaviour changes. Besides, the duration of the restrictions, as well as the severity of the measures (e.g., curfews) in the specific countries, could influence the change of health behaviour.

Regarding tobacco consumption, our data showed that significantly more people increased (24%) than decreased (12%) their smoking behaviour during strict restrictions. Whereas in our study nearly 36% of the respondents changed their smoking behaviour, only 10.3% (increase 6.9%, decrease 3.4%) of the respondents in an Australian study (online survey, N = 1491) reported this [30]. Similar was reported by a group from Belgium: increase 7.4%, decrease 2.5% [28]. A different pattern was reported from Pakistan: of around 6000 interviewed smokers, 86% changed their smoking behaviour (increase 18%, decrease 68%) [33]. In contrast, a high increase (43%) in tobacco smoking was reported in a different study from Germany (N = 558) and was particularly observed among people with lower educational level or pandemic-related changes in the type of employment (leave of absence/home office) [39].

Positive health effects regarding alcohol consumption were reported during the COVID-19 restrictions: more people reported drinking less alcohol than more during this time. Findings from an Australian online survey are in line with our results (increase 26% (Australia) vs. 13% (our study), decrease 18% vs. 20%) [30]. A large study from 21 European countries (N = 40064) also showed a decrease in alcohol consumption during the period of restrictions (April 24th -July 22nd 2020). In Germany, however, this decrease was less pronounced than in other European countries. The authors see possible reasons for this in the increase in alcohol consumption among women and people with risky consumption patterns [45]. However, other studies reported an amplified increase in alcohol consumption during the country-specific restrictions [28, 31, 39, 46]: an international online survey carried out from May to June 2020 (languages: Danish, Dutch, English, Finnish, French, German, Hungarian, Italian, Portuguese, and Spanish; N = 55811) revealed major changes in alcohol consumption: around 36% consumed (slightly) more alcohol, and 22% (slightly) less [46]. The motivational reasons for increased consumption include: boredom, lack of social contact and the lack of a daily structure [28], but also the increase in anxious, depressive behaviour and symptoms of stress [30].

In our study more people reported having exercised less than more during COVID-19 restrictions and can possibly be explained by a limited range of sport opportunities. Similar pattern was also found in further studies [30]. Compared with the results of our study, the proportion of less active people in Australia is lower (29.4% vs. 48.9%). Studies from England [32], Belgium [29] and Italy [34] showed that the type of training (strength training, endurance training), the sport location (indoor-/outdoor-sport) the level of activity before restrictions (active vs. not active) [44], the type of sport (team sport vs. individual sport) [29], and the offer of online courses changed the behaviour of physical activity during this time. Reasons given were to have less time, to sit more and to lack the sporty character (competitive element, team sport) [29]. Maybe certain groups of people now have more time available due to the new circumstances or that online courses are increasingly offered and used [47] and can be an important aspect to maintain or even increase the level of physical activity during the restricted sport offers. A web-based survey conducted on May 2020 (12-29th ) among 5021 students of four German universities (mean age 24.4 years) stated, that 30.6% of the respondents reported an increase in vigorous physical activity and 19.3% a decrease [43]. Characteristics associated with a change in health behaviour were being female, younger age, being bored and having depression symptoms.

Our data help to identify and analyse the effects of the COVID-19 restrictions on the consumption of tobacco cigarettes, alcoholic beverages, and physical activity in the German population. Besides, our data complement the data from many other countries to generate as much knowledge as possible around the world. We were able to indicate that the restrictions in spring 2020 has consequences for the health behaviour of people living in Germany. It is positive that some people have used this time to improve their health behaviour, but for many (especially smokers) there are significant negative health consequences. Regarding physical activity, it would be interesting to differentiate between physical activities (strength training, team sports, other activities, etc.) to find out whether it would be possible and useful to switch to new formats (online courses) to counteract the decrease here.

The present study has some limitations. First, the survey period (June-August 2020) is a few months away from the interested period of our study (March-May 2020, as well as the time immediately before). It is possible that the respondents do not remember the past events exactly (*recall bias*). Second, data were assessed by self-reports. People may answer in a socially desirable way in such surveys, for example by reporting a lower alcohol and tobacco consumption, or higher physical activity. Third, we did not collect the precise level of behaviour change. Knowledge on the increase in daily cigarettes or alcoholic beverages, for example, may allow a deeper understanding on relevant changes. Another aspect is that no causal relationship between a change in health behaviour and the pandemic-related restrictions can be proven with the cross-sectional study design.

However, our study has strengths: besides a large and representative sample, another strength is the analysis of associations of health behaviour change with socioeconomic and sociodemographic characteristics.

## Conclusion

The first national COVID-19 restrictions in 2020 influenced the health-related behaviour of around 40% of the people living in Germany. People with a lower level of education, higher income and younger age seems to be particularly more vulnerable of changing their health behaviour negatively. During the ongoing pandemic, monitoring of health behaviour changes will remain important. Further health policies also need to be developed to counteract negative changes and support positive changes in health behaviour. Particularly affected groups of the population should be targeted.

## Declarations

### Funding

The study was funded in the period 2016-2019 by the Ministry for Innovation, Science and Research of the State of North Rhine-Westphalia and since 2019 by the Federal Ministry of Health.

## Competing interests

The authors declare that they have no actual or potential competing interests.

## Ethics approval

The study was approved by the ethics committee of the Heinrich-Heine-University Duesseldorf (HHU 5386R).

## Author contributions

Stephanie Klosterhalfen: Formal analysis, Data curation, Writing original draft, Visualization. Daniel Kotz: Conceptualization, Methodology, Validation, Writing – review & editing, Supervision, Project administration, Funding acquisition. Sabrina Kastaun: Conceptualization, Methodology, Validation, Writing – review & editing, Supervision, Project administration. All named authors contributed substantially to the manuscript and agreed on its final version.

## Abbreviations

### CI

Confidence interval

### DEBRA

Deutsche Befragung zum Rauchverhalten

### OR

Odds ratio

## References

1. Süddeutsche Zeitung. Die Coronavirus-Pandemie in Bayern - die Monate Januar und Februar. 2020. Available from: <https://www.sueddeutsche.de/bayern/coronavirus-bayern-rueckblick-januar-februar-1.4794769>. Accessed 04 Oct 2020.
2. Federal Government. German government sets up crisis unit 2020 27.02.2020. Available from: <https://www.bundesregierung.de/breg-en/issues/krisenstab-ingerichtet-1726150>. Accessed 04 Oct 2020.
3. Robert Koch-Institut. Täglicher Lagebericht des RKI zur Coronavirus-Krankheit-2019 (COVID-19) 10.03.2020 –aktualisierter Stand für Deutschland 2020. Available from: [https://www.rki.de/DE/Content/InfAZ/N/Neuartiges\\_Coronavirus/Situationsberichte/2020-03-10-de.pdf?\\_\\_blob=publicationFile](https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/2020-03-10-de.pdf?__blob=publicationFile). Accessed 24 Nov 2020.

4. ZDF heute. Corona-Pandemie - Diese Ausgangsbeschränkungen gelten in Europa 29.03.2020. Available from: <https://www.zdf.de/nachrichten/politik/coronavirus-ausgangsbeschraenkungen-was-gilt-wo-europa-100.html>. Accessed 08.Oct 2020
5. Statistisches Bundesamt (Destatis). *Statistik Dossier: Daten zur COVID-19-Pandemie Ausgabe 16/2020*. 2020. Available from: [https://www.lfv-bb.de/s/wp-content/uploads/2020/10/dossier-covid-19\\_Statistisches\\_Bundesamt.pdf](https://www.lfv-bb.de/s/wp-content/uploads/2020/10/dossier-covid-19_Statistisches_Bundesamt.pdf). Accessed 04 Oct 2020.
6. Robert Koch-Institut. Täglicher Lagebericht des RKI zur Coronavirus-Krankheit-2019 (COVID-19) - 20.03.2020 aktualisierter Stand für Deutschland. 2020. Available from: [https://www.rki.de/DE/Content/InfAZ/N/Neuartiges\\_Coronavirus/Situationsberichte/2020-03-20-de.pdf?\\_\\_blob=publicationFile](https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/2020-03-20-de.pdf?__blob=publicationFile). Accessed 24 Nov 2020.
7. Blick.de. Raucherinnen und Raucher sind stärker durch Corona gefährdet. 17.04.2020. Verlag Anzeigenblätter GmbH Chemnitz. Available from: <https://www.blick.de/chemnitz/raucherinnen-und-raucher-sind-st-rker-durch-corona-gef-hrdet-artikel10774479>. Accessed 24.06.2020.
8. Brooks SK., et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet*. 2020. 395(10227): 912-920; [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8)
9. World Health Organization (WHO). Psychische Gesundheit und Covid-19. Available from: <https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/mental-health-and-psychological-resilience-during-the-covid-19-pandemic>. Accessed 08 Jan 2021.
10. World Health Organization (WHO). Press briefing held on 26 March by Dr Aiysha Malik. 2020; Available from: <https://www.youtube.com/watch?v=vYqSxCBGOEg&feature=youtu.be>. Accessed 10 Jan 2021.
11. Usher K, Bhullar N, Jackson D. Life in the pandemic: Social isolation and mental health. *J Clin Nurs*. 2020. 29(15-16): 2756-2757. <https://doi.org/10.1111/jocn.15290>
12. Atalan A. Is the lockdown important to prevent the COVID-19 pandemic? Effects on psychology, environment and economy-perspective. *Ann. Med. Surg*. 2020. 56: 38-42. <https://doi.org/10.1016/j.amsu.2020.06.010>
13. Tran, TD, et al. Alcohol use and mental health status during the first months of COVID-19 pandemic in Australia. *J. Affect. Disord*. 2020. 277: 810-813. <https://doi.org/10.1016/j.jad.2020.09.012>
14. Bommelé J, et al., The double-edged relationship between COVID-19 stress and smoking: Implications for smoking cessation. *Tob Induc Dis*. 2020. 18:36. <https://doi.org/10.18332/tid/125580>
15. Jordan S, et al. Health behaviour and COVID-19: Initial findings on the pandemic *Journal of Health Monitoring*, 2020. Special(8). <https://doi:10.25646/7055>
16. Mattioli AV, et al. COVID-19 pandemic: the effects of quarantine on cardiovascular risk. *Eur J Clin Nutr*. 2020. 74(6): 852-855. <https://doi.org/10.1038/s41430-020-0646-z>
17. Gómez-Pardo E, et al. A Comprehensive Lifestyle Peer Group-Based Intervention on Cardiovascular Risk Factors: The Randomized Controlled Fifty-Fifty Program. *J Am Coll Cardiol*. 2016. 67(5): 476-85.

<http://dx.doi.org/10.1016/j.jacc.2015.10.033>

18. Valero-Elizondo J, et al. Economic Impact of Moderate-Vigorous Physical Activity Among Those With and Without Established Cardiovascular Disease: 2012 Medical Expenditure Panel Survey. *J Am Heart Assoc.* 2016. 5(9):e003614. <https://doi.org/10.1161/JAHA.116.003614>
19. King AC, Powell KE, Kraus WE. The US Physical Activity Guidelines Advisory Committee Report- Introduction. *Med Sci Sports Exerc.* 2019. 51(6): 1203-1205. <https://doi.org/10.1249/MSS.0000000000001946>
20. Ekelund U, et al. Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants. *Br J Sports Med.* 2019. 53(14): 886-894. <https://doi.org/10.1136/bjsports-2017-098963>
21. Lee SF, et al. An investigation and comparison of the effectiveness of different exercise programmes in improving glucose metabolism and pancreatic  $\beta$  cell function of type 2 diabetes patients. *Int J Clin Pract.* 2015. 69(10): 1159-70. <https://doi.org/10.1111/ijcp.12679>
22. Martland R, et al. Can high-intensity interval training improve physical and mental health outcomes? A meta-review of 33 systematic reviews across the lifespan. *J Sports Sci*, 2020. 38(4): 430-469. <https://doi.org/10.1016/j.jad.2019.11.039>
23. Martland R, et al. Can high intensity interval training improve health outcomes among people with mental illness? A systematic review and preliminary meta-analysis of intervention studies across a range of mental illnesses. *J Affect Disord*, 2020. 263: 629-660. <https://doi.org/10.1080/02640414.2019.1706829>
24. Spring KE, Holmes ME, Smith JW. Long-term Tennis Participation and Health Outcomes: An Investigation of "Lifetime" Activities. *Int J Exerx Sci.* 2020. 13(7): 1251-1261.
25. Centers for Disease Control and Prevention (CDC). Physical activity and health. 2020. Available from: <https://www.cdc.gov/physicalactivity/basics/pa-health/index.htm#ReducedCancer>. Accessed 10 Jan 2021
26. Deutscher Bundestag, Drucksache 19/20483, Tabakkonsum und COVID-19 2020, Deutscher Bundestag: Berlin. Available from: <https://dip21.bundestag.de/dip21/btd/19/204/1920483.pdf> Accessed 03 Mar 2021
27. Grossman ER, Benjamin-Neelon SE, Sonnenschein S. Alcohol Consumption during the COVID-19 Pandemic: A Cross-Sectional Survey of US Adults. *Int J Environ Res Public Health*, 2020. 17(24). <https://doi.org/10.3390/ijerph17249189>
28. Vanderbruggen N, et al. Self-Reported Alcohol, Tobacco, and Cannabis Use during COVID-19 Lockdown Measures: Results from a Web-Based Survey. *Eur Addict Res* 2020;26:309–315. <https://doi.org/10.1159/000510822>
29. Constandt B, et al. Exercising in Times of Lockdown: An Analysis of the Impact of COVID-19 on Levels and Patterns of Exercise among Adults in Belgium. *Int J Environ Res Public Health*, 2020.

- 17(11). <https://doi.org/10.3390/ijerph17114144>
30. Stanton R, et al. Depression, Anxiety and Stress during COVID-19: Associations with Changes in Physical Activity, Sleep, Tobacco and Alcohol Use in Australian Adults. *Int J Environ Res Public Health*, 2020. 17(11). <https://doi.org/10.3390/ijerph17114065>
31. Garnett C, et al. Factors associated with drinking behaviour during COVID-19 social distancing and lockdown among adults in the UK. *Drug Alcohol Depend*. 2021. 219: 108461. <https://doi.org/10.1016/j.drugalcdep.2020.108461>
32. Naughton F, et al. Health behaviour change during the UK COVID-19 lockdown: Findings from the first wave of the C-19 health behaviour and well-being daily tracker study. *Br J Health Psychol*. 2021. 26(1): 624-643. <https://doi.org/10.1111/bjhp.12500>
33. Siddiqi K, et al. The impact of COVID-19 on smoking patterns in Pakistan: findings from a longitudinal survey of smokers. *Nicotine Tob Res*. 2020. 23(4): 765-769. <https://doi.org/10.1093/ntr/ntaa207>
34. Di Renzo L, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *J. Transl Med. Res*. 2020. 18(1): 229. <https://doi.org/10.1186/s12967-020-02399-5>
35. Janssen X, et al. Changes in Physical Activity, Sitting and Sleep across the COVID-19 National Lockdown Period in Scotland. *Int J Environ Res Public Health*. 2020. 17(24). <https://doi.org/10.3390/ijerph17249362>
36. Jackson SE, et al. Association of the Covid-19 lockdown with smoking, drinking, and attempts to quit in England: an analysis of 2019-2020 data. *Addiction*. 2020. 116(5): 1233-1244. <https://doi.org/10.1111/add.15295>
37. Stockwell S, et al. Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. *BMJ Open Sport Exerc. Med*. 2021. 7: e000960. <http://dx.doi.org/10.1136/bmjsem-2020-000960>.
38. Naughton F, et al. Health behaviour change during the UK COVID-19 lockdown: Findings from the first wave of the C-19 health behaviour and well-being daily tracker study. *Br J Health Psychol*. 2021. 26(2): 624-643. <https://doi.org/10.1111/bjhp.12500>
39. Georgiadou E, et al. Alkohol und Rauchen: Die COVID-19-Pandemie als idealer Nährboden für Süchte. *Dtsch Arzteb*. 2020. 117: A-1251/B.
40. Kastaun S, et al. Study protocol of the German Study on Tobacco Use (DEBRA): a national household survey of smoking behaviour and cessation. *BMC public health*, 2017. 17(1): 378-378. <https://doi.org/10.1186/s12889-017-4328-2>
41. Statistisches Bundesamt (Destatis). Pressemitteilung Nr. 148 vom 25. März 2021. Available from: [https://www.destatis.de/DE/Presse/Pressemitteilungen/2021/03/PD21\\_148\\_799.html](https://www.destatis.de/DE/Presse/Pressemitteilungen/2021/03/PD21_148_799.html). Accessed 26 Mar 2021
42. Statistisches Bundesamt (Destatis). Pressemitteilung Nr. N 003 vom 18. Januar 2021. Available from: [https://www.destatis.de/DE/Presse/Pressemitteilungen/2021/01/PD21\\_N003\\_799.html](https://www.destatis.de/DE/Presse/Pressemitteilungen/2021/01/PD21_N003_799.html). Accessed 27 Mar 2021

43. Busse H, et al. Engagement in Health Risk Behaviours before and during the COVID-19 Pandemic in German University Students: Results of a Cross-Sectional Study. *Int. J. Environ. Res. Public Health*. 2021. 18(4): 1410. <https://doi.org/10.3390/ijerph18041410>
44. Lesser IA, Nienhuis CP. The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. *Int. J. Environ. Res. Public Health*. 2020. 17(11): 3899. <https://doi.org/10.3390/ijerph17113899>
45. Manthey J, et al. Alkoholkonsum in Deutschland und Europa während der SARS-CoV-2 Pandemie. *Sucht*. 2020. 66(5): 247-258. <https://doi.org/10.1024/0939-5911/a000686>
46. Winstock AR, et al. Global Drug Survey Special Edition on COVID-19. Special Edition Key Findings Report. 2020. Available from: <https://www.globaldrugsurvey.com/gds-covid-19-special-edition-key-findings-report/>. Accessed 02 Jan 2021
47. Kehl M, et al. The Person Who Plays Handball Needs the Ball, the Contact and the Community – Changes in Sport Club Activities Due to the COVID-19 Pandemic and its Significance for Sports Clubs. *Gesundheitswesen*. 2021. 83: 156-165.

## Tables

**Table 1:** Sociodemographic and socioeconomic characteristics of the total sample of 4078 participants (unweighted data).

<b>Age years (mean ± SD)</b>	49.3 ± 18.6
14-17	3.8 (155)
18-24	9.4 (382)
25-39	19.3 (788)
40-64	44.0 (1795)
65+	23.5 (958)
<b>Sex</b>	
Female	51.1 (2084)
Male	48.9 (1994)
<b>Education<sup>§</sup></b>	
Low	26.4 (1076)
Middle	36.6 (1493)
High	32.2 (1315)
<b>Income<sup>  </sup></b>	
Low	12.8 (520)
Middle	64.6 (2633)
High	22.7 (925)

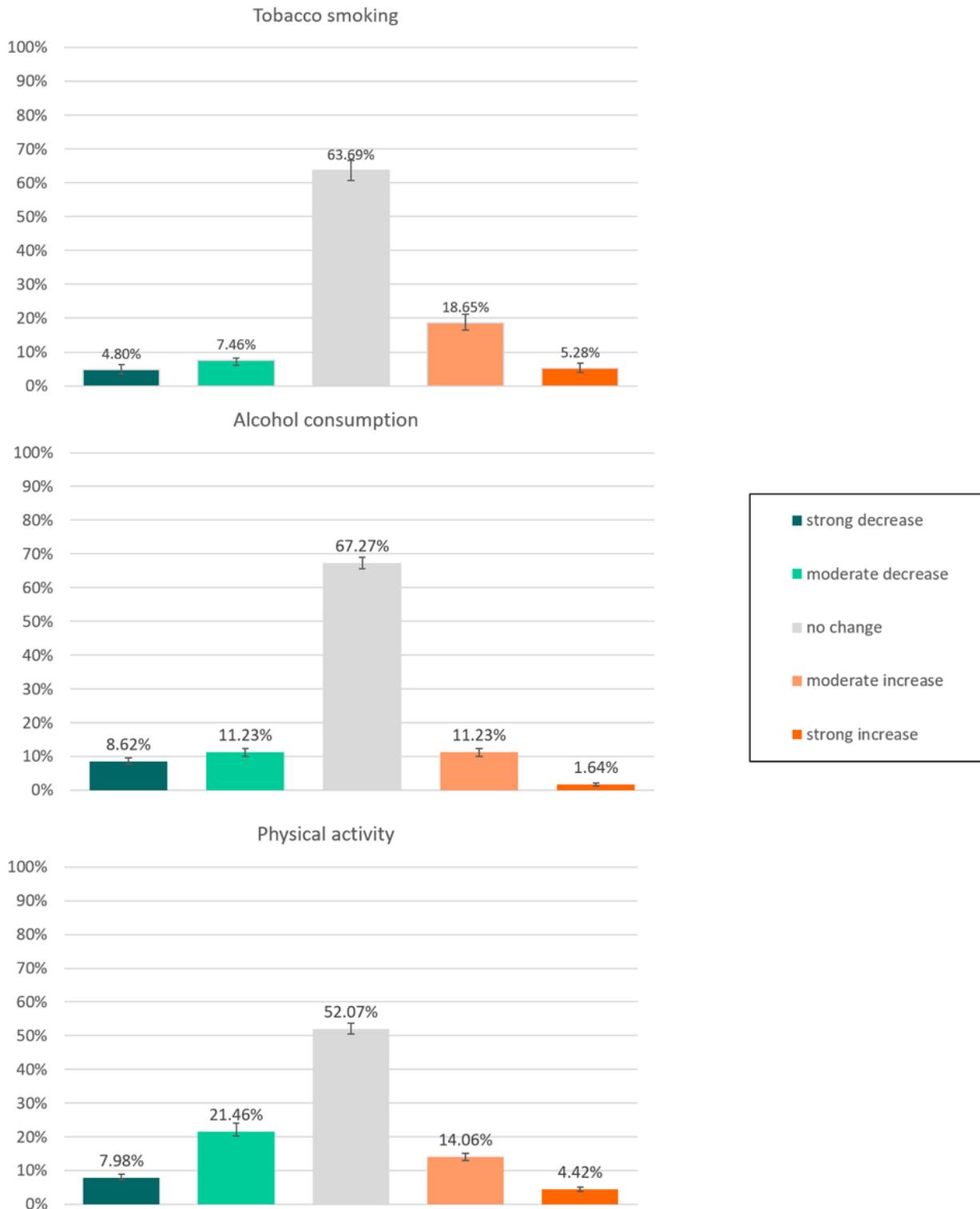
Data are presented as percentages (absolute numbers) within column unless otherwise noted. Differences when calculating the total percentages in column can be explained by missing data. <sup>§</sup>German equivalents to education levels listed from lowest to highest: low=no qualification or junior high school equivalent (“Hauptschulabschluss”), middle=secondary school equivalent (“Realschulabschluss”), high=advanced technical college equivalent (“Fachhochschulreife”) or high school equivalent (“Allgemeine Hochschulreife”). <sup>||</sup>Income is listed from low to high: income in three categories: low (=approximately < 20<sup>th</sup> income percentile), middle (=approx. 20<sup>th</sup> to 80<sup>th</sup> income percentiles), and high (=approx.>80<sup>th</sup> income percentile). The sample of all available DEBRA waves is roughly comparable with the income distribution in the German population.

results of three multinomial logistic regression analyses: Associations of changes regarding smoking behaviour, consumption and physical activity during the first COVID-19 restrictions in Germany with socioeconomic and demographic characteristics of respondents (unweighted data).

Covariates <sup>¶</sup>	OR (95% CI)					
	Tobacco smoking		Alcohol consumption		Physical activity	
	Decrease vs. no change	Increase vs. no change	Decrease vs. no change	Increase vs. no change	Decrease vs. no change	Increase vs. no change
	N=1167 <sup>#</sup>		N=2954 <sup>#</sup>		N=3826 <sup>#</sup>	
Age <sup>§</sup>	0.99 (0.98-1.00)*	0.98 (0.97-0.99)***	0.99 (0.98-0.99)***	0.98 (0.97-0.98)***	1.00 (0.99-1.00)	0.98 (0.97-0.98)***
Sex						
Female (reference)	1	1	1	1	1	1
Male	0.74 (0.50-1.09)	0.88 (0.66-1.17)	1.11 (0.92-1.34)	1.01 (0.80-1.28)	0.80 (0.70-0.93)**	0.87 (0.73-1.05)
Education <sup>‡</sup>						
High (ref)	1	1	1	1	1	1
Middle	0.61 (0.40-0.95)*	1.00 (0.70-1.42)	0.82 (0.66-1.01)	1.04 (0.79-1.36)	0.83 (0.70-0.99)*	0.63 (0.51-0.77)***
Low	0.49 (0.28-0.85)*	1.30 (0.88-1.93)	0.60 (0.46-0.78)***	0.88 (0.63-1.25)	0.71 (0.58-0.87)***	0.40 (0.30-0.52)***
Net household income <sup>§</sup>	1.22 (0.95-1.56)	1.30 (1.08-1.58)**	1.00 (0.89-1.13)	1.26 (1.08-1.46)**	1.02 (0.92-1.13)	1.19 (1.06-1.34)**

were adjusted for all listed covariates. Data are presented as odds ratios (OR) together with a 95% confidence interval (95% CI). \* p< 0.05 \*\*p<0.01 \*\*\*p≤0.001. <sup>§</sup>Age and income (net household income in Euro (€) per month among younger-olds (€0 to €7000 or more)) were treated as continuous variables for regression analyses. <sup>#</sup>Selected cases in analyses). <sup>‡</sup>German equivalents to education levels listed from lowest to highest: low=no qualification or junior school equivalent (“Hauptschulabschluss”), middle=secondary school equivalent (“Realschulabschluss”), and unskilled technical college equivalent (“Fachhochschulreife”) or high school equivalent (“Allgemeine Hochschulreife”).

## Figures



**Figure 1**

Prevalence data on self-reported health behaviour changes during the first COVID-19 restrictions (March to May 2020) compared to the time immediately before these restrictions were implemented (with 95% confidence interval, weighted data).

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTableIKlosterhalfenetal.docx](#)