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RWI – Leibniz-Institut für Wirtschaftsforschung e.V.

Hohenzollernstraße 1–3 | 45128 Essen, Germany

Fon: +49 201 8149-0 | email: rwi@rwi-essen.de

www.rwi-essen.de

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Hohenzollernstr. 1-3, 45128 Essen, Germany

Ruhr-Universität Bochum (RUB), Department of Economics
Universitätsstr. 150, 44801 Bochum, Germany

Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstr. 12, 45117 Essen, Germany

Bergische Universität Wuppertal, Schumpeter School of Business and Economics
Gaußstraße 20, 42119 Wuppertal

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Pandemic-Ready Data: Linking the Socio-Economic Panel with Administrative Health Records

Alexander Lepe[1], Ingo Kolodziej[2,3], Sabine Zinn[1,4]

[1]German Institute for Economic Research, Berlin, Germany

[2]RWI – Leibniz Institute for Economic Research, Essen, Germany

[3]Hochschule Fresenius University of Applied Sciences, Idstein, Germany

[4]Humboldt University of Berlin, Berlin, Germany

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Executive Summary

The COVID-19 pandemic exposed significant weaknesses in Germany's ability to generate timely, equity-sensitive evidence at the household level. While national surveillance systems produced daily counts of confirmed cases, hospitalisations, and deaths, they offered little insight into the social and economic conditions shaping the spread and impact of the virus. Non-pharmaceutical interventions (NPIs), such as school closures and quarantines, reduced transmission but imposed substantial and uneven burdens on households. Without representative, real-time data on these impacts, early policy decisions were made with limited contextual information.

Germany possesses rich but fragmented health and social data resources. The Robert Koch Institute's surveillance data, hospital and insurance records, and surveys such as the Socio-Economic Panel (SOEP) exist in separate silos. Legal and technical barriers, including the absence of a common unique identifier, have prevented rapid linkage. As a result, official statistics failed to capture undetected infections, socioeconomic inequalities, and the full burden of NPIs on households. Evidence from the RKI-SOEP study, which linked SOEP survey data with serological testing, demonstrated that disadvantaged groups faced higher risk of (undetected) infection, lower vaccination rates, and greater psychosocial strain.

Linking the SOEP with administrative health data, particularly statutory health insurance claims, could address these gaps. The SOEP is Germany's largest and longest-running household panel, providing four decades of detailed socioeconomic and demographic information. Integrating this with comprehensive health records would enable the monitoring of infections, health outcomes, and their unequal distribution across social groups. Such a system could support earlier identification of vulnerable groups, help inform targeted interventions, and improve the evaluation of public health measures.

The RKI-SOEP study illustrates the feasibility and value of integrating infectious disease data into a household panel. However, its ad hoc design meant findings were not initially available. Establishing a permanent SOEP–administrative health data linkage, with appropriate consent and privacy safeguards, would shorten reporting delays and strengthen Germany's pandemic preparedness. This approach aligns with the World Health Organization's Pandemic Agreement, which calls for multisectoral, equity-sensitive surveillance systems. While no single system can eliminate all data blind spots, integrating household and health records would represent a major step toward more timely and equitable public health responses. Beyond pandemic preparedness, the same infrastructure could inform strategies to reduce health inequalities and support a more resilient health system.

1. Introduction

At the start of the COVID-19 pandemic, Germany rapidly established a system to publish daily counts of confirmed cases, hospitalisations, and deaths. What remained largely unknown, however, was how private households, which accounted for a substantial share of onward transmission (Madewell et al., 2021), were coping with the crisis. All households were exposed to the effects of the non-pharmaceutical interventions (NPIs), such as quarantines and school closures, that were enacted to curb the spread of COVID-19. While these measures helped to reduce the transmission of infectious diseases (Goliaei et al., 2024; Ullrich et al., 2021), they also resulted in unintended consequences that increased psychological stress and financial insecurity within households (Majeed et al., 2024). In the absence of representative, real-time data on these burdens, policymakers were initially left to make decisions without a sufficiently robust empirical basis for weighing virological risk against social cost.

Bridging this information gap is therefore a principal objective of pandemic preparedness. The World Health Organization's Pandemic Agreement adds momentum to the need to address this gap. This agreement is focused on creating an environment for more equitable and safer responses to future pandemics (World Health Organization, 2025). It calls on all members to establish multisectoral, equity-sensitive systems that can track pathogens and their social consequences. While this agreement lends global weight to the issue, this remains fundamentally a domestic challenge. For years, Germany's data infrastructure has lagged behind other countries, with limited coverage, delayed publication of data, and limited possibilities for data linkage (Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung, 2023), and the COVID-19 pandemic only highlighted these issues. Strengthening this infrastructure requires a platform capable of identifying infections and assessing how both diseases and countermeasures are distributed across different social groups and regions, including by income, age cohort, gender, and migration background.

A linkage between the Socio-Economic Panel (SOEP) and administrative health data could form the foundation for such a platform. The SOEP is a nationwide longitudinal survey that has interviewed roughly 30,000 residents annually since 1984 about various topics including income, work, education, health and family life (Goebel et al., 2019). Among Germany's administrative health datasets, one of the most comprehensive is the statutory health insurance claims data, which contains diagnostic, procedural, and prescription records for more than 70 million insured persons (Forschungsdatenzentrum Gesundheit, 2025). Linking these resources could enable the generation of household-level insights into epidemiological trends and their unequal social impacts. The RKI-SOEP study (Robert Koch-Institut, 2023), which collected biospecimens to assess exposure to COVID-19 among SOEP participants, has already demonstrated both the

feasibility and the scientific value of enriching the SOEP with infectious disease modules (Bartig et al., 2023b; Hoebel et al., 2021).

The remainder of this paper elaborates the case for linking the SOEP to administrative health data. Section 2 examines the shortcomings in Germany's pandemic data architecture that became evident during COVID-19, paying particular attention to the absence of representative household information. Section 3 sets out the rationale for linking the SOEP to administrative health records and outlines the potential benefits of such a linkage. Section 4 draws on findings from the RKI-SOEP study to illustrate the value of integrating infectious disease data into the SOEP. Section 5 concludes by summarising the main arguments and discussing implications for pandemic preparedness and the monitoring of health inequalities.

2. Gaps in Germany's pandemic data landscape

At the start of the COVID-19 pandemic, Germany had multiple health data resources but lacked the means to link them effectively. The Robert Koch Institute (RKI) operated a surveillance system to monitor notified cases and usage of intensive care systems. Hospitals and health insurance companies stored detailed treatment and prescription records, and surveys contained contextual information about individuals. However, most of these resources exist in separate silos. As the NFDI4Health (2023) white paper underscored, legal regulations and the lack of a common unique identifier prevented rapid record linkage. Due to these restrictions, Germany's health data is not being used to its full potential. This ultimately contributed to several knowledge gaps during the beginning of the pandemic.

2.1 Surveillance data without context

The German Infection Protection Act (IfSG), in effect since 2001, laid the groundwork for RKI's ability to quickly respond to COVID-19 (Federal Republic of Germany, 2000). In February 2020, SARS-CoV-2 was made a notifiable disease (Ullrich et al., 2021). In April 2020, the DIVI intensive care registry was created and provided daily reporting of the usage of intensive care units (Bundesministerium für Gesundheit, 2020; Robert Koch-Institut, 2025). Together with official mortality statistics, these systems enabled regular updates on cases, hospitalisations, ICU occupancy, and deaths. While these data were indispensable for pandemic management, they lacked key contextual information. Beyond basic demographic variables such as age, sex, and district, little was known about the socioeconomic and household circumstances influencing exposure and disease progression. This limitation constrained the ability of policymakers to assess the distribution of risk and the potential consequences of NPIs across different social groups.

2.2 Undetected cases

The official statistics for COVID-19 also offered an incomplete picture, as they only counted notified cases. Estimates from the RKI-SOEP study show that during the first year of the pandemic, nearly half of all cases were not reported, and the amount of undetected cases was greatest in the most socioeconomically deprived districts (Neuhauser et al., 2022). These findings imply that testing was less accessible or less frequently used in disadvantaged communities, underscoring the value of regular household-based serological monitoring, as implemented in the United Kingdom's COVID-19 Infection Survey (Pouwels et al., 2021). Although such systems provide less biased prevalence estimates than case-based surveillance, they are generally less timely (Brainard et al., 2023). Nonetheless, integration of serological monitoring could enable more informed and equitable policy responses.

2.3 Further equity gaps

Age, sex, and district alone do not fully capture the spectrum of social determinants that make individuals more vulnerable to the pandemic (World Health Organization, 2021). Analyses linking RKI surveillance data with the German Index of Socioeconomic Deprivation, an area-level measure of socioeconomic status, found that the most deprived areas experienced the largest increases in infection and mortality rates during the second COVID-19 wave (Müters et al., 2021). In addition to socioeconomic inequalities, there were other inequalities missed by the official statistics. Migrants and poorer people also faced greater risk of infection and mortality due to COVID-19 (World Health Organization, 2021). These vulnerable groups were also more likely to experience negative consequences due to the NPIs. Because Germany's surveillance systems did not collect data on these factors, it was difficult to assess these inequalities, thereby narrowing the scope for targeted prevention and resource allocation.

2.4 The burden on households

Households were an important avenue for the transmission of COVID-19 (Madewell et al., 2021), and this is also where the burden of NPIs had a large impact. Individuals navigated quarantine, school closures, and loss of income in ways that depended on family size, housing space, and other social resources. The SOEP-CoV survey, conducted from April to July 2020, studied the factors that influence the socioeconomic impact of the pandemic in Germany (Kühne et al., 2020). Analyses using SOEP-CoV data showed reductions in working hours amongst those with lower levels of education (Schröder et al., 2020), and increased stress due to school closures amongst single parents and parents with low education (Zinn and Bayer, 2021). While these findings were valuable, the absence of linked health data limited the ability to analyse the combined effects of socioeconomic conditions and health status.

2.5 Lessons learned

The first year of the pandemic demonstrated that abundant data resources do not automatically translate into actionable knowledge. Surveillance systems provided essential epidemiological indicators, but lacked the contextual information needed to identify mechanisms and disparities. Survey data offered relevant socioeconomic detail, but without linkage to objective health measures, could not capture the full picture. These datasets can complement one another well, so the lack of a linkage is a missed opportunity for Germany. Linking survey and administrative health data could produce a nationally representative household panel capable of monitoring who becomes infected, how disease spreads within households, and which families bear the greatest social and economic costs. Building the legal and technical capacity for such linkage should be a priority for pandemic preparedness.

3. Linking health data with the SOEP: why the SOEP and what it adds

Germany is in the process of strengthening its health data infrastructure. The Health Data Use Act, which was enacted in 2024 (Federal Republic of Germany, 2024), set the basis for the Health Data Lab (FDZ Gesundheit). The FDZ Gesundheit manages the claims data from all statutory health insurance providers and covers diagnoses, procedures, and prescriptions (Forschungsdatenzentrum Gesundheit, 2025). The current coalition agreement also seeks to improve data access for research by enacting the Research Data Act (CDU et al., 2025). Although these developments are significant, Germany still lags behind several other European countries in terms of the integration and accessibility of health data (NFDI4Health, 2023; Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung, 2023).

One means of narrowing this gap would be to link administrative health data with the SOEP. Such a linkage could add essential social and economic context to health information, allowing for a more complete understanding of how pandemics and their countermeasures affect different groups in the population. If legal and technical frameworks permitted, this linkage could be implemented within a relatively short timeframe and could generate household-centred evidence to inform more equitable responses in future public health emergencies.

3.1 Why the SOEP

Pandemics play out inside households, where factors such as infections, economic shocks, and care obligations accumulate. A household survey is therefore essential for identifying the resources available to individuals, as this shapes their ability to cope (World Health Organization, 2021). The SOEP is Germany's largest and longest-running household panel, covering a wide range of individual and household factors (Goebel et

al., 2019). Its longitudinal design enables the study of both short- and long-term effects of pandemics (Kühne et al., 2020).

The SOEP has demonstrated its ability to adapt rapidly to emerging circumstances, as shown by the launch of the SOEP-CoV and RKI-SOEP studies during 2020 (Hoebel et al., 2021; Kühne et al., 2020). It also has experience in linking survey data to administrative records, notably through SOEP-RV (SOEP linked to pension insurance data; Lüthen et al., 2022) and SOEP-CMI-ADIAB (SOEP survey samples linked to employment records; Antoni et al., 2023). This track record suggests that adding health data linkages would be operationally feasible and could yield high research value.

3.2 What administrative data adds

Integrating administrative health data with the SOEP would make it possible to identify more precisely which groups are most affected during a pandemic and to examine the mechanisms underlying these differences. In principle, linking to the RKI's infectious disease surveillance system could provide the most timely information on the spread of disease within households and communities. However, the surveillance data do not contain sufficient individual-level variables to permit deterministic matching with SOEP respondents. If access to disaggregated surveillance data were possible, statistical matching methods based on variables such as age, sex, and district could be piloted (D'Alberto and Raggi, 2024).

A practical alternative is to link the SOEP with statutory health insurance claims data. This could potentially be achieved through statistical matching, but direct record linkage with participant consent would provide the most reliable results. Although less timely than the surveillance feed, it would still add infectious disease data that can help inform policy makers during a future pandemic. Beyond pandemic preparedness, the combined dataset would enable research on a wide range of health, social, and economic interactions.

4. Case study: RKI-SOEP during COVID-19

The RKI-SOEP study is a population-based study that linked serological testing for SARS-CoV-2 with the rich longitudinal data from the SOEP. In the first wave, conducted from late 2020 to early 2021, data collection also included virological testing (PCR) and a brief questionnaire (Hoebel et al., 2021). The second wave, RKI-SOEP-2, which took place between late 2021 to early 2022, included a more extensive questionnaire covering various topics pertaining to the pandemic, such as vaccination status, healthcare utilization, and physical and mental health (Bartig et al., 2023b). Together, they provide unique insights into how infection risks and immune protection were socially patterned across the first two years of the pandemic.

4.1 Socioeconomic inequalities in infection, detection, and vaccination

Towards the end of 2020, the seroprevalence of SARS-CoV-2 antibodies was estimated to be 1.3% (Hoebel et al., 2022); this estimate rises to 1.7% after adjusting for waning antibodies (Neuhauser et al., 2022). Despite the low overall prevalence, there were pronounced social disparities in infection risk. Findings from the RKI-SOEP study have shown that individuals with low educational attainment have almost twice the odds of having been previously infected with COVID-19 (adjusted OR = 1.9) (Hoebel et al., 2022), but were also less likely to have been tested than individuals with high educational attainment (18% vs 26%) (Neuhauser et al., 2022). One reason for this substantial inequality may be related to differences in the likelihood of working from home, as more than half (57.7%) of the effect of low education on infection risk was attributed to a lower likelihood of working from home (Wachtler et al., 2024). Additionally, compared to individuals with higher socioeconomic status, those with lower socioeconomic status were less likely to have received at least one dose of the vaccine and to have accumulated at least three antigen contacts with SARS-CoV-2 (Bartig et al., 2023a). Furthermore, it is estimated that roughly half of infections in Germany were never reported to health authorities, and this underreporting of infections was most pronounced in more socioeconomically disadvantaged districts (Hoebel et al., 2022). Differences in vaccine uptake were also highly stratified by area-level deprivation, whereby more deprived districts had larger gaps in vaccine uptake between low and high educated groups, which did not narrow over time (Reis et al., 2024).

4.2 Psychosocial consequences of the pandemic

Beyond infection risk, the pandemic generated substantial psychosocial strain, disproportionately affecting disadvantaged groups. Using data from the second wave of the RKI-SOEP study, Beese et al (2024) examined pandemic-induced psychosocial stress across various life domains by socioeconomic status. They found that the widest socioeconomic disparities occurred in relation to financial concerns and partnership strain, where compared to high-income adults, low-income adults were over 5-times as likely to report severe financial stress (Prevalence ratio: 5.5, 95% CI: 3.6-8.5) and roughly two-thirds more likely (Prevalence ratio: 1.7, 95% CI: 1.1-2.5) to experience severe partnership strain. Kersjes et al. (2025) found that pandemic-induced psychosocial stress in the domains of family, financial situation, leisure time, and social life mediated the relationship between education and mental health-related quality of life, whereby higher education was associated with higher mental health-related quality of life. NPIs, such as school closures, were an important source for these stressors. These measures disrupted daily routines, increased care demands, reduced access to social support, and limited coping options, with the burden falling most heavily on households lacking the resources to adapt. These findings highlight that psychosocial

consequences of the pandemic are important concerns but disproportionately affect more disadvantaged groups.

4.3 Summary

The findings from many of the studies using RKI-SOEP data demonstrate that socioeconomic inequalities largely shape the observed differences in infection risk and detection, vaccination uptake, and psychosocial outcomes from the COVID-19 pandemic. More socioeconomically disadvantaged groups had more difficulty coping with the pandemic, and this was likely exacerbated by some of the NPIs. These results highlight the need for integrated monitoring of both epidemiological and social dimensions of health during pandemics. They also demonstrate the feasibility of collecting such information within a household panel framework, where established trust and consent procedures can encourage participation, providing evidence that could guide more equitable public health responses in future crises.

5. Conclusion

The COVID-19 pandemic showed that, although Germany has extensive health data resources, it lacked the capacity to integrate them in a way that could deliver timely, equity-sensitive insights at the household level. Early in the pandemic, decision-making relied primarily on aggregated surveillance data, which provided information on confirmed cases, hospitalisations, and deaths, but offered limited insight into who was most affected and why. Evidence from the RKI-SOEP studies indicates that the health and social consequences of the pandemic were unequally distributed. Socioeconomically disadvantaged households faced higher risks of (undetected) infection (Hoebel et al., 2022; Neuhauser et al., 2022), lower vaccination coverage (Bartig et al., 2023a; Reis et al., 2024), and greater psychosocial burdens (Beese et al., 2024; Kersjes et al., 2025), with many of these pressures intensified by non-pharmaceutical interventions (NPIs) such as school closures, quarantine, and restrictions on social contact. The impact of the pandemic on the social determinants of health may have lasting effects, which could influence outcomes for future generations (World Health Organization, 2021). However, much of the data required to identify these inequalities became available only after key policy decisions had been made.

The SOEP is well positioned to address these limitations. As Germany's largest and longest-running nationally representative household survey, it provides decades of detailed socioeconomic and demographic data that cannot be obtained from administrative health sources alone (Goebel et al., 2019). Linking the SOEP to administrative health records, such as statutory health insurance claims data, would create a data infrastructure capable of identifying who is affected by infectious diseases

and how their ability to cope with the disease and NPIs is shaped by household resources, employment, and living conditions. Such a system could support earlier identification of vulnerable groups and enable the assessment of the impact of the pandemic and the NPIs on these groups.

The RKI-SOEP study demonstrates that integrating infectious disease data into a household survey is both feasible and scientifically valuable. Biospecimen collection and targeted pandemic questionnaires provided insights that would have been impossible to generate from routine surveillance or administrative datasets alone, such as the extent of undetected infections (Hoebel et al., 2022; Neuhauser et al., 2022). However, the time lag in producing these results highlights a limitation of implementing an ad hoc survey. With appropriate consent and data protection measures, linking SOEP participants to administrative health datasets could significantly shorten the interval between events and the availability of evidence. This would improve Germany's ability to monitor epidemiological and socioeconomic aspects of future pandemics including the unequal impacts of NPIs.

Such a linkage would also align with the WHO's Pandemic Agreement, which calls for multisectoral, equity-sensitive surveillance systems (World Health Organization, 2025). While no system can eliminate all blind spots, the integration of health and household data would represent a major advance in preparedness. By embedding household-level context into administrative health data, Germany could ensure that responses are informed by the lived realities of its population, supporting policies that are both timely and equitable. Over the longer term, this integration could also strengthen the evidence base for reducing health inequalities across various outcomes and for building a more resilient health system.

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