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Short Communication

Emerging socio-economic disparities in COVID-19-related deaths during the second pandemic wave in Germany

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ABSTRACT

Over the course of the second pandemic wave in late 2020, new infections with severe acute respiratory syndrome coronavirus-2 shifted from the most affluent to the most deprived regions of Germany. This study investigated how this trend in infections played out for deaths due to coronavirus disease 2019 (COVID-19) by examining area-level socio-economic disparities in COVID-19-related mortality during the second pandemic wave in Germany. The analysis was based on nationwide data on notified deaths, which were linked to an area-based index of socio-economic deprivation. In the autumn and winter of 2020/2021, COVID-19-related deaths increased faster among residents in Germany's more deprived districts. From late 2020 onwards, the mortality risks of men and women in the most deprived districts were 1.52 (95% confidence interval [CI] 1.27–1.82] and 1.44 (95% CI 1.19–1.73) times higher than among those in the most affluent districts, respectively, after adjustment for age, urbanization and population density. To promote health equity in the pandemic and beyond, deprived populations should receive increased attention in pandemic planning, infection control and disease prevention.

Background

During the first pandemic wave of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) from early March to mid-May 2020, the regional socio-economic patterning of infections in Germany differed from that reported from other high-income countries, revealing lower infection rates in socio-economically deprived areas of Germany in the early phase of the first wave (Wachtler et al., 2020a,b). However, during the second pandemic wave from late September 2020 to early March 2021, this pattern reversed, so that Germany's more deprived areas ended up with higher infection rates as of the end of 2020 (Hoebel et al., 2021). At present, it is unclear how this trend played out for deaths related to coronavirus disease 2019 (COVID-19), the respiratory disease caused by infection with SARS-CoV-2. This study investigated socio-economic disparities in COVID-19-related deaths over the course of the second pandemic wave in Germany.

Methods

Data were derived from the German database on notifiable infectious diseases (date: 23 March 2021, 0:00 am), which is administered by the Robert Koch Institute in accordance with the German Infection Protection Act. Mortality rates were calculated as the number of deaths among laboratory-confirmed COVID-19 cases per 100,000 population in Germany. The observation period covers the second pandemic wave in Germany, from late September 2020 (calendar week 40/2020) to early March 2021 (calendar week 9/2021).

The notification data were linked with the German Index of Socio-economic Deprivation, which is a composite index of area-based socio-economic indicators in the domains of education, employment and income (Kroll et al., 2017). The use of an area-based measure was necessary because the notification data do not contain individual socio-economic data. Linkage was achieved at the

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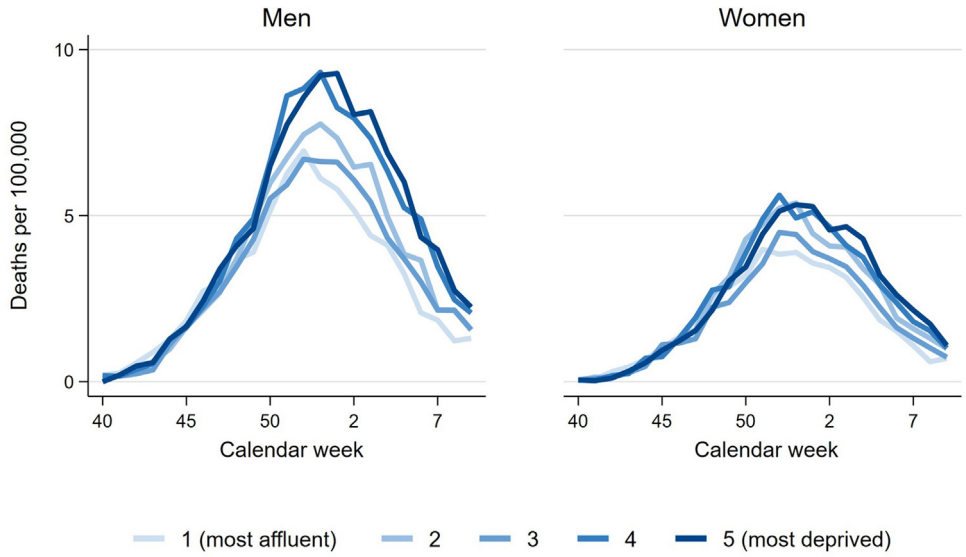

Figure 1. Standardized coronavirus disease 2019-related mortality rate among men and women by quintiles of area socio-economic deprivation and calendar week of death over the second pandemic wave in Germany.

level of Germany's 401 districts, with district being the smallest area level available in the notification data at the time of analysis.

Mortality rates were stratified by quintiles of socio-economic deprivation, and age-standardized to the 2013 European standard population using direct standardization (Eurostat, 2013). In the multi-variable analysis, adjusted mortality rate ratios were estimated by deprivation quintiles using multi-level Poisson regression models with 5-year age groups within districts as first-level units and districts as second-level units. The dependent variable was the count of deaths notified in each first-level unit. The natural logarithm of the population size in the first-level units was included as an offset term to account for the varying number of persons at risk (Hoebel et al., 2018). The regression models included dummy variables for age group and urbanization (metropolitan, urban, rural, sparsely populated), and a continuous covariate for the natural logarithm of the district-level population density to control for these factors (Table S1, see online supplementary material). The regression analysis was conducted separately for an early stage (calendar weeks 40/2020–51/2020) and a later stage (calendar weeks 52/2020–9/2021) of the second wave of the pandemic in Germany. The early stage was marked by an exponentially increasing incidence of infections, peaking in mid-December 2020. The later stage was the wave's post-peak period, with a declining incidence of new infections (Robert Koch Institute, 2021).

Results

During the observation period, a total of 32,193 men and 31,319 women died with a laboratory-confirmed diagnosis of COVID-19. The age-standardized mortality rate increased continuously until calendar week 52/2020 and declined thereafter. Mortality increased faster among people in more deprived districts, which resulted in widening socio-economic disparities in COVID-19-related mortality over the course of the second pandemic wave in Germany (Figure 1). Figures S1 and S2 (see online supplementary material) show map-based illustrations. From calendar week 52/2020 onwards, the mortality risks of men and women in the most deprived districts were 1.52 and 1.44 times higher, respectively, than among those living in the most affluent districts, after adjustment for age, urbanization and population density (Table 1). These disparities in COVID-19-related mortality by socio-economic deprivation were evident in both the working-age population (aged <65 years) and the elderly population (aged ≥65 years), but began to emerge earlier in the pandemic wave among people aged <65 years (Table S2, see online supplementary material).

Discussion

The main results indicate emerging socio-economic disparities in COVID-19-related mortality to the disadvantage of residents in deprived areas over the course of the second pandemic wave in Germany. To explain socio-economic disparities in COVID-19-related outcomes, the literature usually distinguishes at least four potential pathways: increased vulnerability (due to higher burden of pre-existing health conditions), increased susceptibility (due to weakened immune function; e.g. as a result of chronic stress from long-term exposure to adverse circumstances), increased exposure (e.g. due to working conditions), and increased transmission (e.g. due to crowded housing) in disadvantaged socio-economic groups (Bambra et al., 2021). However, most of these explanations appear fairly consistent throughout the pandemic period. Therefore, they alone may not explain why the socio-economic patterning of COVID-19 in Germany changed over the course of the pandemic from the first to the second wave. In this context, it is worth considering factors that changed differently across socio-economic groups over the pandemic period.

Specifically, the first COVID-19 cases in Germany were related to business travel from China and skiing trips to European ski resorts – activities more common among more affluent people – which may explain the higher COVID-19 rates in Germany's more affluent areas in the early first wave (Wachtler et al., 2020b). An important factor that may have changed differently across socio-economic groups as the pandemic progressed was mobility. Whereas privileged groups, such as white-collar and managerial workers, were able to reduce their mobility sharply by working from home during the lockdowns, this was not necessarily the case for more disadvantaged groups. For instance, essential workers in the service, care and production sectors were possibly more likely to have to go to work during the lockdowns, including the need to use public transport to do so (Bambra et al., 2021). Lockdowns may therefore have been less effective in more deprived areas, and disparities in mobility reductions may help explain why COVID-19 rates dropped early in affluent areas, but increased in deprived areas at later stages of the pandemic. Other explanations could be related

Table 1
Adjusted coronavirus disease 2019-related mortality rate ratios for men and women by quintiles of area socio-economic deprivation (quintile 1 – most affluent to quintile 5 – most deprived) and stage of the second pandemic wave in Germany

	Early stage (weeks 40/2020–51/2020)		**Later stage** (weeks 52/2020–9/2021)		**Total period** (weeks 40/2020–9/2021)	
	RR (95% CI)	*p*-value	RR (95% CI)	*p*-value	RR (95% CI)	*p*-value
Men						
Quintile 1	Ref.		Ref.		Ref.	
Quintile 2	1.09 (0.89–1.34)	0.388	1.15 (0.97–1.37)	0.103	1.13 (0.96–1.33)	0.129
Quintile 3	1.01 (0.82–1.25)	0.908	1.12 (0.94–1.33)	0.189	1.07 (0.91–1.26)	0.401
Quintile 4	1.03 (0.83–1.28)	0.786	1.40 (1.18–1.67)	<0.000	1.24 (1.05–1.46)	0.012
Quintile 5	1.07 (0.86–1.33)	0.534	1.52 (1.27–1.82)	<0.001	1.35 (1.15–1.60)	<0.001
Women						
Quintile 1	Ref.		Ref.		Ref.	
Quintile 2	1.07 (0.86–1.33)	0.555	1.21 (1.01–1.44)	0.043	1.14 (0.97–1.35)	0.122
Quintile 3	0.91 (0.73–1.14)	0.409	1.15 (0.96–1.38)	0.136	1.03 (0.87–1.22)	0.714
Quintile 4	0.93 (0.74–1.17)	0.559	1.34 (1.11–1.61)	0.002	1.15 (0.97–1.37)	0.115
Quintile 5	0.93 (0.74–1.17)	0.522	1.44 (1.19–1.73)	<0.001	1.22 (1.02–1.45)	0.027

RR, rate ratio from multi-level Poisson regression with adjustment for age, district type and population density; CI, confidence interval; Ref., reference group.
p-values for pairwise comparisons with the reference group.

to health care, including comparatively limited access to medical care or less frequent opportunities for testing in deprived areas. However, as having health insurance is compulsory in Germany, access to hospitals and intensive care units is likely to be largely universal across the population.

This study is not free of limitations. Due to the ecological study design, causation cannot be inferred from the findings, and the possibility of ecological fallacy cannot be ruled out. However, higher COVID-19-related mortality rates in socio-economically disadvantaged groups have also been found in other countries, not only in ecological but also individual-level studies (Drefahl et al., 2020; Marmot et al., 2020; Wachtler et al., 2020a). Moreover, it should be noted that area-level data from 2017 were used, as these were the most recent available. Nonetheless, the area-level characteristics included are highly stable over time. For example, area-level deprivation and population density had very high intraclass correlation coefficients of 0.98 and >0.99, respectively, over the last 4 years available.

In conclusion, these findings indicate that deprived populations should receive increased attention in infection control, pandemic planning and disease prevention to promote health equity in the COVID-19 pandemic and beyond. In addition, this study highlights the importance of investigating dynamics during pandemics, and that socio-economic disparities in pandemic viral respiratory diseases can depend on pandemic stages and phases.

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Ethical approval

This study was approved by the Ethics Committee of the Medical Faculty of the Heinrich-Heine-University Düsseldorf.

Author contributions

JH and NM developed the concept and design of the analysis. JH performed the statistical analysis. MD and NM contributed to data acquisition. JH, EN and NM drafted the manuscript. All authors were involved in the interpretation of data. OH, MW, MD and ND critically revised the manuscript for important intellectual content. JH and MW obtained funding for the analysis. JH and NM supervised the study. All authors reviewed, edited and approved the final manuscript.

Declaration of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijid.2021.10.037.

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