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The social gradient in COVID-19 vaccination intentions and the role of solidarity beliefs among adolescents

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ABSTRACT

Background: Vaccines against COVID-19 play a prominent role in the policies enacted to combat the pandemic. However, vaccination rates are lowest among adolescents and young adults. Therefore, research on younger individuals is needed to provide a deeper understanding of social disparities and the motives behind vaccination intentions.

Methods: This study draws on a sample (N = 4079) of German high school students and graduates. Based on cross-sectional data from March to July 2021 and linear regression models, which are conditioned on personality, risk preferences, and trust, the study analyses social disparities (i.e., gender, parental education and migration background) in vaccination intentions.

Results: We do not find heterogeneity by gender. Individuals with low-educated parents and a migration background indicate below-average levels of vaccination intention. Differences in solidarity beliefs entirely explain the heterogeneity between individuals with low-educated parents and those with high-educated parents. While differences in beliefs explain a substantial part of the heterogeneity in vaccination intentions, cultural and monetary resources also constitute an important source of difference in vaccination intentions between individuals with and without a migration background. These results are important because our data indicate higher infection risks among individuals with a migration and low education background. Additionally, individuals from lower social origins and with migration backgrounds report higher levels of perceived burdens associated with COVID-19-related policies. The migration results differ between first- and second-generation migrants and by region of origin.

Conclusion: Polarization in solidarity explains social gradients in vaccination intention. A solidarity narrative may not motivate a significant share of young individuals to be vaccinated.

1. Motivation

Vaccination against COVID-19 is the key political strategy for preventing lockdowns and facilitating societal reopenings in all countries. However, in many countries, vaccination rates are not developing at the necessary pace (e.g. Coccia, 2022). For instance, in Germany, data from official statistics suggest that vaccination rates have been almost stalling at approximately 70% since September 2021 (impfdashborad 2021). These low vaccination rates are considered insufficient for "herd immunity" and for preventing a collapse of the healthcare system. Survey data suggest (infas 2021), that in particular, younger individuals (below age 35) are hesitant to be vaccinated against COVID-19—a research finding persistently found across many societal contexts (e.g., Al-Amer et al., 2022; Byrne et al., 2021; Graeber et al., 2021; Nohl et al., 2021; Rhodes, Hoq, Measey, & Danchin, 2021; Trent et al., 2021). As COVID-19 policies rely on high vaccination rates across all age groups, research has to provide more insights into the motivations and factors influencing vaccination uptake among younger individuals.

Existing and rapidly emerging research already reports social gradients in COVID-19 vaccination intention along the dimensions of gender, education, household income, race, and ethnicity (e.g., Al-Amer et al., 2022; Andrade, 2021; Byrne et al., 2021; Graeber et al., 2021; Jacobi & Vaidyanathan, 2021; Kamal et al., 2021; Niño et al., 2021; Nohl et al., 2021; Raz et al., 2021). In addition to these social gradients, research indicates that vaccination intentions vary across occupational groups (e.g., Al-Amer et al., 2022) according to individuals' levels of religiosity and nationalism (Corcoran et al., 2021), sense of purpose in life (Hill et al., 2021), conspiracy beliefs, self-efficacy (i.e., ability to

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accept vaccination when offered), and incentives for not being vaccinated (Eberhardt & Ling, 2021). Additionally, trust in media and the government is positively related to potential vaccination uptake (Grüner & Krüger,2020). Moreover, information about security and efficiency shapes potential vaccination uptake (e.g., Davis et al., 2021; Leng et al., 2021), and individuals' risk perception regarding becoming infected themselves appears important (e.g., Al-Amer et al., 2022; Eberhardt & Ling, 2021; Ruiz & Bell, 2021). Furthermore, experimental data suggest that actual properties such as the risk of side effects, efficiency and region of vaccine origin might affect vaccination uptake (Motta, 2021). In terms of communication policies, experimental research on nudging strategies already indicates that framing individuals' vaccination decisions as encouragement for unknown others to also be vaccinated could be an effective strategy, particularly among older individuals (Sasaki, Saito, & Ohtake, 2022). Moreover, financial incentives and communication about the impact of vaccinations on infections and herd immunity appear to be ineffective in promoting vaccination intention (Sprengholz et al., 2021).

This study contributes to this research stream and investigates differences between gender, migration background and social origin (i.e., parental education) in COVID-19 vaccination intentions among German adolescents. Thus far, no research has provided evidence on the influence of social origins on vaccination intention. Furthermore, our research advances current knowledge for analyzing the role of solidarity (i.e., the belief that vaccination is an expression of solidarity) in vaccination intention, which constitutes an important narrative in the current public debate (e.g., Scholz, 2021). In general, focusing on young individuals appears important because vaccination rates among younger populations are rather low. Thus, more knowledge about vaccination uptake among this population is needed.

A further key contribution of our research is the application of a sociological mechanism-based approach to scrutinize social disparities in COVID-19 vaccination intentions. This is, we focus on modeling the direct and indirect effects of gender, migration status and social origin in explicitly specifying confounding and mediating variables in the data (e.g., Morgan & Winship, 2015). In our mechanism-based approach, we analyze four potential pathways that might explain social gradients in COVID-19 vaccination intentions.

As the literature shows that the socioeconomic position of households affects vaccination intentions and uptake (e.g., Al-Amer et al., 2022; Graeber et al., 2021; Nohl et al., 2021), the first pathway examined addresses language, economic and educational resources. As resources between individuals from different social origins and migration backgrounds vary, the socioeconomic position of households might explain social gradients in vaccination intention. Exposure to COVID-19 infections may constitute a second pathway. Although research already indicates that infections might be positively associated with vaccination intentions (e.g., Nicolo et al., 2021), COVID-19 exposure may also be negatively associated with intentions because past infections provide protection against potential severe disease processes. As COVID-19 infection risks are unevenly distributed across different social groups, we test whether personal or familial infection experiences might explain social gradients in COVID-19 vaccination intentions, independent of the effect direction between exposure and vaccination intentions.

We use belief in vaccination-related solidarity as a third mechanism and test whether the widely used narrative that COVID-19 vaccine uptake constitutes an act of societal solidarity can explain social gradients in vaccination intention. Experimental research on altruism already indicates that vaccine messaging, which emphasizes that the individual decision affects the wellbeing of vulnerable groups (i.e., a solidarity belief), might increase vaccination uptake (Cucciniello et al., 2021). The fourth mechanism refers to the perceived burden of COVID-19 policies. Research indicates that COVID-19 policies (e.g., school closures or mandatory mask wearing) have different effects on individuals from different parts of the social strata (e.g., Engzell et al., 2021; Hearne & Niño, 2021; Papageorge et al., 2021). Thus, perceived burdens associated with the COVID-19 pandemic (i.e., subjective burdens associated with mandatory mask wearing and school/university closures) could help explain social gradients in COVID-19 vaccination intention.

Employing a cross-sectional Germany-wide survey (N = 4079; CAWI/CATI interviews between March and July 2021) with graduates from the academic track of upper secondary education in Germany enables us to deliver new insights on motives and social disparities in vaccination intentions among adolescents. As we explicate potential pathways through which social gradients in vaccination intention emerge, our study provides important results for policy makers. Moreover, as COVID-19 vaccines decrease the likelihood of severe disease processes (e.g., Antonelli et al., 2021), research on vaccination intentions is of the utmost importance—even in a population that has low mortality risks. Furthermore, given that vaccines decrease the transferability of COVID-19 (e.g., Harris et al., 2021; Levine-Tiefenbrun et al., 2021), high vaccination rates reduce the infection pressure on vulnerable groups within society. In a broader sense, our study also provides results that have implications for stratification research, finding pronounced differences by migration background in COVID-19-related hospitalizations and intensive care unit admissions (e.g., Gustafsson, San Sebastian, Fonseca-Rodriguez, & Connolly, 2022).

2. Methods

2.1. Data

The data for this study stem from a project called the BerO study. The main aim of this project is to evaluate the effectiveness of an intensification of job counseling for students in the academic school track (i.e., Gymnasium) in Germany. From this project, data from four survey waves are already available, and the data were collected between autumn 2019 and spring 2021. The study includes individuals who were in their junior or senior year of high school in 2019. Students came from 214 schools across eight German federal states. In response to the COVID-19 pandemic, the project team enriched the questionnaire by a powerful COVID-19 module after survey wave 2 (spring 2020), which was wavewise adjusted to the development of the pandemic. This study uses data from survey wave four, which took place from March to July 2021 during the third wave of the pandemic. Fig. 1 gives an overview of the timeline of the data collection.

For the fourth survey wave, 4817 individuals participated. From this population, we use individuals with full information on all variables employed in the statistical analysis. Due to the panel character, some case exclusions occurred because individuals did not respond in survey wave 3. However, some items from wave 3 are important for our modeling, and therefore, we have to exclude some temporal non-respondents. Our complete case analysis comprises 4079 cases. In the appendix, we provide the results on a sample selection model. This model suggests that only risk aversion, the missing information categories on the migration background and time preferences are statistically significantly associated with sample inclusion. Thus, these variables should be included in every model to mitigate selection bias (for further details, refer to Table A4 in the Online Appendix).

2.2. Measures

Vaccination intention: Answers to the following question constitute the main outcome variable of this study: "What is the likelihood that you will get vaccinated against COVID-19?" Respondents answered this question on a scale ranging from 0 to 10. In the analysis, we coded individuals who had already been vaccinated (approximately 13.5% of the sample) with a value of 10. As a robustness check, we exclude those cases from the analysis. Nevertheless, this workaround does not yield different results (see Table A3 in the Online Appendix).

Gender: We employ a binary variable indicating a male gender. Note that this refers to the gender ascribed to individuals at birth.

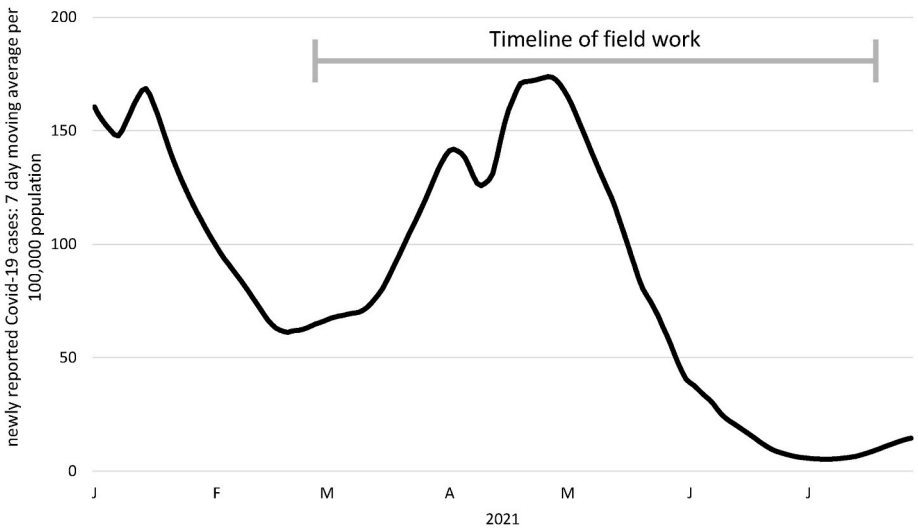

Fig. 1. Survey timeline of BerO wave four and COVID-19 infections in Germany.

Parental education: We employ a binary variable indicating whether at least one parent holds a university degree. As these types of questions constitute a source of missing information, we include a missing case category for this variable.

Migration background: We employ three definitions of migration backgrounds. The main analysis uses a binary variable indicating whether a student him or herself immigrated to Germany or at least one parent immigrated to Germany. A further alternative specifies the generation status. First-generation migrants are individuals who immigrated to Germany. Second-generation migrants comprise individuals who were born in Germany but have at least one parent who immigrated to Germany. A further variable indicates the region of origin of migrants independent of their first- or second-generation migration status. In some cases, the father's and mother's country of origin differ. For those cases, we use the father's information. For 20 students in the full sample, their own country of origin and that of their parents differ. For those few cases, we use the students' country of origin.

Resources: We employ three resources. First, the main language spoken at home, is a dummy variable that indicates whether the main household language is not German. This variable approximates cultural resources (e.g., Sullivan, 2001). Second, subjective household income approximates financial resources. This variable measures on a five-point scale whether individuals have either much less household income than needed for a decent life (value 1) or much more than needed for a decent life (value 5). This item was measured in survey wave 3 (fall/winter 2020). We are aware that objective measures would be preferable. However, health research indicates that subjective measures of individuals' socioeconomic position also carry predictive power when researchers also condition objective measures (e.g., Präg, 2020). Third, when investigating differences in vaccination intentions among genders and among individuals with different migration backgrounds, we employ parents' education levels as a further proxy for the socioeconomic position of high school students' families. In addition to household income, parental education approximates other labor market-related resources associated with social status and knowledge about labor market-related processes (e.g., Mood, 2017).

COVID-19 infection exposure: We employ two different dummy variables. First, one indicates whether survey respondents had already had COVID-19. Second, a variable indicates whether a family member had already had COVID-19.

Solidarity belief: For solidarity, we rely on answers to the following survey question: "Getting vaccinated against COVID-19 constitutes an expression of societal solidarity. To what extent do you agree with this statement?" Individuals answered this question on a scale ranging from 0 to 10.

COVID-19 strain: We use two measures approximating the COVID-19 burden and rely on answers to the following question: "How much of a burden have the following hygiene and distancing rules created for you since March 2020? A: School or university closures; B: Mandatory mask wearing". Answers range from 1 "Very low" to 5 "Very strong".

2.4. Covariates

Interpersonal trust: We use the KUSIV3 scale to measure interpersonal trust (Bierlein et al., 2014). This scale consists of three items. Cronbach's alpha indicates a good internal validity of 0.74, and a principal component analysis reveals that all questions load one factor (eigenvalue = 1.316).

Big Five personality traits: To account for personality traits in our statistical analyses, we employ a short form of the Big Five inventory (Goldberg, 1981; John et al., 1991). This short form is widely used in many longstanding household panels (e.g., British Household Panel, German Socio-Economic Panel, The Household, Income and Labour Dynamics in Australia Survey) and it has been demonstrated to predict social behavior. German short forms of the Big Five inventory appear to be good proxies of the global personality structure of individuals (Rammstedt & Danner, 2006).

Time preferences: To approximate time discounting preferences, we employed a construct from rational choice sociology (Breen et al., 2014). The employed measure asks young individuals, "If you were offered three different jobs with different starting salaries, which one would you take?" Individuals can choose between the following alternatives: First, a job with an average salary from the beginning onwards. Second, a job with a low salary for the first two years and a high salary after that period. Third, a job with a very low salary for the first four years, then a very high salary later on. We employ a dummy variable indicating individuals with myopic time preferences if they opt for the first choice.

Self-efficacy: We use a ten-item scale originally developed by Schwarzer and Jerusalem (1995) that was translated into 33 different languages and is widely used in research. The Cronbach's alpha indicates a good internal validity of 0.82, and a confirmatory factor analysis reveals that all questions approximate one latent construct (eigenvalue = 3.157).

Grit: We rely on an eight-item scale originally developed by Duckworth et al. (2009), which was validated on a German sample (Schmidt, Fleckenstein, Retelsdorf, Eskreis-Winkler, & Möller, 2019). The Cronbach's alpha indicates a good internal validity of 0.78, and a factor

Table 1
Sample description.

	Mean	SD
Outcome		
Vaccination intention (0–10)	8.175	2.708
Social gradient		
Male (1 vs. 0)	0.351	
At least one parent with a university education (1 vs. 0)	0.555	
Missing information	0.101	
Migration background (1 vs. 0)	0.274	
Missing information	0.023	
Mechanisms		
Language other than German as main household language (1 vs. 0)	0.096	
Subjective household income		
1 much less than one needs for a decent life	0.013	
2	0.058	
3	0.223	
4	0.560	
5 much more than one needs for a decent life	0.139	
Missing information	0.008	
Infected with COVID-19 themselves (1 vs. 0)	0.050	
Family member infected with COVID-19 (1 vs. 0)	0.198	
Solidarity belief (0–10)	7.148	2.884
Perceived burden of school closures (1–5)	3.510	1.170
Perceived burden of mask wearing (1–5)	2.595	1.354
Covariates		
Interpersonal trust (1–5)	3.266	0.780
Self-efficacy (1–4)	2.915	0.402
Grit (1–5)	3.454	0.612
Myopic (1 vs. 0)	0.119	
Big Five – Openness (1–7)	4.795	1.223
Big Five – Contentiousness (1–7)	5.199	1.025
Big Five – Extraversion (1–7)	4.771	1.381
Big Five – Agreeableness (1–7)	5.460	0.947
Big Five – Neuroticism (1–7)	4.273	1.241
Risk aversion (1–11)	6.617	2.164
Graduation cohort (1 vs. 0)	0.447	
Overall life satisfaction (0–10)	6.637	2.079
N	4079	

Data: Wave 4 of BerO study.

analysis presents a one-factor solution (eigenvalue = 2.592).

Risk aversion: To measure risk aversion, we rely on answers to the following question: "Are you generally a person who is willing to take risks or do you try to avoid taking risks?" Answers range from 1 "not at all willing to take risks" to 11 "very willing to take risks". An experimental validation study has shown that the single-item question can predict individuals' risk-taking behavior and, most importantly, that the general risk question has higher predictive power than other survey questions, such as the lottery question or domain-specific measures (Dohmen et al., 2005).

Happiness: Supplementary analysis hints at happiness selection predicting vaccination intentions. Therefore, overall happiness constitutes a valuable control variable. We employ the standard question (Veenhoven, 2012), "How satisfied are you with your life, all things considered?" The respondents answered this question on a scale from 0 to 10 (0 is "completely dissatisfied" and 10 is "completely satisfied").

Graduation cohort: Our sample consists of two high school cohorts. One cohort graduated in 2020, while the other graduated in 2021. Thus, daily life routines between those cohorts differ because the 2020 cohort had already started postsecondary education during the time of the field work, while the 2021 cohort was mainly enrolled in school.

School fixed effects: To capture regional variation, all models use school fixed effects. Although some individuals in the sample had already left school, employing school fixed effects has the advantage of capturing important differences in school discourses about vaccination during the COVID-19 pandemic.

Table 1 provides an overview of all measures used and their distributions in the employed sample of 4079 adolescents.

2.4. Statistical analyses

We analyze our cross-sectional data with multiple linear regressions. In the first steps, however, we show the distribution of our main outcome variable by subgroup and investigate social gradients in the resources, COVID-19 infection exposure, solidarity beliefs and COVID-19 burden in our sample. Next, the main analysis investigates whether these factors can explain social disparities in vaccination intention. Thus, we employ a mechanism-based approach to investigate potential channels leading to social gradients in vaccination intention. The final analyses focus in detail on different operationalizations of migration history.

3. Results

Before presenting the social gradients in COVID-19 vaccination intentions, we first present social disparities in cultural and economic

Table 2
Social gradients in parental resources, COVID-19 infection exposure, solidarity belief and COVID-19 policy burden.

	Gender (male vs. female)	Parental Education (university vs. nonuniversity)	Migration background (personal or parental migration history vs. no migration history)
Panel A: Resources			
Foreign language	0.010 (0.010)	−0.063*** (0.010)	0.319*** (0.009)
Subjective HH-income[a]	0.118*** (0.027	0.372*** (0.027)	−0.371** (0.028)
At least 1 parent with uni. educ.	0.044** (0.017)	-	−0.141*** (0.018)
Panel B: COVID-19 infection exposures			
Personal infection	−0.001 (0.007)	−0.022** (0.007)	0.036*** (0.008)
Infection within family	−0.025 (0.013)	−0.031* (0.014)	0.069*** (0.014)
Panel C: Solidarity belief	0.144 (0.095)	0.924*** (0.097)	−0.950*** (0.101)
Panel D: COVID-19 strain			
Perceived burden of school closures	−0.270*** (0.038)	−0.063 (0.040)	0.172*** (0.041)
Perceived burden of mask wearing	−0.146*** (0.044)	−0.378*** (0.046)	0.309*** (0.047)
N	4079	4079	4079

*$p < 0.05$., **$p < 0.01$, ***$p < 0.001$; standard errors in parentheses.
[a] This analysis excludes 32 cases because of missing information.

resources (Panel A), COVID-19 infection exposure (Panel B), solidarity beliefs (Panel C), and perceived burden of certain COVID-19-related policies (Panel D). Table 2 reveals notable heterogeneity between social groups. Regarding gender, however, Panels A, B, and C do not reveal substantial differences. It appears that males are slightly more likely than females to have highly educated parents and to report higher household incomes. In contrast, Panel D reveals that males perceive lower burdens from COVID-19 policies than females.

Regarding parental education, Table 2 reveals substantial variation. Panel A shows that students from highly educated backgrounds are less likely to indicate a language other than German as their main household language. Furthermore, individuals from highly educated backgrounds report higher household incomes. Interestingly, Panel B reveals that individuals with highly educated parents are less likely to report having had a COVID-19 infection and or having had one within the family. Panel C shows strong differences in solidarity beliefs. Individuals from lower educated families agree less with the statement that vaccination against the COVID-19 disease constitutes an act of societal solidarity. Panel D also reveals that individuals from highly educated backgrounds are less burdened by mandatory mask wearing.

Table 2 indicates substantial variation in resources, infections, solidarity, and COVID-19 burdens between individuals with and without a migration background. Obviously, individuals with a migration background are more likely not to speak German at home. Furthermore, Table 2 reveals that the socioeconomic position of migrant households substantially differs from that of nonmigrants. Individuals with migration backgrounds are more likely to have lower educated parents and more often state that their households cannot afford a decent living. Panel B depicts striking differences in infection probabilities. Young individuals with a migration background have a three and a half percentage point higher risk of being infected themselves (approximately 4% of natives report such an infection; approximately 7.5% of individuals with a migration background report such an infection) and a seven percentage point higher risk of reporting a COVID-19 infection within the family (approximately 18% of natives report such an infection; approximately 25% of individuals with a migration background report such an infection). Furthermore, substantial differences in the belief that vaccination is an act of societal solidarity emerge (33% of SD). Interestingly, Panel D shows that migrants appear to perceive more burden associated with COVID-19-related policies such as school/university closures and mask wearing.

Fig. 2 provides distributions of vaccination intention by gender, parental education, and migration background. The upper left part of Fig. 2 shows no differences between males and females in vaccination intentions. In contrast, the upper right part of Fig. 2 shows substantial differences in vaccination intentions by parental background. The solid black line indicates that individuals with highly educated parents compared to low-educated parents (gray solid line) are far more likely to indicate a greater than 80% intention to be vaccinated. Answers of individuals with low-educated parents (gray solid line) strongly differ from those of individuals with highly educated parents. The gray solid line shows that the density of answers is far higher in the lower part of the answer scale for individuals with low-educated parents. The lower left part of Fig. 2 shows differences by migration status. Individuals with no migration background have substantially higher vaccination intentions, as indicated by the gray solid line, compared to individuals with migration background.

Thus far, the results indicate substantially lower COVID-19 vaccination intentions among individuals with lower educated parents and migration backgrounds. Given the high safety and efficiency of current COVID-19 vaccines and substantially higher infection risks and higher COVID-19 strains among individuals of lower social origin and with migration backgrounds, social gaps in potential COVID-19 vaccine uptake constitute a somewhat surprising finding.

Next, we scrutinize whether the factors depicted in Table 2 can explain differences in vaccination intentions between social groups. We present the results of this workaround in Table 3. Panel A shows differences between genders, Panel B shows differences between

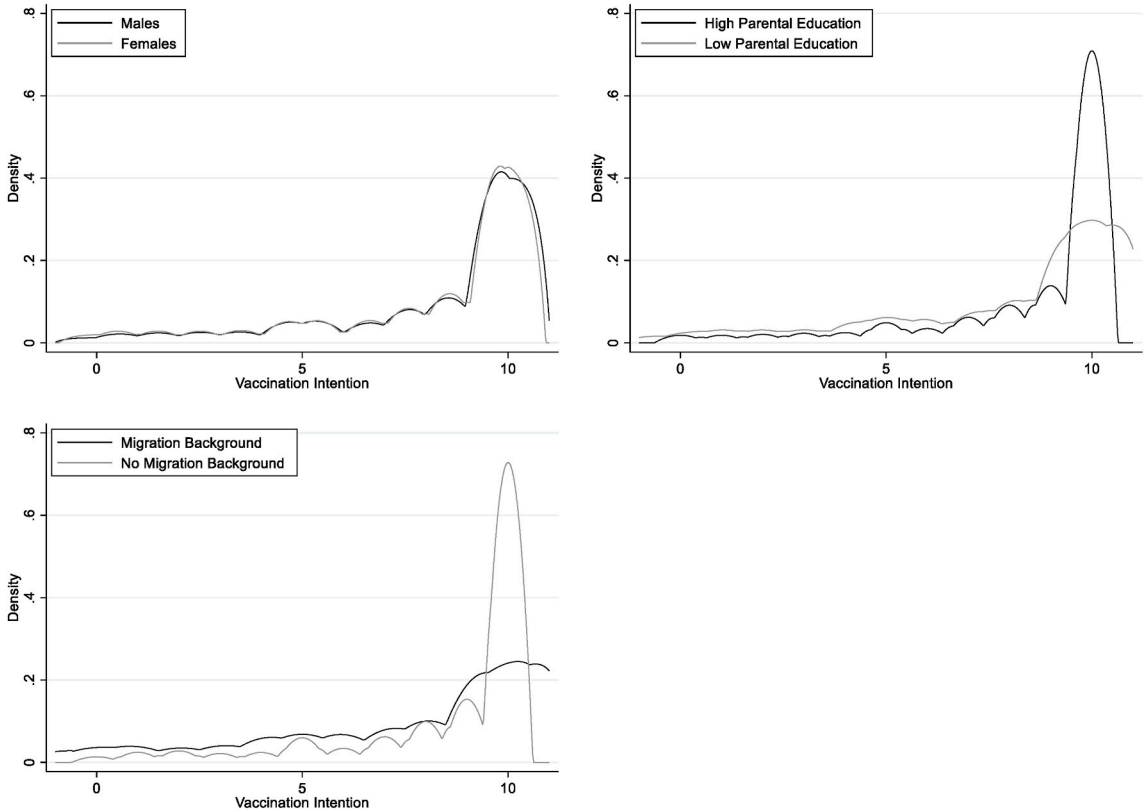

Fig. 2. Overall distribution of vaccination intentions (gray solid line) and distribution by gender, migration and parental background (kernel density estimations).

Table 3
Social gradients and mechanisms of vaccination intentions.

	(1) raw	(2) + resources	(3) + infection	(4) + solidarity belief	(5) + COVID-19 strain
Panel A					
Males	0.101	0.092	0.091	0.000	0.006
	(0.096)	(0.095)	(0.095)	(0.073)	(0.073)
Covariates	✓	✓	✓	✓	✓
Adj. R^2	0.118	0.136	0.137	0.493	0.500
Panel B					
At least 1 parent with uni. educ.	0.438***	0.371***	0.365***	0.042	0.011
	(0.095)	(0.095)	(0.095)	(0.073)	(0.073)
Covariates	✓	✓	✓	✓	✓
Adj. R^2	0.125	0.136	0.137	0.493	0.500
Panel C					
Migration background	−0.912***	−0.569***	−0.562***	−0.345***	−0.350***
	(0.100)	(0.110)	(0.110)	(0.085)	(0.084)
Covariates	✓	✓	✓	✓	✓
Adj. R^2	0.114	0.135	0.136	0.492	0.499
N observations	4079	4079	4079	4079	4079

Note: Results from linear regressions. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; standard errors in parentheses. Refer to Table A1a to A1c in the Online Appendix for full regression results.
Control variables: Graduation cohort, happiness, interpersonal trust, school fixed effects, Big Five personality traits, self-efficacy, grit, risk aversion, time preferences.
(1) Raw includes control variables only.
(2) Resources include control variables, dummy variable of foreign language as main household language, subjective household income (1–5), and a dummy variable indicating at least one parent with a university education. Note, however, that Panel B does not include parental education as a resource.
(3) Infection includes control variables, resources, a dummy indicating a personal infection, and a dummy indicating an infection within the family.
(4) Solidarity belief includes control variables, resources, infections, and an indicator for solidarity belief (0–10).
(5) The COVID-19 burden includes control variables, resources, infections, solidarity belief, and a variable indicating the perceived burden of school closures (1–5) and mask wearing (1–5).

individuals by parental education, and Panel C depicts differences between individuals with and without migration backgrounds.

Panel A shows almost no differences between males and females. The first column of Table 3 shows a one percentage point difference, which is statistically insignificant. This small difference vanishes when we condition on resources, infections, and solidarity belief. Thus, the small gender difference is mainly explained by small differences in solidarity beliefs between the genders.

Panel B of Table 3 shows differences by parental education. The first column indicates that individuals from highly educated parents have 4% (i.e., 16% of SD) higher vaccination intentions. While differences in resources and infection risks only slightly explain variation between both groups, disparities in solidarity beliefs explain almost the entirety of differences in vaccination intentions between individuals from highly and less educated backgrounds.

Panel C of Table 3 shows differences by migration background. The first column indicates substantial differences between individuals with and without migration backgrounds. Individuals with migration backgrounds have an average vaccination intention that is nine percentage points (33% of SD) lower than that of individuals with no migration background. Roughly one-third of this gap can be explained by differences in the socioeconomic position of migrant families. While infections do not lower the intention gap, differences in solidarity belief explain almost an additional third of the migration gap in vaccination intentions. The last column of Panel C shows that perceived COVID-19 burden does not reduce the gap. Interestingly, infections and the COVID-19 burden do not contribute to closing the migration gap in COVID-19 vaccination intentions, although individuals with a migration background are more likely to report (personal or familial) infections and higher burdens associated with school/university closures and mask wearing.

As substantial differences between individuals with and without migration backgrounds occur, Table 4 shows results that further differentiate between certain migrant groups. Panel A contrasts vaccination intentions between German-born individuals without migration experience (reference group), individuals who themselves migrated to Germany (first generation), and individuals who were born in Germany but have at least one parent who migrated to Germany (second generation). Panel B takes the region of origin into account while not discriminating between generation statuses.

Panel A reveals that first-generation migrants have higher vaccination intentions than second-generation migrants. Interestingly, differences between individuals without a migration background and first-generation migrants can be explained by the socioeconomic position of households. For second-generation migrants, the socioeconomic position of the household explains approximately 35% of the gap in COVID-19 vaccination intention. Differences in solidarity beliefs explain a slightly larger part (approximately 40%) of the intention gap. Thus, in our sample, the explanatory power of solidarity beliefs appears more important among second-generation migrants, while the socioeconomic position of households explains almost the entirety of the gap between first-generation migrants and natives. Moreover, the results on generation status emphasize the importance of differentiating between different migrant groups.

Panel B of Table 4 shows major variation in vaccination intentions by region of origin. While individuals with an Asian (−0.044; 1.62% of SD), American (−0.307; 11.34% of SD) or Western, Middle or Northern European (−0.124; 4.58% of SD) background have similar COVID-19 vaccination intentions as individuals without a migration background, differences between natives and individuals with an African (−0.810; 29.91% of SD) or Eastern European (−0.584; 21.57% of SD) background are moderate. However, differences between natives and individuals with a Southern European (−1.131; 41.77% of SD), potential forced migration (−1.470; 54.28% of SD), Turkish (−1.511; 55.78% of SD), Balkan (1.660; 61.30% of SD), or Russian (−1.741; 64.29% of SD) background are substantial. Furthermore, the results suggest that the resource and belief mechanism explain substantial parts of the differences between natives and different migrant groups. The explanatory power of the model thereby varies between 36 and 78%. In sum, Table 4 reveals great heterogeneity in COVID-19 vaccination intention by region of origin, ranging from zero differences to stark differences, thereby stressing the importance of fine-grained analyses of migrant gaps in

Table 4
Detailed migration background and mechanisms.

	(1) raw	(2) + resources	(3) + infection	(4) + solidarity belief	(5) + COVID-19 strain	Reduction in %
Panel A						
Migration background (ref. none)						
First generation	−0.614**	−0.158	−0.164	−0.139	−0.139	78%
	(0.215)	(0.226)	(0.226)	(0.174)	(0.172)	
Second generation	−0.967***	−0.627***	−0.618***	−0.374***	−0.379***	61%
	(0.106)	(0.114)	(0.114)	(0.087)	(0.087)	
Covariates	✓	✓	✓	✓	✓	
Adj. R^2	0.115	0.136	0.136	0.492	0.499	
N observations	4079	4079	4079	4079	4079	
Panel B						
Migration background (ref. none)						
Turkey	−1.511***	−1.121***	−1.102***	−0.797***	−0.756***	50%
	(0.218)	(0.224)	(0.225)	(0.173)	(0.172)	
Former Yugoslavia	−1.660***	−1.254***	−1.220***	−0.788**	−0.761**	64%
& Albania	(0.309)	(0.315)	(0.315)	(0.242)	(0.241)	
Russia and Former	−1.741***	−1.273***	−1.272***	−0.814***	−0.807***	64%
Soviet Parts	(0.220)	(0.230)	(0.230)	(0.177)	(0.176)	
Southern Europe	−1.131***	−0.911**	−0.914**	−0.447	−0.460	59%
	(0.335)	(0.333)	(0.333)	(0.256)	(0.254)	
Eastern Europe	−0.584**	−0.347	−0.345	−0.166	−0.175	70%
	(0.201)	(0.202)	(0.202)	(0.155)	(0.154)	
W./Mid./N. Europe	−0.124	−0.044	−0.051	−0.090	−0.093	-
	(0.233)	(0.232)	(0.232)	(0.178)	(0.177)	
Afghanistan/Syria/Iraq	−1.470***	−0.963**	−0.938**	−0.527*	−0.525*	64%
	(0.320)	(0.325)	(0.325)	(0.250)	(0.249)	
Asia	−0.044	0.458	0.450	0.260	0.231	-
	(0.272)	(0.280)	(0.280)	(0.215)	(0.214)	
Africa	−0.810*	−0.651*	−0.640*	−0.522*	−0.519*	36%
	(0.323)	(0.321)	(0.321)	(0.247)	(0.245)	
Americas	−0.307	−0.207	−0.202	0.049	−0.058	-
	(0.341)	(0.340)	(0.340)	(0.261)	(0.260)	
Residual	0.016	0.453	0.437	0.538	0.608	-
	(0.873)	(0.867)	(0.867)	(0.666)	(0.661)	
No information	−0.045	0.452	0.442	0.263	0.279	-
	(0.354)	(0.369)	(0.369)	(0.283)	(0.281)	
Covariates	✓	✓	✓	✓	✓	
Adj. R^2	0.126	0.144	0.144	0.495	0.502	
N observations	4079	4079	4079	4079	4079	

Note: Results from linear regressions. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; standard errors in parentheses. Refer to Table A2a and A2b in the Online Appendix for full regression results.
Covariates: Graduation cohort, happiness, interpersonal trust, school fixed effects, Big Five personality traits, self-efficacy, grit, risk aversion, and time preferences.
(1) Raw includes covariates only.
(2) Resources include covariates, a dummy for foreign language as the main household language, subjective household income (1–5), and a dummy variable indicating at least one parent having a university education. Note, however, that Panel B does not include parental education as a resource.
(3) Infection includes covariates, resources, a dummy indicating a personal infection, and a dummy indicating an infection within the family.
(4) Solidarity belief includes covariates, resources, infections, and an indicator for solidarity belief (0–10).
(5) The COVID-19 burden includes covariates, resources, infections, solidarity belief, and a variable indicating the perceived burden of school closures (1–5) and mask wearing (1–5).

potential COVID-19 vaccine uptake.

4. Conclusion and discussion

This paper analyzed social disparities in vaccination intentions among German high school graduates using a novel cross-sectional data collection (March to July 2021) from 4079 individuals. We proposed a sociological mechanism-based approach to explicate potential drivers of vaccination intention gaps between social groups. Therefore, we analyzed differences in cultural and economic resources, personal and familial infections, solidarity beliefs, and perceived burdens associated with COVID-19-related policies (i.e., mandatory mask wearing and school/university closures). Our study revealed the following main results:

In contrast to existing research, we do not find gender differences in COVID-19 vaccination intentions. According to previous research gender differences typically occur because health care workers tend to be more hesitant towards COVID-19 vaccinations (e.g., Zintel et al., 2022). Moreover, pregnancy, fertility intentions and breastfeeding (e.g., Galanis et al., 2021) play a role in vaccination hesitancy. As these factors are mostly not relevant for female adolescents it appears plausible that no gender differences were found.

Furthermore, we found that COVID-19 vaccination intentions differ between individuals from different social origins. Vaccination intention variation according to parental education strongly decreases when we include the vaccination related solidarity belief. Thus, polarization in solidarity according to social origin leads to differences in COVID-19 vaccination intentions.

In line with previous research (e.g., Niño et al., 2021; Raz et al., 2021) we found pronounced differences in vaccination intentions between individuals of different migration backgrounds. Both the socio-economic position of the household and solidarity beliefs are important drivers of intention gaps, while exposure to COVID-19 infections and perceived burdens associated with COVID-19-related policies cannot explain differences between individuals with and without migration backgrounds.

As differences by migration status are pronounced, we further differentiated the migration status. This workaround revealed that first generation migrants have higher vaccination intentions than second-generation migrants. Differences in the socioeconomic position of the household explain almost 70% of the difference between natives and first-generation migrants. While the household position also explains a substantial part of the gap between second-generation migrants and natives, differences in the vaccination related solidarity belief are more important. A subgroup analysis moreover suggests that individuals with an Asian, American and Middle, Northern or Western European background have similar vaccination intentions to natives and that individuals with an Eastern European and African background only moderately differ from natives in their vaccination intentions. However, compared to natives, individuals with a Southern European, potential forced migration (Iraq, Afghanistan, and Syria), Turkish, Balkan or Russian background differ substantially in their vaccination intentions. Overall, the proposed modeling strategy explains substantial parts of COVID-19 vaccination intention gaps across different cultural backgrounds.

In addition to these social gradients, we found that solidarity beliefs explain almost 40% of the variation in vaccination intentions against COVID-19 among adolescents independent of general risk preferences, personality, interpersonal trust and time preferences. Thus, an individual's decision to be vaccinated is perceived to be an act done for the common good in contrast to purely a self-interested action. This area of conflict in individuals' decision-making needs further investigation in future work that is able to directly test the predictive power of self-interest and common good orientations in vaccination uptake.

Moreover, our results suggest a substantial polarization in solidarity beliefs within society. As the analysis by migration background revealed that the explanatory power of solidarity beliefs appears more important among second-generation migrants than among first-generation migrants, subculture-related differences in solidarity beliefs might be important drivers of vaccination hesitancy. Therefore, public statements that emphasize solidarity as the main motive for COVID-19 vaccination may not motivate a substantial share of the young migrant population. Note, however, that our measure of solidarity is not perfect. First, we measured solidarity belief and vaccination intentions simultaneously. Thus, post hoc rationalizations in addition to social desirability biases might distort our conclusions. Second, as our questionnaire does not include a measure of general altruism, we are not able to distinguish between this latent trait and vaccination-related solidarity beliefs. Thus, solidarity could be either socially and culturally biased or associated with group-specific meanings. However, even if not perfectly measured, our employed construct discriminates among social groups quite well.

Moreover, from a rational point of view, it is surprising that exposure to COVID-19 infections hardly affects our outcome because Heffetz and Guy (2021) show for the US that perceived individual infection risk affects individuals' health-protection behavior. However, a personal and/or family members' previous infection might lead to ambivalent conclusions regarding one's health protection behaviors.

A central limitation of our data is sample selection because we have data only on high school students. One could argue that migrants and individuals from lower social origins who are underrepresented at academic tracks of upper secondary education in Germany are positively selected groups in terms of ability, motivation, career orientation or self-esteem. Thus, the presented differences in vaccination gaps might constitute a lower bound.

The cross-sectional data of our study constitute another limitation. Further experimental and longitudinal studies are needed to validate our results. However, data on vaccination are scant, and our proposed modeling accounts for very important confounders such as personality traits (Big Five, self-efficacy, and grit), time and risk preferences and interpersonal trust. Thus, the presented findings have important policy implications.

Interestingly, although our data indicate higher COVID-19 infection risks and perceived burdens induced by school closures and mandatory mask wearing for individuals with lower educated parents and migration backgrounds, these factors do not contribute to social gradients in vaccination intentions. Thus, policy makers should increase efforts to cast light on the potential individual costs of COVID-19 infections and learning loss. Motivating young adults could be in particular promising as children's vaccination uptake could motivate parental vaccination decisions.

Our results mainly suggest that targeted policies are needed that take polarizations in solidarity beliefs and cultural and socioeconomic resources of individuals into account to increase intention to be vaccinated against COVID-19. Thus, mainly focusing on a solidarity narrative will not motivate a significant share of young individuals to be vaccinated against COVID-19. Against this background, closings of sport clubs, discos and bars might even inhibit greater increasing vaccination rates among young individuals with low levels of solidarity beliefs because reducing social contact might constitute a disincentive for this particular group. Simultaneously, during the fourth COVID-19 wave in Germany, an increasing number of universities applied stricter contact rules and allowed only recovered or vaccinated individuals in person access to campuses. As migrants and individuals from low social origins are more likely to be unvaccinated, such policies have the potential to exacerbate existing inequalities in educational opportunities.

CRediT author statement

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Ethical statement

The fieldwork for this study has been approved from the ethic council of the university of Bamberg.

Declaration of competing interest

The Authors declare that there is no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2022.101054.

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