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RESEARCH

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# Depressive symptoms, education, gender and history of migration - an intersectional analysis using data from the German National Cohort (NAKO)

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## Abstract

**Background** The educational gradient in depressive symptoms is well documented. Gender and history of migration have also been found to be associated with depressive symptoms. Intersectional approaches enable the analysis of the interplay of different social factors at a time to gain a deeper understanding of inequalities in depressive symptoms. In this study, intersectional inequalities in depressive symptoms according to education, gender and history of migration are analysed.

**Methods** The German National Cohort (NAKO,  $N=204,783$ ) collected information on depressive symptoms (PHQ-9), which was used as an outcome variable. Educational attainment (ISCED-97), gender, and history of migration constituted the different social strata in the analyses. The predicted probabilities of depressive symptoms for 30 social strata were calculated. Multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA) was applied, using logistic regression and social strata were introduced as higher-level unit interaction terms.

**Results** The analyses revealed an educational gradient in depressive symptoms, with differences within each educational group when gender and history of migration were introduced to the models. The predicted probabilities of depressive symptoms varied between the most advantaged and the most disadvantaged social strata by more than 20% points. Among the three studied variables, education contributed the most to the variance explained by the MAIHDA models. The between-strata differences were largely explained by additive effects.

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**Conclusions** We observed a robust educational gradient in depressive symptoms, but gender and history of migration had substantial contribution on the magnitude of educational inequalities. An intersectional perspective on inequalities in depressive symptoms enhances current knowledge by showing that different social dimensions may intersect and contribute to inequalities in depressive symptoms. Future studies on inequalities in depression may greatly benefit from an intersectional approach, as it reflects lived inequalities in their diversity.

**Keywords** German national cohort, NAKO, Intersectional analysis, Educational inequalities, Depression, History of migration, Gender, MAIHDA

## Background

The educational gradient of depressive symptoms is well documented by extensive research: the lower the educational attainment is, the greater the risk of experiencing depressive symptoms [1–3]. As such, education can be understood as a fundamental cause of mental health outcomes, including depressive symptoms [4]. Among the components explaining the educational gradient are poorer coping mechanisms, behaviour-related risk factors, stress exposure, critical life events, a lower sense of control, fewer material resources, and lower access to health care for people with lower educational attainment [2, 5]. However, studies on educational inequalities in depressive symptoms have been criticized for neglecting within-group heterogeneity and focusing mostly on single-axis inequalities [6, 7]. These methods and analyses might not reveal the interplay of different social categories, as there are several other inequalities in depressive symptoms at the population level, such as inequalities by age, gender, history of migration, or ethnicity [8–10]. The interaction of these social categories may affect the educational gradient of depressive symptoms.

In earlier research, gender and a history of international migration were repeatedly shown to be associated with depressive symptoms. With respect to gender and depressive symptoms, higher risks have consistently been detected in women than in men [4, 7–13]. On the basis of an international meta-analysis of data from more than 1.7 million women and men, Salk and colleagues reported significantly increased odds of depression in women compared with men [14]. These differences varied across the lifespan, with a peak in adolescence, but remained relatively stable across later adulthood. When examining associations of history of migration and depressive symptoms, international studies point towards higher rates in migrant populations. In their overarching review of reviews, Close et al. reported increased risks of poor mental health for first-generation migrants but reported wide variation in prevalence [15]. In terms of a potential healthy migrant effect in mental health, there may be a mental health advantage for some immigrants at time of arrival (younger, male), but most of the evidence shows a decline in mental health after immigration and higher mental health risks in migrant populations [16]. Few studies have investigated the associations between

a history of migration and depressive symptoms in Germany [9, 17–19]. In a first publication based on data from the German National Cohort (NAKO), we identified greater depressive risks for migrant populations than for non-migrant populations in Germany [10]. Similar results were found in analyses based on a European sample [20].

The benefit of an intersectional approach is to analyse interactions at the intersections of privilege and disadvantage to gain a comprehensive understanding of inequalities in depressive symptoms. It goes back to black feminist movements in the U.S., specifically the Combahee River Collective and later Kimberlé Crenshaw [21, 22]. The experiences of black women being subjected to multiple forms of discrimination and inequality led to the formation of intersectionality to analyse the structures produced by interlocking systems of privilege and disadvantage (sexism, ageism or racism [23]). The intersectionality approach is increasingly applied, as it emphasizes multidimensional aspects of inequality and the potential multiplicative effects of different disadvantages [23].

In their review, Patil et al. reported that there are only a few studies on intersectional inequalities in depressive symptoms, and they have focused mainly on the U.S [6]. Evans and Erickson [7] applied a new approach in intersectionality research, i.e., the multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA). Their analysis revealed that different social strata, identified by gender, ethnicity, and income, differed substantially from each other in terms of depressive risks. Studies on intersectional inequalities in depressive symptoms in Germany are lacking. Wandschneider and colleagues analysed subjective mental health along the intersections of sex, gendered practices, and history of migration on the basis of German panel data but did not include indicators of socioeconomic status such as income or education [24]. In their review, Trygg and colleagues [25] identified only one European study that analysed health outcomes at the intersections of gender, household income, and country of birth on the basis of Swedish data [26]. As most of the evidence up to date stems from the US, the transferability and comparability of these results is difficult, especially because of differences in educational systems, social stratification, and

differing categories concerning the history of migration in European countries compared with the US.

Based on data from the NAKO, the aim of the present paper is to analyse the variations within the educational gradient in depressive symptoms when gender and history of migration are simultaneously considered. The following research questions will be addressed via an intersectional approach: Are there variations within the educational gradient in depressive symptoms according to gender and history of migration in Germany? Do the intersectional strata significantly differ in terms of depressive symptoms? Do education, gender, and history of migration interact, indicating intersectional inequalities in depressive symptoms?

## Methods

### Data

The NAKO is a prospective multicentre cohort study in Germany [27]. The main goal of the NAKO is to investigate risk factors and causes of common chronic diseases. The study design was described elsewhere [27]. In brief, data collection and assessment are organized through 18 study centres, covering rural and urban areas [28–30]. The baseline assessment took place from March 2014 until September 2019 and included standardized face-to-face interviews, self-administered questionnaires, various physical examinations, and the collection of biospecimens. The NAKO included 204,783 participants aged 19–74 years at baseline, selected on the basis of random samples from the population registration authorities of the respective study locations, stratified by sex (1:1) and age (10.0% each 10-year group between 20 and 39 years and 26.7% in each 10-year group between 40 and 74 years). The overall response at baseline was 17%, but it varied between 9% and 32% across the study centers [31]. Further details on the sampling and data assessment can be found elsewhere [28, 29]. All participants provided written consent for study participation, and the study centers' local ethical committees gave their approval. The complete study was carried out in accordance with the Declaration of Helsinki.

### Measures

#### *Dependent variable*

Depressive symptoms were assessed via the Patient Health Questionnaire (PHQ-9) [32], a well-established measure that has also been used in recent NAKO analyses [3, 10, 33]. The PHQ-9 consists of nine items asking about depressive symptoms in the past two weeks. Each item has a four-point scale ranging from 0 (“not at all”) to 3 (“almost every day”). A sum score ranging from 0 to 27 was calculated. The Cronbach's alpha for the PHQ-9 scale was 0.84, indicating the high internal consistency of the scale. A validated cut-off score of 10 points or higher

indicates depressive symptoms in terms of a moderate to severe depressive episode [34]. A binary variable derived from the PHQ-9 score ( $\geq 10$  vs.  $< 10$ ) was used in the present analyses for two reasons. First, the PHQ-9 score is heavily right skewed, which is why we cannot use a simpler, linear model. Second, we aimed to identify relevant depressive symptoms and therefore we did not use the mean value of the PHQ-9 score. The mean value is approximately 5, with a standard deviation of approximately 3.5, which means that people with moderate to severe depressive symptoms (PHQ-9 score  $\geq 10$ ) are lost in the overall sample.

#### *Independent variables*

Education was used as an indicator for the socioeconomic status and was assessed on the basis of the International Standard Classification of Education (ISCED-97), which is recoded into three levels (“low” = ISCED-level 1/2, “intermediate” = ISCED-level 3/4 and “high” = ISCED-level 5/6) [35].

History of migration was assessed according to a set of basic indicators for mapping migrant status in Germany [36], as proposed by Wiessner and colleagues for the NAKO data [30]. History of migration was recorded on the basis of the nationality and country of birth of both the study participants and their parents. This enabled a distinction of five subgroups: those without a history of migration, two subgroups of first-generation migrants with personal experience of migration (those with German citizenship (naturalized) and those without German citizenship), the group of German resettlers (a group of migrants from the former Soviet Union with German ancestors) and descendants of migrants (born in Germany having at least one parent not born in Germany) [30].

The gender of the respondents was recorded. On the basis of the numbers of subgroups of education (three), gender (two), and history of migration (five), 30 social strata were calculated. Age was introduced as a control variable (19–39 years, 40–59 years, 60 years and older).

#### *Missing data*

On average, approximately 16% of the individual items across all the variables were missing. The variables gender and age had no missing values, while the highest proportion of missing values was found for the variables education (9.1%) and PHQ-9 (7.5%). The missing data pattern was analysed, and missing data were imputed via multivariate imputation by chained equations method, generating five imputed datasets [37]. The outcome (PHQ-9) was included for imputation, as recommended by several authors [37–39]. Strata variables were included as regular terms, not their interaction. The method for imputing missing values depends on the variable's nature.

For continuous variables, predictive mean matching was applied, logistic regressions were used for binary variables, and polytomous logistic regression was used for categorical variables with more than two levels.

Comparisons of results based on the non-imputed data including missing values and the imputed data sets can be found in the supplementary material (see [S1](#) and [S2](#)).

### Statistical analyses

In this study, we used the multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA), which is a statistical approach in social epidemiology that has increasingly gained attention in recent years. It is based on multilevel modelling where the different social strata are specified as higher-level units (“random effects”) [23]. This means that the estimated outcome in different social strata is “shrunk”, i.e., the (often too high) effects for smaller strata are pulled towards a global average. This is a desired property of multilevel models to protect against bias due to the ‘small N problem’ [40], which relates to single-level regression models, where predictors of social strata are entered as interaction terms. Larger numbers of strata can lead to strata that only have few observations, even in large datasets. These “outliers” result in biased estimates for strata on the basis of relatively few cases.

In our analysis, we used logistic regression multilevel models with “depressive symptoms” as the outcome. Social strata, defined by gender, education, and history of migration, were used as higher-level unit interaction terms (“random intercepts” on level 2) in all the models, whereas age was used as a control variable at the individual level (“fixed effect”).

The applied MAIHDA approach [23] comprises several steps. First, a “base model” with random effects only was fitted, with no further covariates. The goal was to summarize the overall inequality in the sample by calculating the intraclass correlation coefficient (ICC). The ICC ranges from zero to one and can be interpreted as the proportion of variance explained by the groups used as higher-level units [41]. The higher the ICC value is, the more the social strata contribute to the variance observed in the sample. An ICC close to zero would mean that belonging to a certain social stratum is not associated with the inequalities under study.

Next, additional multilevel models (“main effects models”) were fitted, one for each dimension (gender, education, and migration history) used to construct the social strata. The variables representing each dimension were separately added as predictors at the individual level, while the random effects remained unchanged. This step in the MAIHDA framework affects the resulting models’ ICC values and allows the calculation of the extent to which each dimension has an additive effect on

inequalities, which is called the proportional change in variance (PCV, ranging from 0 to 1). The larger the PCV is, the greater the contribution of one dimension of the social strata to the overall inequalities (see also [42, 43]).

In the final multilevel model (“full model”), all three dimensions were added as predictors on an individual level to assess whether there are simple additive effects regarding inequalities or whether there is an indication of interaction. The PCV will be nearly one when inequalities due to social strata are attributable to additive effects of gender, education, or migration history only. When the PCV is considerably lower than one, the remaining proportion of the total variance can be attributed to the interaction effects of the observed inequalities between strata.

To visualize the results and to determine how strongly each of the 30 different social strata ( $5 \times 2 \times 3$ ) was associated with the outcome, ranked predicted probabilities were calculated, which illustrated the range, spread, and pattern of inequalities between strata. These estimate the adjusted probabilities of the “presence of depressive symptoms” for each stratum. As we focus on the potential of intersectional analysis for analysing the variability within educational inequalities in depressive symptoms, we visually emphasized the ranked predicted probabilities by education for each social stratum under study. Pairwise comparisons between the predicted probabilities were calculated within each level of education to test whether differences in inequalities between strata are statistically significant. Since all combinations of pairwise comparisons would result in very large tables, we focused on comparisons of strata against the group with the highest probability of depressive symptoms within each educational level.

All analyses were carried out via R statistical software and the packages `glmmTMB`, `performance` and `ggeffects` [44–46]. The related R code is deposited at [osf.io](https://osf.io) (DOI: <https://doi.org/10.17605/OSF.IO/C58GT>).

### Results

In [Table 1](#), an overview of all variables used in the present analyses is shown. A higher prevalence of depressive symptoms (PHQ-9 score of 10 or higher) was found in groups with low educational attainment (13.9%), in women (8.8%), and in groups with a history of migration. Depressive symptoms were more often reported by persons under the age of 40 years.

In [Table 2](#), the fixed effects of the MAIHDA logistic regression models are reported. In Model 1, age was introduced as a covariate. The ICC for the basic model indicated that approximately 5% of the explained variance can be accounted for by the random effects of history of migration, gender, and education. The introduction of fixed effects by history of migration decreased

**Table 1** Depressive symptoms (PHQ-9), cut-off score ( $\geq 10$ ), according to social dimensions and covariables; German National cohort (NAKO),  $N = 204,783$

	% in the sample	% PHQ-9 $\geq 10$ (95% CI)	p Value*
<b>Total</b>		7.4 (7.3, 7.5)	
<b>Education</b>			< 0.001
Low	2.7	13.9 (13.0, 14.9)	
Intermediate	42.2	9.0 (8.9, 9.2)	
High	55.1	5.8 (5.6, 5.9)	
<b>Gender</b>			< 0.001
Men	49.5	5.9 (5.8, 6.1)	
Women	50.5	8.8 (8.6, 9.0)	
<b>History of migration</b>			< 0.001
Non-migrants	83.1	6.9 (6.8, 7.1)	
1st generation migrants, without German citizenship	5.1	9.2 (8.6, 9.7)	
1st generation migrants, German citizenship	5.2	9.8 (9.2, 10.4)	
Descendants of migrants	5.0	9.7 (9.1, 10.3)	
Resettlers	1.7	9.0 (8.1, 10.0)	
<b>Age groups</b>			< 0.001
< 40	20.3	8.8 (8.5, 9.1)	
40–59	52.7	8.1 (7.9, 8.3)	
$\geq 60$	27.0	4.9 (4.7, 5.1)	

\*Chi-square test

**Table 2** History of migration, gender, education, and depressive symptoms (PHQ-9, cut-off score  $> 10$ ), MAIHDA logistic regression models, adjusted for age; German National cohort (NAKO),  $N = 204,783$

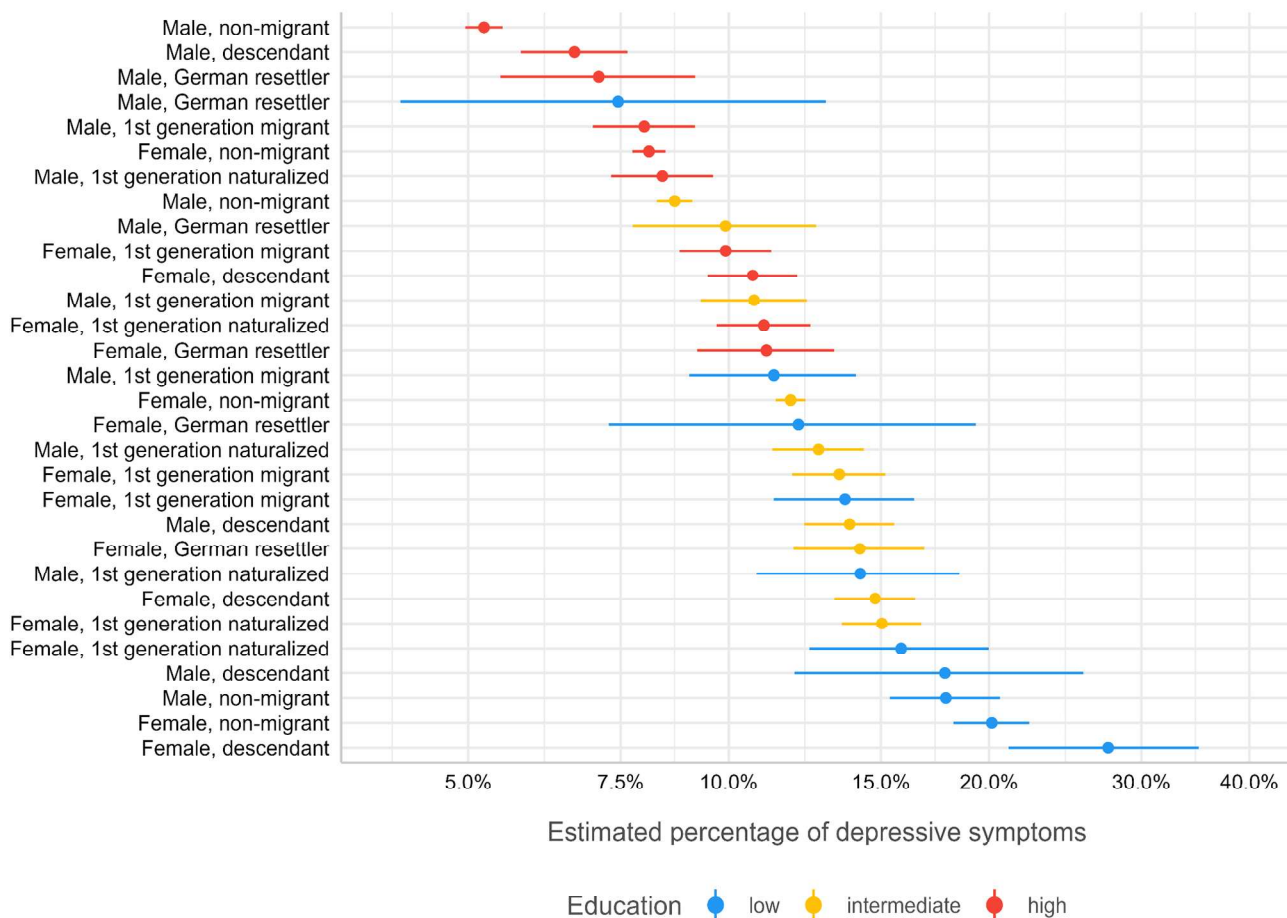
Parameter	Model 1	Model 2	Model 3	Model 4	Model 5
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>(Intercept)</b>	0.13 (0.11, 0.15)	0.12 (0.09, 0.17)	0.11 (0.09, 0.13)	0.09 (0.08, 0.11)	0.07 (0.06, 0.08)
<b>Age (ref. &lt; 40 years)</b>	1.00	1.00	1.00	1.00	1.00
40–59 years	0.91 (0.87, 0.94)	0.91 (0.87, 0.94)	0.91 (0.87, 0.94)	0.90 (0.87, 0.94)	0.90 (0.87, 0.94)
60+ years	0.52 (0.49, 0.55)	0.52 (0.49, 0.55)	0.52 (0.49, 0.55)	0.52 (0.49, 0.55)	0.52 (0.49, 0.55)
<b>History of migration (ref. non-migrants)</b>		1.00			1.00
1st generation migrants		1.01 (0.63, 1.60)			1.04 (0.86, 1.26)
1st generation migrants, naturalized		1.18 (0.74, 1.88)			1.24 (1.02, 1.50)
Descendants of migrants		1.36 (0.85, 2.18)			1.35 (1.11, 1.64)
German resettler		0.86 (0.53, 1.41)			1.04 (0.83, 1.31)
<b>Gender (ref: men)</b>			1.00		1.00
Women			1.43 (1.07, 1.90)		1.39 (1.22, 1.58)
<b>Education (ref: high)</b>				1.00	1.00
Low education, ISCED-level 1 or 2				2.14 (1.65, 2.78)	2.23 (1.87, 2.66)
Intermediate education, ISCED-level 3 or 4				1.56 (1.23, 1.98)	1.57 (1.35, 1.81)
<b>ICC<sup>1</sup></b>	0.051	0.047	0.042	0.020	0.007
<b>PCV<sup>2</sup>(Model 1 compared to all others)</b>	-	0.094	0.185	0.615	0.874

<sup>1</sup> Intraclass Correlation Coefficient

<sup>2</sup> Proportional Change in Variance

the explained variance at level 2 (ICC 0.047), indicating a minimal effect of higher-level variation by history of migration (PCV=0.094). The odds ratios for depressive symptoms were increased in 1st generation migrants with German citizenship and descendants of migrants. The introduction of gender as an additional fixed effect decreased the ICC by approximately 0.01, similarly indicating an effect of higher-level variation by gender (PCV=0.185). In Model 4, the educational gradient in depressive symptoms became visible, i.e., lower educational attainment was associated with increased odds for depressive symptoms. The ICC was reduced by 0.02; likewise, a PCV of 0.615 indicated a high share of explained variance attributable to education. In Model 5 where all fixed effects were accounted for, the educational gradient in depressive symptoms remained significant and similar effects of gender and history of migration were detected as in Models 2 and 3. The ICC was low at 0.007 and the PCV of 0.874 indicated a high share of explained variance attributable to the fixed effects in the model. As indicated by the PCV of 0.87, there remains some evidence for interactive effects.

To assess the magnitude of inequalities in depressive symptoms according to education, gender, and history of migration, the predicted probabilities of depressive symptoms for each of the 30 social strata were calculated based on Model 1. Figure 1 presents the distribution of probabilities of depressive symptoms, including 95% confidence intervals. The social stratum of highly educated and non-migrant males had the lowest predicted probability of depressive symptoms. The probabilities of most other social strata followed an educational gradient. There were few exceptions to this pattern, such as non-migrant males with intermediate educational levels or male first-generation migrants with low education levels. Within each educational stratum, considerable variance was observed. For example, in the low-educated strata (Fig. 1, blue), there was a difference of approximately 20% points, varying from 7% probability in low-educated male German resettlers to approximately 28% probability of depressive symptoms in low-educated female descendants. In general, women and those with a history of migration had higher probabilities of depressive



**Fig. 1** Ranked predicted probabilities (95% CI) of depressive symptoms (PHQ-9, cut-off score > 10) for 30 different social strata on the basis of education, gender, and history of migration; based on MAIHDA logistic regression Model 1; German National Cohort (NAKO), N= 204,783

**Table 3** Pairwise comparison within the highly educated social stratum on the basis of ranked predicted probabilities of depressive symptoms (PHQ-9, cut-off score  $\geq 10$ ) by gender and history of migration; German National cohort (NAKO),  $n = 112,755$ 

High education	Contrast <sup>1</sup> , %-points	95% CI	<i>p</i>
<i>German resettler-female</i>	<i>Ref.</i>	<i>Ref.</i>	
Non-migrant-male	-0.06	-0.08, -0.04	< 0.001
Descendant-male	-0.04	-0.07, -0.02	< 0.001
German resettler-male	-0.04	-0.07, -0.01	0.004
1st generation migrant-male	-0.03	-0.05, -0.01	0.009
1st generation naturalized-male	-0.03	-0.05, 0.00	0.024
Non-migrant-female	-0.03	-0.05, -0.01	0.004
1st generation migrant-female	-0.01	-0.03, 0.01	0.343
Descendant-female	0.00	-0.03, 0.02	0.745
1st generation naturalized-female	0.00	-0.03, 0.02	0.952

<sup>1</sup> Contrasts indicate differences in %-points in relation to the reference group

**Table 4** Pairwise comparison within the low-educated social stratum on the basis of ranked predicted probabilities of depressive symptoms (PHQ-9, cut-off score  $\geq 10$ ) by gender and history of migration; German National cohort (NAKO),  $n = 5,540$ 

Low education	Contrast <sup>1</sup> , %-points	95% CI	<i>p</i>
<i>Descendant-female</i>	<i>Ref.</i>	<i>Ref.</i>	
German resettler-male	-0.20	-0.28, -0.12	< 0.001
1st generation migrant-male	-0.16	-0.24, -0.09	< 0.001
German resettler-female	-0.15	0.06, 0.25	< 0.001
1st generation migrant-female	-0.14	-0.21, -0.06	< 0.001
1st generation naturalized-male	-0.13	-0.21, -0.05	0.001
1st generation naturalized-female	-0.12	-0.20, -0.04	0.004
Descendant-male	-0.10	-0.19, 0.00	0.052
Non-migrant-male	-0.10	-0.17, -0.02	0.011
Non-migrant-female	-0.07	-0.15, 0.00	0.048

<sup>1</sup> Contrasts indicate differences in %-points in relation to the reference group

**Table 5** Pairwise comparison within the intermediate-educated social stratum on the basis of the predicted probabilities of depressive symptoms (PHQ-9, cut-off score  $\geq 10$ ) according to gender and history of migration; German National health study (NAKO),  $n = 86,488$ 

Intermediate education	Contrast <sup>1</sup> , %-points	95% CI	<i>p</i>
<i>1st generation naturalized-female</i>	<i>Ref.</i>	<i>Ref.</i>	
Non-migrant-male	-0.06	-0.08, -0.05	< 0.001
German resettler-male	-0.05	-0.08, -0.02	< 0.001
1st generation migrant-male	-0.04	-0.07, -0.02	< 0.001
Non-migrant-female	-0.03	-0.05, -0.02	< 0.001
1st generation migrant-female	-0.02	-0.04, 0.01	0.171
1st generation naturalized-male	-0.02	-0.05, 0.00	0.039
German resettler-female	-0.01	-0.02, 0.04	0.568
Descendant-male	-0.01	-0.04, 0.01	0.291
Descendant-female	-0.00	-0.02, 0.03	0.816

<sup>1</sup> Contrasts indicate differences in %-points in relation to the reference group

symptoms than men and those without a history of migration within each educational stratum.

To detect the significance of these variations, as presented in Fig. 1, pairwise comparisons were performed, with the group with the highest probability of depressive symptoms within each educational stratum used as the reference group (see Table 3–4). In the high educational stratum, differences varied between 0 and 6% points and were therefore smaller than the differences observed in the lowest educational stratum (Table 3). Five of these differences in the high educational stratum were statistically significant. Within the intermediate educational stratum, the observed differences varied between 0 and 6% points, with largest difference for non-migrant males compared to naturalized female migrants (Table 5). Four out of nine observed differences reached statistical significance. Within the low educational stratum, differences varied between 7 and 20% points. Largest difference was observed for male German resettlers compared to female migrant descendants and one out of nine differences in the lowest educational stratum did not reach statistical significance (Table 4).

Results in the Tables and in Fig. 1 showed strongest associations between education and depressive symptoms. This is in line with the calculated proportional change in the between stratum variance in the MAIHDA logistic regression models (see Table 2). Education had the strongest impact on the explained variance in the model (PCV = 0.62), followed by gender (PCV = 0.19) and history of migration (PCV = 0.09).

## Discussion

On the basis of data from the NAKO and logistic MAIHDA models, estimates for depressive symptoms in 30 different social strata, which were defined by educational level, gender and history of migration, were calculated. Similar to previous findings in the field, the analyses revealed an educational gradient in depressive symptoms [1–4]. Adding new knowledge to the field, the identified educational gradient varied substantially by gender and history of migration. The MAIHDA approach revealed that within each educational stratum, differences in the probability of depressive symptoms existed. For example, women with a history of migration tended to show more depressive symptoms within each educational stratum. The social stratum with the lowest probability of depressive symptoms was highly educated non-migrant males. The probabilities for depressive symptoms varied between the least and the most disadvantaged social strata by more than 20%. The analyses also revealed that education contributed more to the variance explained by the MAIHDA models than did gender and history of migration. Additive effects largely explain the variance between the social strata, but there remains some

evidence for interactive effects, meaning that the calculated odds in the full model exceed the expected values in some cases. However, evidence for interactive effects is rather weak, we did not identify a clear pattern of interaction and we cannot rule out potential effects of data imputation. In order to assess these effects, we added a comparison of the results based on imputed and non-imputed data in the supplementary material (see supplementary material S3-S5).

A critique of analytic approaches in risk-factor epidemiology is the focus on variability between different social categories while neglecting the variability within and potential overlap of these categories. Thereby these strategies potentially overlook the interdependence of social factors and social strata [47, 48]. As our analyses revealed, the characteristics of other social factors, such as gender or history of migration, can have a significant effect on how pronounced educational inequalities in depressive symptoms ultimately turn out to be, even within different educational groups. The combinations of social dimensions can be more relevant for the outcome than the social dimension itself; by combining two or more social dimensions, the probabilities of depressive symptoms can exceed the originally assumed risk of these social dimensions. According to our results, the interaction of education and gender seems to be especially relevant, as men can be found more often in the lower risk probabilities for depressive symptoms, as well as within lower educational backgrounds, than women.

When comparing the three social factors that were used to identify the different social strata, education had the strongest effect on depressive symptoms, followed by gender and history of migration. This is in line with previous findings showing the magnitude of socioeconomic inequalities in depressive symptoms and mental health [1, 7, 49–51]. A number of known risk factors for depressive symptoms, such as psychosocial stressors, behavioural risk factors, limited resources, and lower access to health care, are more likely to occur in groups with lower educational backgrounds and can help explain these findings [49, 52].

Similar to a work by Evans and colleagues on depression in adolescence and early adulthood [7], we found substantial differences between different social strata and their respective risks of depressive symptoms, and in some cases, these differences exceeded the expected additive effects. Evans and colleagues found interactive effects in their U.S. cohort study on depression in adolescents and young adults, especially for being female and Latin or Native American [7]. They focused on family income, gender, race/ethnicity and immigration history, while in our study education, gender and history of migration were used. The significant differences which we identify in our analyses within educational strata,

especially within the lower educated, showed that the mental health consequences of being a woman with a history of migration and a low level of education were quite different from those experienced by a man with low levels of education and without a history of migration. The different social strata need to be understood as unique positions within society with unique experiences in everyday life. This important lesson can be learned from an intersectional perspective on educational inequalities in depressive symptoms [7].

Descendants of migrants are especially vulnerable to depressive symptoms within the lowest educational strata (see also 10). Compared to other groups with a history of migration, descendants are less likely to experience language barriers or barriers related to citizenship or residence status. It is more likely that a stronger desire for social acceptance and disappointed hopes for educational careers, especially in comparison to the previous generation of immigrants, translates into greater risks of depressive symptoms [53–56]. A longer duration of residence in Germany has been found to be associated with worse mental health outcomes [57]. Moreover, constant attribution as an immigrant and recurrent experiences of stigma and discrimination might play a role in explaining greater mental health risks [9].

### Strengths and limitations

We limited the analyses to three social dimensions and 30 social strata on the basis of previous knowledge of the social risk factors for depressive symptoms [10, 12, 58] to ensure that the analyses were comprehensible. Intersectional analyses are, to a certain degree, limited by data capacity; therefore, only a finite number of social strata can be applied.

Earlier studies have noted that variance in intersectional MAIHDA analysis is often low overall. The share of variance that is explained by between-strata differences does not exceed 5% in our analyses, which is comparable to the findings of similar previous studies [7]. Small ICC values in logistic regression models do not necessarily indicate negligible effects [59]. In order to investigate in how far the binary outcome in the logistic regression models resulted in small ICC values, we also conducted a linear mixed model analysis using a log-transformed outcome (see supplementary material S6-S8). The results corroborated the logistic regression model, indicating no significant underperformance.

The overall response in NAKO was approximately 17%, even though representative sampling schemes were applied (see also [30, 60]). Responses vary considerably across different NAKO study centres [29, 31]. The study population differs from the general population, as seen in the underrepresentation of low-educated groups, making up only approximately 2% of the total NAKO sample. The

smaller sample size in low-educated groups needs to be taken into account when variations in the probability of depressive symptoms are interpreted. It is likely that this leads to an underestimation of depressive risks in low educated groups and that the calculated estimates are also less precise due to the lower number of cases.

A further selection effect cannot be ruled out when looking at history of migration. For those participants with limited knowledge of the German language, measures to increase participation, such as home visits in some study areas, have been taken [61]. But the study language of the NAKO is German, and other languages or translations are not provided, limiting its participation to those with sufficient German language skills [60]. These selection effects led to an underrepresentation of marginalized groups [19, 62], especially those lacking officially registered addresses or sufficient resources for participating in the NAKO study. This may in turn be associated with an underestimation of depressive risk as well as related inequalities.

A limitation concerns the assessment of gender in the NAKO. This approach is limited to biological sex, as diverse genders, self-assessed genders, gender practices or sexual orientations were not assessed in the study [63].

There is a chance of underestimation of depressive symptoms in men compared with women in the sample. The standard instruments used in the NAKO, such as the PHQ-9, might not adequately reflect masculine norms and their effects on the assessment of depression and depressive symptoms [64]. On the other hand, the PHQ-9 has been evaluated to assess depression similarly in men and women in the general population [65].

A strength of the MAIHDA approach presented here is the visualization of the findings. The visualizations of the different social strata and their relative risks of depressive symptoms (see Fig. 1) revealed the variability of risks within a single social stratum, such as low education. Considering this within-group variation and finding analytic ways to make these variations visible is a major benefit of the MAIHDA approach in analysing intersectional inequalities in depressive symptoms [23]. When probabilities of depressive symptoms are calculated on the basis of the MAIHDA approach, no reference category is needed, where either the most privileged or marginalized groups are used as a reference to which all others are compared. Here, we were able to assess the probabilities of depressive symptoms in different social strata without referring to a specific group. Moreover, in MAIHDA social strata are compared to the population grand mean (see 59).

## Conclusions

Intersectionality as a framework for analysing social inequalities in depressive symptoms can be valuable, as it helps in understanding the multiple forms of advantages and disadvantages when different social dimensions are considered simultaneously. Our results reveal diversity within the educational gradient in depressive symptoms when gender and history of migration are added as social dimensions, resulting in 30 different social strata. We also find evidence that the specific combinations of these social dimensions matter for the risk of depressive symptoms. For example, within the low educated strata, which generally show higher risks of depressive symptoms compared to those with intermediate or high education, it matters if one is a woman and a descendant of migrants or a non-migrant male, as risks of depressive symptoms vary significantly between these groups (20% points). In this regard, our analyses can shed light on the complexity of the intersections of different social strata. By doing so, the results of our analyses contribute to a deeper understanding of inequalities in depressive symptoms. MAIHDA enables new possibilities for analysing social inequalities in depressive symptoms and other (health) outcomes and can identify these differences between different social strata. Examining the variety of intersectional inequalities in depressive symptoms can help identify vulnerable groups affected by multiple disadvantages that can be addressed by targeted intervention programs.

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12939-025-02479-2>.

Supplementary Material 1

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## Author contributions

NV, DL and OK developed the research questions. NV and DL prepared the data for analyses, and DL conducted the data analyses. HB, KB, PB, HBr, SC, ND, VH, SJ, AK, TK, LK, BL, ML, JM, CMF, RM, NO, TP, MR, BS, IMV, HV and CW were involved in the data collection of the NAKO. NV, DL and OK drafted the manuscript. NV, DL and OK contributed to the interpretation of the data. All authors revised, read and approved the final manuscript.

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## Data availability

Data is provided within the manuscript or supplementary information files. The related R code is deposited at osf.io (DOI: 10.17605/OSF.IO/C58GT). The

study used secondary data from the German National Cohort health study (NAKO), which is available on reasonable request under: <https://nako.de/informationen-auf-englisch/>.

## Declarations

### Ethics approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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