

ORIGINAL ARTICLE

Health-related and socio-economic burden of the COVID-19 pandemic in Vienna

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Abstract

Previous pandemics have rarely affected everyone equally and, so far, the COVID-19 pandemic is no exception. Emerging evidence has shown that incidence rate, hospitalisation rate, and mortality due to COVID-19 are higher among people in lower socio-economic position (SEP). In addition, first investigations indicate that not everyone is equally affected by this pandemic's collateral public health damage. Using a stratified random sample of 1,004 participants living in Vienna, a Central European city with approximately 1.9 million inhabitants, this study analysed the distribution of 10 adverse health-related and socio-economic outcomes attributable to the COVID-19 pandemic across socio-economic strata. To this end, we estimated differences in the incidence rate of these outcomes by SEP and each of its indicators using zero-inflated Poisson and logistic regression models, adjusted for age and gender. Data were collected during first lockdown measures between 27 April and 17 May 2020. Differences in the incidence rate between the two lowest and two highest SEP groups were clearly visible. Participants in the lowest SEP category had a 32.96% higher incidence rate (IRR = 1.333 [95% CI: 1.079–1.639]), and participants in the second lowest SEP category had a 44.69% higher incidence rate (IRR = 1.447 [95% CI: 1.190–1.760]) compared with participants in the highest SEP category. In sum, 6 out of 10 adverse COVID-19-related outcomes were, to a greater or lesser extent, disproportionately experienced by Viennese residents in lower SEP. Inequalities were most visible between income groups and for the outcomes job loss, worsening of the financial situation, and worse mental health. These results strengthen and extend the current evidence on the unequally distributed burden of the COVID-19 pandemic. In light of effect heterogeneity across SEP indicators, we encourage future investigators to pay increased attention to their operationalisation of SEP. Such awareness will help to correctly identify those in most urgent need of supportive policies.

KEYWORDS

Austria, COVID-19, health inequalities, pandemic, socio-economic position, Vienna

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1 | BACKGROUND

Previous pandemics have rarely affected everyone equally. In retrospect, analyses have shown that the disease burden of the Black Death in the 14th century (Scott & Duncan, 2001), the Influenza pandemic in 1918 (Bengtsson et al., 2018; Grantz et al., 2016; Mamelund, 2006; Murray et al., 2006), and the H1N1 Influenza in 2009 (Lowcock et al., 2012; Rutter et al., 2012) was disproportionately carried by people in low socio-economic positions (SEPs). Putting together the insights of decades of research into health inequalities, many essays, editorials, and comments have pointed out several reasons for why the COVID-19 pandemic will likely be no exception (Ahmed et al., 2020; Ali et al., 2020; Bambra et al., 2020; Bowleg, 2020; Devakumar et al., 2020; Dorn et al., 2020; Liem et al., 2020; Marmot & Allen, 2020; Patel et al., 2020; Ribeiro & Leist, 2020; The Lancet, 2020; Van Lancker & Parolin, 2020; Wang & Tang, 2020). These explanations often aim to answer why incidence rate, hospitalisation rate (severe cases), and mortality due to COVID-19 are higher among people in lower SEP.

Presently, the constant emergence of new evidence indeed corroborates the anticipated inequalities in the risk of infection with, hospitalisation, and death due to COVID-19 (Chen & Krieger, 2020; Kim & Bostwick, 2020; Lassale et al., 2020; Nazroo & Becares, 2020; Plümpner & Neumayer, 2020; Price-Haywood et al., 2020; Schmitt-Grohé et al., 2020; Wadhwa et al., 2020). However, the COVID-19 pandemic might not only disproportionately affect people in lower SEP in regard to the virus itself. There are serious concerns for potential collateral damage as a consequence of lockdown measures. Certainly, such societal lockdowns are effective in containing the spread of the virus but might be accompanied by delicate costs for public health. The temporary closure of businesses, restricted tourism, cancelling of public events, and so forth has led to unemployment levels unmatched by the financial crisis in 2008. Drawing from evidence of the consequences of this previous economic shock and subsequent recession, a rise in suicide rates and an increased prevalence of mental illnesses, particularly among the socially disadvantaged, are anticipated (Barr et al., 2015; Corcoran et al., 2015; Kawohl & Nordt, 2020; Reger et al., 2020). However, not only the economic shock induced by a lockdown may exacerbate health inequalities. Health-related adverse experiences in the wake of the COVID-19 pandemic can also be unequally distributed across socio-economic strata because of occupation, housing conditions, opportunities for home office and home schooling, and access to recreational spaces.

In anticipation of an unprecedented mental health crisis caused by societal shutdowns, many researchers have collected and analysed survey data on different mental health outcomes during the first nationwide lockdown measures across the globe between March and May 2020. This rapid evolvement of the peer-reviewed and not yet peer-reviewed evidence produced a large body of literature on this pandemic's initial effects on mental health documenting an increase in population level anxiety, depression, psychological distress, suicidal ideation, and loneliness (Bu et al., 2020; Chandola

What is known about this topic?

- Previous pandemics have rarely affected everyone equally.
- Emerging evidence showed that the burden of the COVID-19 pandemic in regard to the virus itself is disproportionately carried by low-income groups and ethnic minorities.
- Less is known about the distribution of the collateral public health damage caused by societal lockdowns.

What this paper adds?

- This study analyses data from a stratified random sample of people living in Vienna, a Central European city with 1.9 million inhabitants.
- Our results strengthen the evidence on the unequal distribution of this pandemic's collateral public health damage across socio-economic strata for an urban Central European context.
- Inequalities were most visible along income groups and for the adverse outcomes job loss, worsening of the financial situation, and worse mental health.

et al., 2020; Jia et al., 2020; Niedzwiedz et al., 2021; O'Connor et al., 2020; Pierce et al., 2020). Hardly surprising, these decreases in mental health were not equally distributed across society. Inequalities along different indicators of SEP were visible for many mental health outcomes (Chandola et al., 2020; Iob et al., 2020; O'Connor et al., 2020; Pieh et al., 2020; Pierce et al., 2020) and for aggregate measures combining adverse socio-economic and health-related outcomes (Witteveen & Velthorst, 2020; Wright et al., 2020). By now, available longitudinal data even allowed researchers to study how this pandemic's effects on mental health changed since its beginning, showing that the incidence of common mental disorders (CMD) among adults without CMDs 1 year earlier sharply increased (29%) in April 2020 but again decreased (9%) by July 2020 (Chandola et al., 2020). Moreover, the same data indicated that this decline of social and psychological stressors was not equally present across socio-economic strata (Chandola et al., 2020). Drawing from different longitudinal data on anxiety and depressive symptoms between 23 March and 9 August 2020, another study conducted in the United Kingdom confirms this observation. Although the initial adverse mental health effects have steadily levelled off in the course of this observed time frame, people with lower household income have not only started this phase of the pandemic with worse mental health but also remained at a higher level of anxiety and depressive symptoms throughout (Fancourt et al., 2021).

Using data from a stratified random sample of Viennese residents collected during the early phase of this pandemic, we analysed whether adverse health-related and socio-economic outcomes were

disproportionately experienced along socio-economic strata. We contribute to the rapidly accumulating evidence on the unequally distributed burden of the COVID-19 pandemic by providing estimates on how unequally this crisis affected different socio-economic groups in regard to socio-economic, physical, and mental health outcomes in an urban, Central European, context.

2 | METHOD

2.1 | Data

Our data consist of a stratified random sample of 1,004 Viennese residents aged 16 or older. Vienna, the capital of Austria, is a Central European city with approximately 1.9 million inhabitants. Austria is a neighbour of Italy which detected the first case of COVID-19 in Europe on 21 February 2020 (Indolfi & Spaccarotella, 2020), 6 days before the first case was detected in Vienna (Czypionka, 2020). Subsequently, the first Austrian-wide lockdown measures came into effect on the 17th of March at around 1,332 (at that time 166 in Vienna) detected cases out of which 1,150 cases were detected in the preceding week (BMSGPK, 2020). All shops (reopened on the second of May) and restaurants were opened again on the 15th of May at around in total 16,093 reported cases in Austria (in total 2,865 in Vienna). Three hundred seventy-nine new cases were reported in the week before reopening (BMSGPK, 2020). In sum, Austrian lockdown measures were in place for more or less 60 days. Data were collected between the 27th of April and the 17th of May by the social research institute SORA (Institute for Social Research and Consulting) via computer-assisted telephone interviews. In total, 8,448 participants aged 16 or older were drawn from a random sample stratified by the 23 districts of Vienna (11.9% response rate). To mitigate the impact of the response rate on representativeness, the data were weighted according to age, gender, education, employment status, and citizenship of the underlying study population.

2.2 | Variables

2.2.1 | Adverse health-related and socio-economic outcomes

We constructed a variable that captures the cumulative experience of adverse outcomes of each study participant in the wake of the COVID-19 pandemic. In our data, the experience of 10 different adverse outcomes attributable to the pandemic were available. Three were socio-economic outcomes: (a) whether the financial situation of participants has worsened in the course of the pandemic, (b) whether participants have lost their job due to the pandemic, or (c) whether participants were forced into "short work." In order to prevent employers from dismissing their employees, a "short work" ("Kurzarbeit") scheme was negotiated in which the

state covers the personnel expenses of employers while working hours and thus income of employees is reduced. Working hours of employees in short work have to be reduced by at least 10% but are not allowed to be lower than 10% of previous working hours during the entire short work period. Affected employees get at least 80% of their gross income. However, not all additional compensations are covered which could, in some cases, lead to an effective reduction of income by more than 20% (ÖGB & AK, 2020). Seven adverse outcomes were health related: (a) self-perceived worsening of mental or (b) of physical health in the course of the pandemic, (c) severely or rather severely suffering from symptoms of acute stress disorder due to COVID-19-related experience or reporting, (d) very or quite worried oneself or (e) someone close gets infected with COVID-19, and (f) oneself or (g) someone close suspected or diagnosed with COVID-19. For the health-related adverse outcome of suffering from symptoms of acute stress disorder (c), participants were asked to report whether they have, in the wake of the COVID-19 pandemic, "never," "sometimes," "often," or "all the time" experienced any of 14 symptoms related to acute stress disorder taken from the "DIPS Open Access: Diagnostic Interview for Mental Disorders" (Margraf et al., 2017; Margraf et al., 2017). In a follow-up question, participants who reported having experienced any symptoms of acute stress disorder were asked whether they suffer "not at all," "a bit," "rather severely," or "severely" from these experiences.

The experience of each outcome was coded as dichotomous variables (0 = has not experienced; 1 = has experienced) and summed up to form a score ranging from 0 to 10, denoting the total count of adverse experiences of the participant. Although some outcomes might be more damaging to health than others, we did not apply any arbitrary weightings to our outcomes. Instead, we chose to additionally present separate analyses for each outcome (Figure 3 and S1–S5 and Table S5).

2.2.2 | Equivalised household income

Participants were asked to indicate their monthly household net income by choosing the appropriate category: <900€ (1), 900–1,200€ (2), 1,200–1,500€ (3), 1,500–2,000€ (4), 2,000–2,500€ (5), 2,500–3,000€ (6), 3,000–4,000€ (7), 4,000–4,500€ (8), 4,500–5,000€ (9), 5,000–5,500€ (10), 5,500–6,000€ (11), and >6,000€ (12). To account for household size and composition, we used the OECD (Organisation for Economic Co-operation and Development) scale to weight each member of the household. The age cut-offs were adjusted according to the information available. The first adult member (≥ 16 years old) has a weight of 1. Each additional adult member has a weight of 0.5, and each additional child or adolescent (<16) has a weight of 0.3. The household income category was then equivalised by dividing it by the sum of these weights. Because of inconvenient interpretation of these values, which is due to the way household income was assessed, we categorised the equivalised monthly household net income values into quintiles.

2.2.3 | Highest educational attainment

Highest educational attainment had four different categories: compulsory school, lower secondary education, upper secondary education, and tertiary education.

2.2.4 | Household overcrowding

Having information about square metres (sqm) of the accommodation and household composition, we assessed overcrowding by using the same method applied in the Austrian micro census. According to this method, overcrowding is present if more than one person lives on less than 35 sqm, if more than two persons live on less than 60 sqm, if more than three persons live on less than 70 sqm, if more than four persons live on less than 90 sqm, and if more than five persons live on less than 110 sqm.

2.2.5 | Occupational position.

Participants who reported being employed were asked to indicate their occupational position: “unskilled labour,” “skilled labour,” “highly skilled labour,” or “managing position.” If participants reported to be unemployed, they were asked for their last occupational position.

2.2.6 | Socio-economic position

We constructed an SEP score composing of equivalised household income, highest educational attainment, and household overcrowding. The score ranged from 0 to 8. The higher the score, the higher the SEP of the participant.

Participants were given 0 to 4 points depending on which income quintile they are in—0 points for placing in the poorest 20% of households and 4 points if a participant was located in the richest 20% of households. Zero (0) points were given for participants whose highest educational attainment was compulsory school, 1 point for lower secondary school, 2 points for upper secondary school, and 3 points for tertiary education. Participants were given 0 points if overcrowding was present and 1 if overcrowding was not present.

Although an important component of the concept of SEP information about the occupational position of the participants was excluded due to the properties of our sample, 50.7% (weighted) had no occupational position but were retired persons, students, on maternity leave, or reported “other” (e.g., “at home”). However, we conducted separate analyses for each component of SEP available presented in [Table 3](#) and [Figure S4](#).

Because a linear interpretation of this SEP score is deemed inappropriate, we further categorised our SEP variable into four balanced categories (0 to 2 = 1, 3 to 4 = 2, 5 to 6 = 3, and 7 to 8 = 4) which can be used in a more flexible model specification. Due to the arbitrariness in our measurement of SEP, we re-estimated our models

with different operationalisations of SEP. To this end, we created a measurement of SEP that used income quartiles instead of quintiles. Participants in the lowest 25% of the income distribution received 0 points, whereas the richest 25% received 3 points. Thus, this sum score ranged from 0 to 7 and was, again, categorised into four categories (0 to 1 = 1, 2 to 3 = 2, 4 to 5 = 3, and 6 to 7 = 4). Furthermore, we also used two more data-driven approaches to measure the SEP of study participants. Using the polychoric correlations among our three indicators of SEP (equivalised household income, education, and household overcrowding), we extracted the principal component score obtained by principal component analysis (PCA) with one extracted component. Similarly, using the same polychoric correlations, we extracted the factor scores from an exploratory factor analysis (EFA) assuming one underlying factor to measure SEP. Both additional measurements of SEP were categorised into quartiles, as we preferred trading a loss in efficiency for lower bias in our modelling approach (in the potential presence of nonlinear associations).

2.2.7 | Demographic characteristics

Gender of participants could either be “male,” “female,” or “other,” and age was given in years.

2.3 | Statistical analysis

To assess if adverse health-related and socio-economic outcomes attributable to the COVID-19 pandemic were disproportionately experienced across socio-economic strata, we estimated zero-inflated Poisson regression models. Thus, it was tested if, and to what extent, placement in the socio-economic strata is associated with the incidence rate of COVID-19-related adverse experiences in Vienna. We chose zero-inflated Poisson regression models, because a value of zero in our score can either be due to truly not having experienced any of the collected adverse outcomes or because the conditions for experiencing job loss and short work were not given in the first place. As this was the case for participants who were not participating in the labour market or were already unemployed before the pandemic, a corresponding dummy variable was included in the inflation equation accounting for the excess zeroes in our sum score for adverse experiences.

In a second analysis, we assessed the effect of each indicator of SEP and occupational position on the incidence rate of adverse outcomes separately. Like this, it is possible to detect if any single component of SEP is driving the relationship between SEP and COVID-19-related adverse outcomes. Additionally, we present concentration curves that show the distribution of the cumulative burden of this pandemic's health-related and socio-economic damage along shares of equivalised household incomes.

In line with a similar study (Wright et al., 2020), we also used logistic regression models to estimate the likelihood of experiencing each single adverse outcome making up our sum score by SEP. This

allowed us to assess whether socio-economic gradients were present in any, some, or every adverse outcome in our composite score. As another sensitivity analysis, zero-inflated negative binomial regression models were estimated and compared with zero-inflated Poisson regression models to assess the impact of marginal overdispersion present in our sum score on our estimates. Furthermore, we used differently operationalised measurements of SEP (see above) in our zero-inflated Poisson and logistic regression models. We also conducted separate analyses using the raw categorical information on household income instead of its equalised version.

All statistical models were estimated without any adjusting variables and adjusting for age and gender of participants.

Statistical analyses were conducted in Stata version 16/IC (StataCorp, 2019). Statistical code used for the presented analyses is openly available on <https://www.researchgate.net/profile/Moritz-Oberndorfer> and will also be unconditionally provided by the corresponding author upon request.

3 | RESULTS

Unweighted sample characteristics are shown in Table 1. Considering demographic characteristics, 54.4% of our unweighted sample was female with a mean age of 49.28 years [48.18–50.37] across genders. Hundred seventy-nine (17.8%) participants were assigned to the lowest SEP category, 31.5% to the second lowest, 29.0% to the second highest, and 15.8% to the highest SEP category. Due to missing data, 5.9% of the sample were not assigned to any SEP category. As a component of our SEP variable, 5.9% were living in overcrowded households. Weighted sample characteristics are shown in Table S1. Applying weights mitigated the overrepresentation of Viennese residents with tertiary education, high income, in highly skilled labour, and women in our data and rendered it fairly representative of the underlying study population. However, our weighted sample still differed in the proportion of overcrowded households compared with micro census data.

Table 2 presents descriptive statistics for our adverse health-related and socio-economic outcomes in the weighted sample. On average, Viennese residents experienced 1.727 [95% CI: 1.597–1.857] out of 10 adverse outcomes related to the COVID-19 pandemic, and 71.9% (722) of the participants experienced one or more adverse outcomes. The three most commonly experienced incidents were (a) being very or quite worried someone close gets infected with COVID-19 (36.6%), (b) that one's financial situation has worsened (30.2%), and (c) that one's self-perceived mental health has worsened (26.7%). The three least frequently experienced outcomes were job loss (3.8%), have been suspected or diagnosed with COVID (4%), and have been suffering from symptoms of acute stress disorder (5.9%). There were no missing data regarding our 10 adverse outcomes.

Figure 1 visualises the results covering the main interest of this study. By comparing the estimated number of experienced adverse outcomes of each SEP category, differences in the incidence rate of adverse COVID-19-related outcomes between the two lowest and

TABLE 1 Unweighted sample characteristics

Variable	Unweighted count (unweighted %)/mean [95% confidence interval]
Socio-economic position	
1 (low)	179 (17.8%)
2	316 (31.5%)
3	291 (29.0%)
4 (high)	159 (15.8%)
Missing	59 (5.9%)
Highest educational attainment	
Compulsory school	142 (14.1%)
Lower secondary	375 (37.4%)
Upper secondary	214 (21.3%)
Tertiary	273 (27.2%)
Missing	0
Equalised household income	
First quintile (poorest 20%)	198 (19.7%)
Second quintile	260 (25.9%)
Third quintile	224 (22.3%)
Fourth quintile	166 (16.5%)
Fifth quintile (richest 20%)	140 (13.9%)
Missing	16 (1.6%)
Household overcrowding	
Not overcrowded	888 (88.5%)
Overcrowded	59 (5.9%)
Missing	57 (5.7%)
Occupational position	
Unskilled	72 (7.2%)
Skilled	255 (25.4%)
Highly skilled	117 (11.65%)
Managing position	54 (5.4%)
Self-employed	92 (9.2%)
Maternity leave, student, retired, and other	414 (41.2%)
Missing	0 (0%)
Gender	
Female	546 (54.4%)
Male	458 (45.6%)
Missing	0
Age	49.28 [48.18–50.37]

two highest SEP groups became clearly visible. However, the well-known gradual relationship between SEP and health, called “socio-economic gradient,” cannot be observed in Figure 1. Accordingly, although there was no statistically significant difference between the two lowest categories of SEP (Wald test: $p = .376$, adjusted model) and between the highest categories (Wald test: $p = .819$, adjusted model), the model estimated a significantly higher incidence of adverse experiences for participants in the two lowest SEP

TABLE 2 Weighted descriptive statistics of adverse outcome related to the COVID-19 pandemic

Outcomes	Weighted count (weighted %)/mean [confidence interval]
All outcomes	1.727 [1.597-1.857]
Experienced one or more outcome	722.0 (71.9%)
Financial situation worsened	303.6 (30.2%)
Job loss	38.4 (3.8%)
Short work	124.2 (12.4%)
Mental health worsened	268.2 (26.7%)
Physical health worsened	156.5 (15.6%)
Suffering from symptoms of acute stress disorder	59.5 (5.9%)
Suspected or diagnosed with COVID-19	40.5 (4.0%)
Someone close suspected or diagnosed with COVID-19	137.2 (13.7%)
Very/quite worried to get infected with COVID-19	238.7 (23.8%)
Very/quite worried someone close gets infected with COVID-19	368.0 (36.6%)

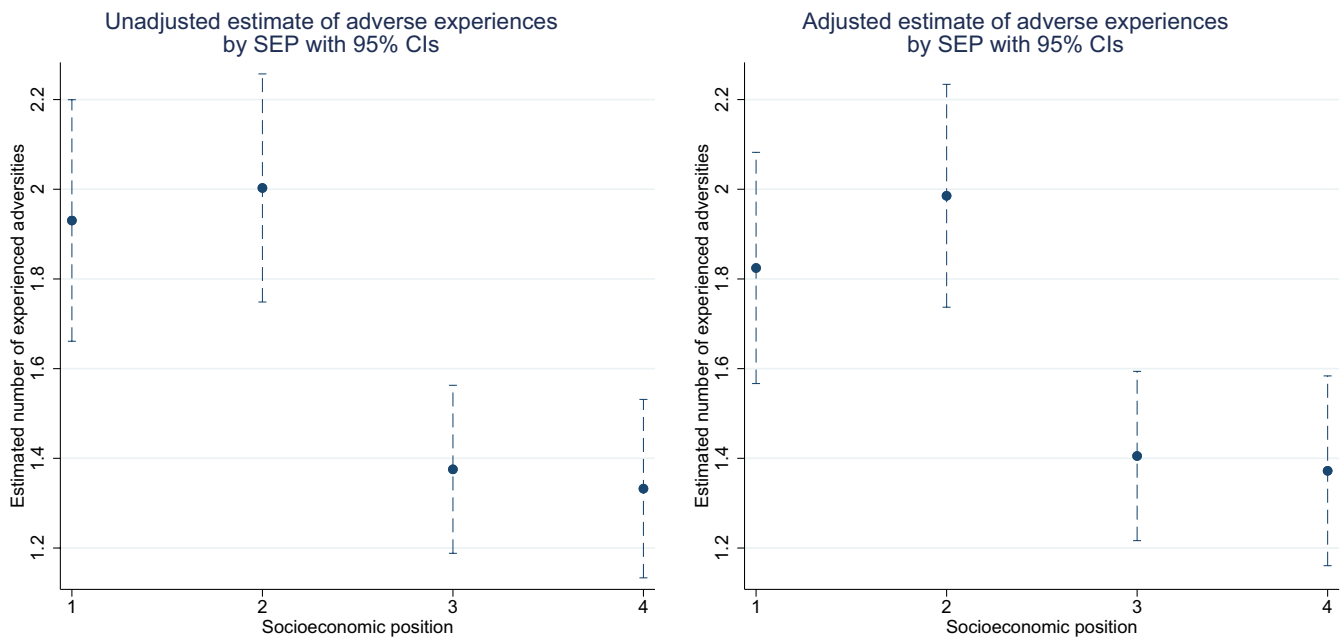


FIGURE 1 Estimated mean number of experienced adverse COVID-19-related outcomes by socio-economic position (1 = low, 4 = high) with 95% confidence intervals. Estimates were derived from zero-inflated Poisson regression models. Estimates in the left panel are unadjusted. Estimates in the right panel are adjusted for gender and age

categories (1 and 2) compared with participants in the two highest SEP groups (3 and 4) ($p < .001$). Whereas participants in the highest SEP category, adjusted for age and gender, experienced 1.372 [95% CI: 1.161-1.584] COVID-19-related adverse outcomes, the model estimated 1.985 [95% CI: 1.737-2.234] incidents for participants in second lowest and 1.825 [95% CI: 1.567-2.082] for the lowest SEP category. In other words, participants in the lowest SEP category had a 32.96% higher incidence rate (IRR = 1.333 [95% CI: 1.079-1.639]), and participants in the second lowest SEP category had a 44.69% higher incidence rate (IRR = 1.447 [95% CI: 1.190-1.760]) of adverse health-related and socio-economic outcomes compared with participants in the highest SEP category.

Table 3 displays the estimated effects of each component of our SEP measure (estimates for household overcrowding as the only indicator of SEP are presented in Table S2) and occupational position (which was not part of our SEP measurement) on the number of adverse experiences attributable to COVID-19 adjusted for age and gender. Crude estimates can be found in Table S3. Looking at the separately estimated effects of equalised household income, education, and occupational position on the number of adverse experiences, equalised household income appears to be the driving factor behind the association between SEP and the incidence rate of COVID-19-related adverse outcomes. The level of education and occupational position had no statistically significant effect on the

TABLE 3 Incidence rate ratios (IRR) for the experience of adverse COVID-19-related outcomes by socio-economic position (Model 1), equivalised household income (Model 2), highest educational attainment (Model 3), and occupational position (Model 4)

Model	Adjusted incidence rate ratio (lin. std. err.)	95% CI	p-value	Observations (weighted)
<i>Model 1—socio-economic position</i>				943 (929)
1 (lowest)	Ref. category			
2	1.088 (0.104)	[0.902–1.313]	0.376	
3	0.770 (0.075)	[0.636–0.933]	0.008	
4 (highest)	0.752 (0.080)	[0.610–0.927]	0.008	
<i>Model 2—equivalised household income</i>				986 (985.4)
First quintile (poorest 20%)	Ref. category			
Second quintile	0.864 (0.081)	[0.719–1.040]	0.122	
Third quintile	0.799 (0.079)	[0.657–0.970]	0.024	
Fourth quintile	0.644 (0.084)	[0.499–0.831]	0.001	
Fifth quintile (richest 20%)	0.703 (0.084)	[0.556–0.888]	0.003	
<i>Model 3—highest educational attainment</i>				1,001 (998.3)
Compulsory school	Ref. category			
Lower secondary	1.029 (0.107)	[0.834–1.262]	0.783	
Upper secondary	1.131 (0.130)	[0.903–1.418]	0.283	
Tertiary	0.910 (0.090)	[0.750–1.105]	0.341	
<i>Model 4—occupational position</i>				587 (550.8)
Unskilled	Ref. category			
Skilled	0.805 (0.093)	[0.642–1.011]	0.062	
Highly skilled	0.816 (0.119)	[0.614–1.086]	0.164	
Managing position	0.879 (0.136)	[0.649–1.190]	0.402	
Self-employed	0.818 (0.106)	[0.634–1.055]	0.121	

Note: IRRs were estimated by zero-inflated Poisson regression models and are adjusted for gender and age.

Abbreviation: CI, confidence interval.

number of reported incidents. Age was associated with a slightly decreased IRR (0.993 [95% CI: 0.988–0.998]) in Model 1, and being female was associated with a higher IRR (1.173 [95% CI: 1.013–1.359]). These effect estimates did only change negligibly in Models 2–4.

The concentration curve presented in Figure 2 visualises the unequal distribution of the COVID-19 related burden along equivalised household income. Although the poorest 30% of the Viennese population held 15.14% of the total equivalised household income, they carried 38.97% of the total burden of our adverse health-related and socio-economic outcomes (concentration index = -0.117 [95% CI: -0.162 to -0.073]). Adverse incidents were more unequally distributed among men than women, but statistical tests showed no statistically significant difference between genders ($p = .135$).

Apart from assessing the effect of each SEP component on the number of adverse incidents, we also estimated the effect of SEP on each single outcome separately in logistic regression models adjusting for age and gender (Figure 3). For only two outcomes, (a) being very or quite worried that someone close gets infected with COVID-19 and (b) someone close has been diagnosed or suspected with COVID-19, there were no differences in the estimated probability of experiencing these across SEP categories. For one

outcome—worsened physical health—a comparison between the two lowest and the two highest categories was only significant on an alpha level of 0.10. Another job-related outcome—being forced into a short work scheme—showed a reversed socio-economic gradient: Participants in higher SEP categories were more likely to be in short work. In sum, 6 out of 10 adverse COVID-19-related outcomes available in our data set were estimated to be, to a greater or lesser extent, disproportionately experienced by Viennese residents in lower SEP.

Results presented in Table 3 were almost identical to the results obtained by estimating zero-inflated negative binomial models (results presented in Table S4). However, estimating Model 4 this way yielded slightly lower IRRs for all occupational positions (reference category = unskilled) and resulted in lower p -values, rendering the effect of being in a skilled compared with an unskilled occupational position (IRR = 0.793 [95% CI: 0.637–0.986]) statistically significant on an alpha level of 0.05 ($p = .037$). We also used zero-inflated Poisson and logistic regression models to test the sensitivity of our estimates to different operationalisations of SEP (Table S6). Our four different operationalisations of SEP yielded similar effect estimates. Data-driven measurements (PCA and EFA) of SEP resulted in slightly steeper socio-economic gradients in the sum score of adverse

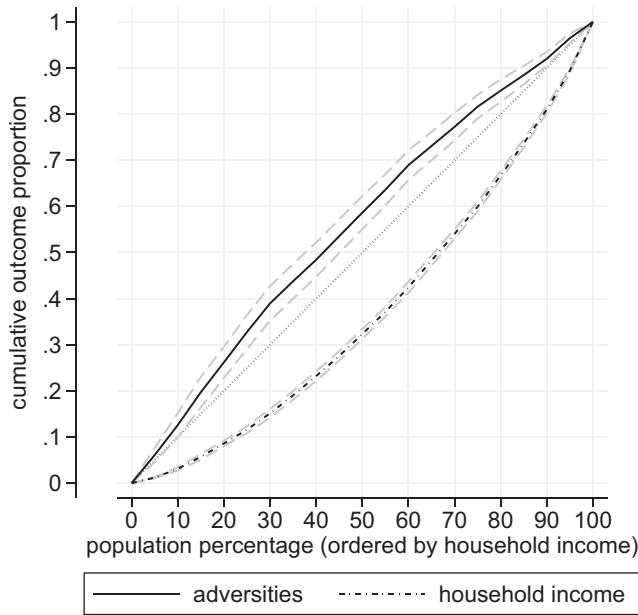


FIGURE 2 Concentration curve for adverse COVID-19-related outcomes and Lorenz curve for equivalised household income. The solid line represents the cumulative proportion of adverse outcomes by population percentage ordered by equivalised household income. The dotted line represents the equality line on which the experience of adverse outcomes would be equally distributed across income groups. The line including dashes and dots represents the share of equivalised household income that is held by each population percentage ordered by equivalised household income on the x-axis

outcomes (Table S6). The polychoric correlation matrix used to conduct PCA and EFA is shown in Table S7.

Using the nonequivalised monthly net household income confirms this graded relationship (Table S6). The estimated average incidence rate for Viennese residents with a household income above 4,000€ was 1.35, whereas residents with a household income below 1,500€ experienced, on average, two adverse outcomes.

4 | DISCUSSION

In analysing data from a stratified random sample of 1,004 Viennese residents collected during first Austrian-wide COVID-19 lockdown measures, our results indeed corroborate expressed concerns that the burden of this pandemic has so far been unequally distributed across socio-economic strata: Viennese residents in lower SEPs bore a disproportionate share of the health-related and socio-economic burden of the COVID-19 pandemic than their counterparts in higher SEPs. However, if, and to what extent Viennese residents in lower SEPs were more adversely affected by this pandemic depends on which outcome is considered and how SEP was operationalised. Estimating the adjusted probabilities for the experience of each adverse outcome by SEP separately, we found that being in the two lowest SEP categories compared with being in the highest SEP category was most strongly associated with a higher incidence rate of (a) suffering from symptoms of acute stress disorder attributable to COVID-19, (b) having lost one's job due to COVID-19, (c) a

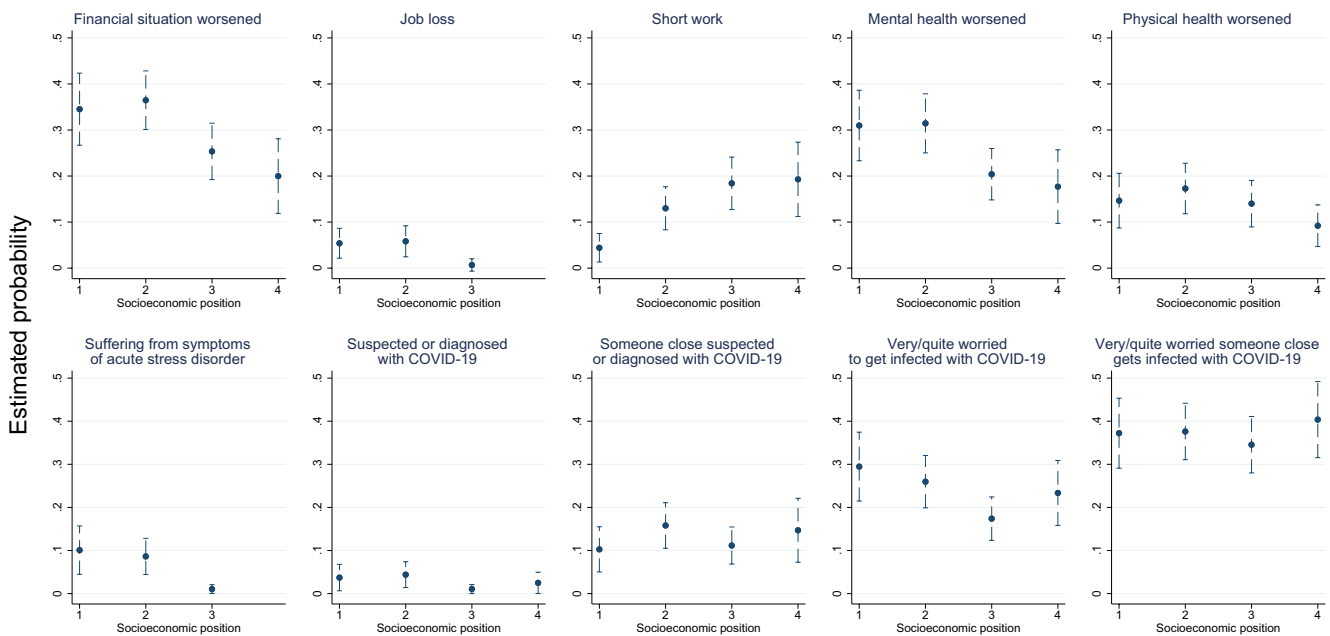


FIGURE 3 Estimated probability of experiencing each adverse COVID-19-related outcome included in the sum score by socio-economic position with 95% confidence intervals. Estimated probabilities were derived from logistic regression models adjusted for age and gender

worsened financial situation due to COVID-19, and (d) a worsened self-perceived mental health due to COVID-19. In contrast, the effect of SEP on the incidence rate of short work pointed in the opposite direction: Although only 1 out of 449 participants in highest two SEP categories had lost their job, participants in higher SEP were more likely to be forced into short work.

The effect of SEP on the incidence rate of adverse COVID-19-related outcomes was also different for each indicator of SEP. Although our data suggest that the sum of adverse experiences were not disproportionately experienced along different levels of education or occupational position, the incidence rate increased as equivalised household income decreased (Table 3). By looking even closer, the data also suggest that different components of SEP predicted the incidence rate of each outcome differently (Figures S2–S5). For example, by estimating the adjusted probability of experiencing a worse financial situation by quintile of equivalised household income, the anticipated gradient became clearly visible (Figure S2). Interestingly, there were no such detected differences across educational levels for the same outcome (Figure S3), and using occupational position as a predictor gave rise to, again, a different picture (Figure S4). Although this could certainly reflect causal heterogeneity in the effect of SEP indicators on the incidence rate of our outcomes, these inconsistencies in the effect of each single component of SEP could also be due to misclassification of participants into SEP categories and/or the relatively small sample size.

Our findings are similar to one of the earliest published studies investigating the cumulative burden of adverse COVID-19-related outcomes by SEP during the first wave of this pandemic in the United Kingdom (Wright et al., 2020). However, our study does not only strengthen previous evidence but also extends it for an urban central European context. Whereas the sample analysed in the aforementioned study was not randomly selected, our study participants were drawn from a stratified random sample. Moreover, we did not assess the same adverse outcomes. Although Wright et al. analysed the adverse experience of (a) job loss, (b) job loss of partner, (c) a cut in household income, (d) an inability to pay bills, (e) losing one's accommodation, (f) inaccessibility of sufficient food and (g) medication, (h) somebody close is ill in hospital, (i) losing someone close, or (j) being suspected or diagnosed with COVID-19, we also assessed outcomes that were more directly related to the health consequences of this pandemic apart from contracting the virus itself. Thereby, we found that the COVID-19 pandemic also affected the mental health of Viennese residents unequally. Accounting for gender and age, participants in lower SEP showed a higher probability of worse mental health than before the pandemic and were more likely to suffer severely or rather severely from symptoms of acute stress disorder due to the pandemic.

Generally, these results confirm what other data on the unequal mental health impact of this pandemic have suggested (Fancourt et al., 2021; Iob et al., 2020; Pieh et al., 2020; Pierce et al., 2020). The effect heterogeneity regarding different indicators of SEP we have observed in our data appears to be reoccurring in other studies estimating inequalities along multiple indicators of SEP. Although researchers consistently found inequalities in the mental health impact of this

pandemic across income groups (Bu et al., 2020; Fancourt et al., 2021; Pieh et al., 2020; Pierce et al., 2020), evidence for a graded relationship across educational levels and COVID-19's mental health burden is weaker. Niedzwiedz et al. (2021), comparing outcomes before and during the early phase of this pandemic, found no graded relationship between educational levels and psychological distress or loneliness. Furthermore, including income and education in their analyses, Bu et al. (2020) found that household income was a predictor for belonging to worse latent growth trajectory classes in loneliness in the United Kingdom (for two of three comparisons between classes) during the first lockdown in the United Kingdom, whereas educational level was not.

Similar to our results, two other studies observed that people in lower SEP have not only experienced worse mental health outcomes but also experienced a higher incidence rate of economic hardship (Witteveen & Velthorst, 2020; Wright et al., 2020), revealing the presence of a socio-economic gradient in a variety of outcome dimensions.

There are some limitations to our study. Considering intersectionality (Bowleg, 2020), our data set prevented us from investigating potential moderators of the association between SEP and adverse COVID-19-related outcomes. Like this, we were limited in our ability to identify vulnerable groups apart from SEP and its indicators. Further, our operationalisation of SEP is to some extent arbitrary and might also suffer from misclassification, which, as has been shown, could have affected the results of this study. Additionally, due to ordered categorical assessment of household income in our survey, the classification of equivalised household incomes into quintiles was also imprecise. To investigate the scope of this potential bias, we re-estimated our models with different measures of SEP and nonequivalised household income (Table S6 and Figures S6–S8). Furthermore, albeit a central indicator of SEP (Galobardes et al., 2007), the scope of our data and its information on occupational class prevented a more comprehensive measurement of SEP.

Despite our data being cross-sectional, the survey questions referring to the analysed adverse outcomes were posed retrospectively or in direct relation to the pandemic which allowed us to attribute these adverse experiences to COVID-19. For example, participants were asked about their self-perceived physical and mental health in contrast to their perception before the pandemic. Similarly, participants were explicitly asked whether they lost their job due to the pandemic. Even though we are confident that the outcomes chosen do not just reflect circumstances that would have been true in absence of COVID-19, the answers to our survey questionnaire may have still been subject to information and recall bias.

Clearly, our study did not cover every possible adverse COVID-19-related outcome. Apart from the outcomes studied by Wright et al. (Wright et al., 2020) and our analysis, several further adverse experiences in the wake of this pandemic, like loneliness because of isolation, are of interest. As early evidence is indicating excess mortality due to other causes than COVID-19 in England and Wales (Vandoros, 2020), a further investigation of potential socio-economic patterns in non-COVID excess mortality during the pandemic is needed. Being worried to get infected, which was socio-economically patterned in our

data, and low health literacy could prevent or delay hospitalisation when necessary and thereby widen health inequalities.

Moreover, our data included randomly selected residents of Vienna, a Central European city with approximately 1.9 million inhabitants, which limits the generalisability of our results to other spatial contexts. Also, this study cannot provide any estimation of the long-term health-related effects of these unequal experiences of the COVID-19 pandemic. On the one hand, this will depend on future measures that aim to contain the spread of the virus in combination with measures that aim to prevent further economic damage and initiate economic recovery. On the other hand, as people are adapting to this “new normality” in their everyday life over time, the indirect adverse health effects of the COVID-19 pandemic and their socio-economic patterns could diminish (Chandola et al., 2020; Fancourt et al., 2021).

5 | CONCLUSION

To conclude, this study strengthens the current evidence on the unequally distributed burden of the COVID-19 pandemic along socio-economic strata. People in lower SEP had a higher incidence rate of adverse COVID-19-related outcomes, “exposing and amplifying inequalities” (Marmot & Allen, 2020). These inequalities were most visible between income groups and for the outcomes job loss, worsening of the financial situation, and worse mental health. In light of differences in the effect sizes by indicator of SEP, we encourage future investigators to pay close attention to the impact their operationalisation of SEP has on their results. Such awareness will help to correctly identify those who are in most urgent need of supportive policies.

6 | CREDIT AUTHOR STATEMENT

MO: Conceptualisation, Methodology, Formal Analysis, Data Curation, Writing – Original Draft, Visualisation; **TED:** Conceptualisation, Validation, Writing – Review & Editing, Supervision; **M Brunmayr, KB, BD:** Resources, Project Administration; **M Bach:** Funding Acquisition, Supervision, Writing – Review & Editing.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data cannot be shared but statistical code used for all analyses is openly available on https://www.researchgate.net/publication/351626929_Equally_Affected_all_statistical_code_1705. The corresponding author will also provide STATA Do-files unconditionally upon request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.