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# The influence of education on gender attitudes among ethno-religious majority and minority youth in Germany from a longitudinal perspective

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It is well-known that exposure to education is related to egalitarian gender attitudes. Yet, previous studies did not sufficiently take the temporal variation of this relationship into account, especially regarding ethno-religious minority and majority adolescents in Europe. Adolescence represents crucial years for attitude development. We analyze the association between secondary education and gender attitudes of female and male youth belonging to the majority, Muslim, and non-Muslim minority in Germany by employing the CILS4EU-DE panel data with more than 3200 adolescents. Obtaining a secondary school degree is associated with more egalitarian gender attitudes in general. However, different patterns emerge for the various ethno-religious groups and for females and males. Particularly, the effect of secondary education in general is stronger for boys than girls, and upper secondary education is stronger for Muslim minorities than for majority youth. Thus, attitudes develop during adolescence, and education can lead to more egalitarian gender attitudes among some groups but not all equally.

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## Introduction

Gender equality is still a contentious and highly relevant issue in Europe (European Commission, 2022). It has also been connected to the integration of immigrants and their descendants in the past decades (e.g., Diehl et al., 2009; Kretschmer, 2018; Maliepaard and Alba, 2016; Ng, 2022; Röder, 2014; Röder and Mühlau, 2014). While many European societies are experiencing a shift from traditional to more egalitarian gender attitudes (e.g., Knight and Brinton, 2017; Lee et al., 2007), many immigrants are originally from countries that are still, on average, less egalitarian (Inglehart and Norris, 2003). It seems that gender attitudes are closely related to religion (Glas et al., 2018). Especially Muslim minorities in Europe tend to hold, on average, less egalitarian gender-related attitudes compared to majority-group members (e.g., Diehl et al., 2009; Röder, 2014) but are located in-between those of the population in the country of residence and origin (Norris and Inglehart, 2012).

Education and the school context seem to be important for gender attitudes (Bolzendahl and Myers, 2004; Mastari et al., 2022; Sánchez Guerrero and Schober, 2021; Thijs et al., 2019). Yet, to our best knowledge, previous research has mostly approached the role of education on gender attitudes in Europe with regard to ethno-religious minorities from a cross-sectional perspective, observing that higher-educated minorities differ less from the majority group in their gender attitudes (e.g., Maliepaard and Alba, 2016). However, gender attitudes are dynamic, and they can change, and changes can ideally be observed by analyzing them from a longitudinal perspective (Cunningham, 2008; Vespa, 2009).

This study aims to fill this gap and addresses the following question: to what extent does obtaining a secondary school degree affect the gender attitudes of the majority group, Muslim, and non-Muslim minorities in Germany? To our best knowledge, there is no study investigating the temporal variation in the development of gender-related attitudes and educational changes during the transition from adolescence to early adulthood of ethno-religious minority and majority youth in Europe. Moreover, with the exception of only a few authors (e.g., Idema and Phalet, 2007; Kretschmer, 2018; Maliepaard and Alba, 2016; Sánchez Guerrero and Schober, 2021), studies in Europe focused on adults rather than adolescents. However, the attitudes of young people are flexible (Alwin and Krosnick, 1991), implying that gender attitudes during adolescence are more dynamic and prone to change, particularly when youth undergo secondary school transitions. As adolescence is a significant time span where the development of gender attitudes takes place (Fan and Marini, 2000), education is expected to have a liberalizing effect on gender attitudes (e.g., Bolzendahl and Myers, 2004; Fan and Marini, 2000; Maliepaard and Alba, 2016). In those relatively egalitarian Western societies (Inglehart and Norris, 2003), education exposes individuals to egalitarian ideas which makes them more prone to adopt these ideas (Bolzendahl and Myers, 2004).

Schools as agents of transmission of gender attitudes received less attention compared to parents (Halimi et al., 2016; see e.g., Cunningham, 2001; Idema and Phalet, 2007; Kretschmer, 2018; Kulik, 2002; Spierings, 2015). However, adolescents spend a considerable amount of time at school and with peers. The initial parental value transmission can lose its significance as young people become increasingly influenced, for instance, by education and peers (Davis, 2007; Davis and Greenstein, 2009). Thus, schools and interaction with peers might further contribute to their development of gender attitudes (Fan and Marini, 2000; Maliepaard and Alba, 2016; Sánchez Guerrero et al., 2023; Sánchez Guerrero and Schober, 2021). Studies found that specific life experiences regarding, for instance, education or transitions into the labor market are good predictors of gender-related attitudes (Fan and Marini, 2000; Moen et al., 1997) and were even seen as better predictors than family characteristics as adolescents become older (Davis, 2007).

We draw on four waves of the novel Children of Immigrants Longitudinal Survey in Four European Countries - Germany (CILS4EU/CILS4EU-DE; Kalter et al., 2016a, 2016b, 2017, 2019) data with more than 3200 adolescents observed across an age span from around 13–24 years to investigate the relationship between gender attitudes and education. We differentiate in our analyses between majority-group members, Muslim, and non-Muslim minorities to investigate the effect of education on gender attitudes among different ethno-religious groups in Germany. We use this grouping, as previous research suggested that it is an increasingly salient category; particularly, Muslims are perceived as very disadvantaged and distinctive from the majority group on different dimensions of integration (e.g., Sniderman and Hagendoorn, 2007; Tillie et al., 2013). The group of non-Muslims includes, for instance, adolescents who are originally from the Former Soviet Union, Poland, as well as Italy, and the group of Muslims originates, for instance, in Turkey, the Middle East, and North Africa.

We moreover address the question if achieving a secondary school degree affects the gender attitudes of females and males differently. Previous studies have consistently shown that females are, on average, more egalitarian compared to males (e.g., Fan and Marini, 2000; Idema and Phalet, 2007) as females have a stronger interest in gender equality (Bolzendahl and Myers, 2004). Previous studies moreover indicate that the impact of education is gendered (see e.g., Kane, 1995; Shu, 2004). We therefore presume that females and males might have distinct gains from secondary education influenced by their different interest structures affecting their gender attitudes differently.

The aim of this paper is, therefore, to study the influence of secondary education on gender attitudes of adolescents of various ethno-religious groups as well as of females and males from a longitudinal perspective by using novel panel data that cover the transition from adolescence to early adulthood. It will thereby enhance our understanding of the role of education in the formation of gender attitudes during adolescence by ethno-religious groups and gender.

## Theoretical background

This study is based on the idea that gender attitudes are dynamic attitudes that can change over time (Cunningham, 2008; Vespa, 2009). The life course paradigm provides a good starting point (Halimi et al., 2016; Vespa, 2009) and discusses five principles (Blossfeld et al., 2019; Elder Jr. et al., 2006, pp. 10–14) that we apply to the link between education and gender attitudes: 1. *The Principle of Life-Span Development* according to which we should focus on the development over a long lifespan. 2. *The Principle of Agency*, which states that individuals' intentions and their perceptions of costs and benefits need to be considered. 3. *The Principle of Time and Place* that underlines individuals' embeddedness in place and time. 4. *The Principle of Timing*, which sees individuals during critical life periods, e.g., completion of school, as more vulnerable and prone to change their gender attitudes (see Fan and Marini, 2000). 5. *The Principle of Linked Lives* and the idea that adolescents' lives are interlinked with schools, peers, parents, and religious communities that shape their gender attitudes. According to the paradigm, it is necessary to go beyond the conceptualization of gender attitudes as a static concept and particularly pay attention to educational transitions.

While abundant research has dedicated attention to the power of parental characteristics on children's gender attitudes

(Halimi et al., 2016; see e.g., Cunningham, 2001; Idema and Phalet, 2007; Kretschmer, 2018; Kulik, 2002; Spierings, 2015), this study is primarily interested in the role of education and schools in gender attitudes. These factors are arguably more important during secondary socialization (see Halimi et al., 2016) than in later life when gender attitudes become more solidified and educational influence wanes (Thornton et al., 1983; Zuo and Tang, 2000). As home and school can transmit competing normative structures, this study also considers the point of agency (Elder Jr. et al., 2006, pp. 11–12) and argues that education might empower individuals (Shu, 2004) to deviate from structures transmitted during primary socialization. Thus, the study accounts for the life course paradigm by going beyond a cross-sectional assessment of gender attitudes and accounting for individuals being nested in time, cultural context, and networks.

**The liberalizing effect of education on gender attitudes of ethno-religious majority and minority groups**. In general terms, gender attitudes can be defined as "[…] the underlying concept of an individual's level of support for a division of paid work and family responsibilities that is based on the notion of separate spheres" (Davis and Greenstein, 2009, p. 89). According to Davis and Greenstein (2009), less egalitarian attitudes stress the significance of clearly divided domains regarding family and work by gender: women are responsible for family duties and domestic work, whereas men represent the main breadwinner of the family.

Education could play a crucial role in fostering more egalitarian gender attitudes, especially during adolescents' secondary socialization (Davis, 2007). Education generally liberalizes gender attitudes and exposes students to the prevalent values of a country (Maliepaard and Alba, 2016). Scholars in gender equality attitudes commonly refer to the exposure-based explanations, which assume "[…] that individuals develop or change their understanding of women's place in society and their attitudes toward feminist issues when they encounter ideas and situations that resonate with feminist ideals" (Bolzendahl and Myers, 2004, pp. 761–762). These feminist attitudes could potentially be spread in the educational system (Bolzendahl and Myers, 2004), as education transmits the prevalent values and norms of a society (Coenders and Scheepers, 2003). The following mechanisms for the transmission of norms are relevant: first, through teaching (material) and second, through social interaction (Phelan et al., 1995; Stubager, 2008) by observing role models (see also social learning theory, Bandura, 1977) or experiencing social conditioning where acceptable behavior is rewarded and unacceptable behavior is punished according to behaviorist learning theories (Glass et al., 1986; Min et al., 2012). Third, the influence of education can be mediated by "cognitive sophistication" and the development of cognitive skills affecting attitudes and values (Bobo and Licari, 1989; Phelan et al., 1995; Stubager, 2008). Indeed, it has been shown that cognitive skills are important for gender attitudes among adolescents (Ullrich et al., 2022).

As in most Western societies - relative to other parts of the world - gendered expectations are more egalitarian (Inglehart and Norris, 2003), it can be assumed that these relatively more egalitarian values are conveyed to youth in schools. Prior studies found that immigrants and their descendants have, on average, less egalitarian gender attitudes compared to European majority-group members (e.g., Diehl et al., 2009; Kretschmer, 2018; Röder and Mühlau, 2014). Both the new assimilation (Alba and Nee, 2003) and the segmented assimilation theory (Portes and Zhou, 1993) can help to explain immigrants' and their descendants' gender attitudes (see e.g., Maliepaard and Alba, 2016).

The new assimilation theory suggests that immigrants and their descendants assimilate to a great extent into mainstream society over time and across generations (Alba and Nee, 2003). The theory suggests that persons of native and immigrant origin could converge in their attitudes, and this process can be two-sided, where both groups adapt to each other over time and generations (Alba and Nee, 2003). Indeed, it has been shown that immigrants and their descendants adapt to the level of gender attitudes of European majorities over time and generations (la Roi and Mood, 2023; Röder and Mühlau, 2014). The segmented assimilation theory, by contrast, emphasizes the variety of pathways related to the process of incorporation of ethnic minorities into the destination society (Portes and Zhou, 1993). This theory questions assimilation into the mainstream as a default, and the authors emphasize that both "selective" (socio-economic assimilation while simultaneously maintaining strong ties to the ethnic community and culture of origin) and "downward assimilation" are further possible outcomes (Portes and Zhou, 1993). Segmented assimilation theory proposes an explanation for why minorities choose other pathways over assimilation into mainstream society. They might withdraw into their ethnic communities and retain attitudes that are widespread in the country of origin because of experiences of exclusion in the country of residence, i.e., through education. This is coined "reactive ethnicity" (Portes and Rumbaut, 2001, p. 284). Accordingly, some minorities - predominantly non-Western and Muslim minorities who perceive higher levels of discrimination and exclusion - in Europe still remain less egalitarian, as suggested by segmented assimilation theory (Glas, 2022; Maliepaard and Alba, 2016; Röder, 2014).

Nevertheless, both approaches underline the importance of socioeconomic status for inclusion (Alba and Nee, 2003; Portes and Zhou, 1993) by providing a platform for social interaction with native peers and exposure to mainstream gender attitudes, particularly in higher school tracks (Maliepaard and Alba, 2016) where native children are overrepresented compared to children of immigrants (Kristen, 2002). Immigrant children thus have a higher likelihood of intermingling with native children and adopting more egalitarian gender attitudes in higher school tracks (Maliepaard and Alba, 2016). However, there is also self-selection in peer networks (Kretschmer and Leszczensky, 2022) characterized by relatively stable levels of homophily (Titzmann and Silbereisen, 2009) that might hamper the interaction between groups.

Moreover, opportunities for intergroup contact are also created within school classes. Previous studies on gender attitudes revealed that the gender attitudes of classmates in school are associated with adolescents' gender-related attitudes of immigrant and native origin in different European countries (Sánchez Guerrero and Schober, 2021). It has been furthermore shown that young people gain more egalitarian gender attitudes with more schooling and education (Davis, 2007; Fan and Marini, 2000). With respect to ethnic minorities, studies illustrated that education tends to affect gender equality attitudes of ethnic minorities in a more egalitarian direction (e.g., Maliepaard and Alba, 2016). Combining exposure-based explanations of the liberalizing effect of education with assimilation theories, we hypothesize that *both adolescents belonging to an ethno-religious minority and the majority, develop more egalitarian gender attitudes with higher levels of secondary school degrees (H1).*

However, children of immigrants might be exposed to competing values (e.g., Kalmijn and Kraaykamp, 2018; Röder and Mühlau, 2014): to less egalitarian gender attitudes of their parents and to more egalitarian attitudes in schools. Studies have shown that first-generation immigrants and parents of ethnic minority youth have, on average, less egalitarian gender attitudes

than European majorities (Kretschmer, 2018; Röder, 2014; Röder and Mühlau, 2014) and that parental transmission of values affects the gender attitudes of adolescents (e.g., Cunningham, 2001; Idema and Phalet, 2007), which explains ethnic differences to some extent (Kretschmer, 2018). Thus, values they might face at home and in schools might diverge more strongly for ethno-religious minorities than for majority youth. If values at home are in conflict with the exposure to more egalitarian views in school, education might have a stronger effect on ethno-religious minorities' gender attitudes because the more values transmitted by parents differ from values conveyed in school, the more fundamentally the exposition of egalitarian views in school can change gender attitudes initially socialized by parents. This is in line with the compensatory effect of (civic) education on political socialization, assuming that education and schooling can compensate for inequalities in political socialization among youth with disadvantaged social backgrounds (Campbell, 2008; Hoskins et al., 2017; Neundorf et al., 2016). Accordingly, education might compensate for the gender attitudes of those adolescents who initially are socialized by less egalitarian parents. As Muslim minorities have the least egalitarian gender attitudes (Diehl et al., 2009; Röder, 2014), Muslim youth might be exposed to the largest value difference, implying even a stronger educational effect in comparison to majority youth. On top of that, Muslim minorities face high levels of exclusion and disadvantage in Europe, with Islam being considered to be a stronger symbolic marker (Alba, 2005; Drouhot and Nee, 2019; Foner and Alba, 2008), implying that the compensatory effect of education might be the strongest among them. We therefore assume that *higher levels of secondary school degrees have a stronger impact on the gender attitudes of ethno-religious - especially Muslim - minority compared to majority youth (H2).*

**The liberalizing effect of education on gender attitudes of females and males**. Similarly, to the stronger effect of education for ethno-religious minorities, we could expect that education has a different effect for females and males. Some scholars argue that education affects certain gender-related attitudes differently for females and males (Kane, 1995; Shu, 2004). While some studies have found that the effect of education on certain gender-related attitudes is more pronounced for women than for men in different countries (Alexander and Welzel, 2011; Du et al., 2021; Kane, 1995; Shu, 2004), we argue that education might influence the gender attitudes of males more strongly than those of females. As females are, on average, more egalitarian than males (Bolzendahl and Myers, 2004; Davis and Greenstein, 2009; Fan and Marini, 2000; Idema and Phalet, 2007; Röder and Mühlau, 2014), education will possibly catalyze males' initial less egalitarian gender attitudes. This has also been coined as the compensatory effect of (civic) education (Campbell, 2008; Hoskins et al., 2017; Neundorf et al., 2016). Prior research revealed indeed a greater influence of schools on the development of empathy among males (Batanova and Loukas, 2012), and higher levels of empathy will allow males with more schooling to put themselves into the position of females in society. A recent study conducted in Germany has also shown that classrooms with more egalitarian peers are associated with more egalitarian gender attitudes, particularly among males (Taraszow et al., 2023). We therefore expect that *higher levels of secondary school degrees have a stronger impact on the gender attitudes of males than females among minorities and the majority alike (H3).*

**The German context**. We expect gender attitudes to be influenced by the different educational tracks students are in, as well as their ethno-religious origin. The educational system in Germany can be generally summarized as follows (Kultusminister Konferenz, 2021, n.d.): the 16 federal states of Germany have autonomy in educational matters. Primary education normally begins at the age of six and ends in most federal states in grade 4. At that point, schools and/or parents need to decide about the type of secondary school track and whether their children can go on to the highest school track (*gymnasial track*) that leads to an upper secondary school degree (*Abitur*) after completing grade 13 (in some federal states after grade 12) and qualifies for admission to the university. An intermediate school track leads to an intermediate secondary school degree (*Realschulabschluss*) after grade 10. A lower school track leads to a lower secondary school degree (*Hauptschulabschluss*) after grade 9. Compulsory education lasts about nine years overall in most federal states. Besides *Abitur*, adolescents can also obtain the general educational part of a higher secondary vocational school degree (*Fachabitur*) after grade 12 (or grade 11) at upper secondary schools, which qualifies under certain conditions for admission to universities of applied sciences.

The German educational system is, therefore, characterized by early tracking and high stratification, which has various educational and occupational consequences; switching is possible but challenging (Alba and Foner, 2015, pp. 173–174; Henninges et al., 2019). Immigrant children tend to be clustered in the lower tracks (Kristen, 2002), which leads to a substantial gap in educational attainment between majority and certain minority children (Kristen and Granato, 2007). The immigrant population primarily consists of *Aussiedler* originating in Germany but emigrating from Eastern Europe, former guest workers from Italy, Spain, Greece, Turkey, Morocco, Portugal, Tunisia, and Yugoslavia (Oltmer and Hanewinkel, 2021), whereby the Turkish minority makes up the largest immigrant group (Statistisches Bundesamt, 2024). Especially the Turkish minority is struggling to catch up in the education system (Kristen and Granato, 2007; Segeritz et al., 2010) and experiences discrimination in various arenas of life (e.g., Carol et al., 2019; Koopmans et al., 2019). Most Turkish immigrants and their descendants identify with Islam, but overall, an intergenerational decline in religious practices can be observed (Pfündel et al., 2021; Pollack et al., 2016). Muslims constitute the third largest religion in Germany after Catholics and Protestants (Bundeszentrale für politische Bildung, 2020). Different Muslim associations are also involved in the organization of religious education (Bösing et al., 2023).

## Data, measurements, and methods

**Data and sample**. In order to test our hypotheses, we draw on the Children of Immigrants Longitudinal Survey in Four European Countries (CILS4EU/CILS4EU-DE; Kalter et al., 2016a, 2016b, 2017, 2019). This panel survey was first collected in the school year 2010/2011 in four European countries - Germany, the Netherlands, Sweden, and England - and surveyed students around the age of 14 years with and without immigration background in schools. Subsequent waves of the international panel survey were gathered in 2011/2012 (wave two) and in 2012/2013 (wave three). Since 2014, the German survey arranged several follow-up studies. We only refer to the German subsample until wave six, which comprises the dependent variable - gender attitudes - in waves one, two, four, and six (2010/2011, 2011/2012, 2014, 2016/2017). In Germany, 5013 adolescents participated in the survey of the first wave.

The main analytical sample comprises children with and without immigration background in Germany. It only contains individuals who provided the relevant information in at least two waves[1]. Cases with missing values on the relevant variables used in the fixed- and random-effects regression models were dropped

from the analyses. We end up with an analytical sample of 3232 adolescents and 10,472 person-years[2]. Thereof, 1487 are adolescents belonging to the majority (approx. 46.01 percent) with 4892 person-years, 1085 are adolescents belonging to a non-Muslim minority (approx. 33.57 percent) with 3520 person-years, and 660 are adolescents belonging to a Muslim minority (approx. 20.42 percent) with 2060 person-years. The age range of the youth (around 13–24 years) across the observed waves in the analytical sample covers the most important years of secondary school transitions in the German education system.

**Measurements**. The dependent variable is gender attitudes. The survey asked, "In a family, who should do the following?" with respect to "taking care of children, cooking, earning money and cleaning the house" with the following possible answers: "mostly the man, mostly the woman and both about the same". For all items, "mostly the man" as well as "both about the same" were coded as one (egalitarian), and "mostly the woman" was coded as zero (non-egalitarian), with the exception of "earning money". This item was coded as zero when "mostly the man" (non-egalitarian) and one when "mostly the woman" as well as "both about the same" (egalitarian) was answered. The four items were added to an index with values from zero (non-egalitarian) to four (egalitarian) (see Kretschmer, 2018). Cronbach's alpha is 0.71.

Our main independent variable is educational attainment, which captures the highest secondary school degree achieved by respondents. We only focus on secondary school degrees that can be obtained within the general educational system. Information on educational attainment was collected by the survey in two ways. First, each wave asked if the respondent graduated from school and which degree was obtained. Second, in wave six, information on school degrees was gathered retrospectively with a life history calendar[3]. We take information on secondary school degrees from both. In case there were missing values in the life history calendar from wave six, we imputed information from each wave (waves one to six)[4].

Educational attainment is a categorical variable that can take the values of no degree (persons who have not obtained a secondary school degree), lower secondary school degree (*Hauptschulabschluss*), intermediate secondary school degree (*Realschulabschluss*), higher secondary vocational school degree after grade 12 (*Fachabitur*) and upper secondary school degree (*Abitur*). Higher levels of secondary school degrees indicate more exposure to egalitarian gender attitudes in the education system. We dropped respondents who stated that they obtained other secondary school degrees. No degree is the reference category in the analyses.

We furthermore add gender (1 = female, 0 = male) and distinguish between majority-group members, Muslim, and non-Muslim minorities[5]. With regard to the latter, information was taken from two sources and combined with each other: immigrant generation[6] and religious denomination. Majority-group members belong to no religion or religions other than Islam and were born in Germany, their parents, and grandparents, too. Muslim minorities are immigrant children up to the 3.75th generation (adolescents and their parents were born in Germany, but at least one grandparent was born outside Germany) and belong solely to Islam. Non-Muslim minorities are immigrant children also up to the 3.75th generation but belong to no religion or religions other than Islam. Majority-group members represent the reference category in the analyses. For a small number of respondents, the immigration background was unclear (see Dollmann et al., 2014). We, therefore, dropped them from the sample. This information was derived from wave one. Missing values were imputed by deriving information from wave two. Lastly, we control for survey waves in order to capture time trends: 2010/11 (reference category), 2011/12, 2014, and 2016/17.

Another set of variables covers cultural and social characteristics. We control for subjective religiosity. The survey asked, "How important is religion to you" on a scale from one ("very important") to four ("not at all important"). We recoded this variable so that four indicates "very important". Thus, higher values equal higher religiosity. Additionally, in order to capture information about social integration, we take the number of German friends into account. It was asked how many of the friends have a German background. The values range from one ("almost all or all") to five ("none or very few"). Again, the values were recoded, which means that five implies "almost all or all" and, therefore, represents higher levels of social integration.

In order to control for the parental background of the children, parents highest level of education is considered and consists of four categories: no certificate (reference category), below upper secondary school degree, upper secondary school degree and university degree. This information was taken from the parental survey in wave one that gathered information about one parent of the adolescents.

**Modeling**. To examine the effect of educational attainment on gender attitudes, linear random- and fixed-effects models with robust standard errors clustered at the individual level are performed and compared to each other. The fixed-effects models only consider within-individual variation and take time-constant unobserved heterogeneity into account (Allison, 2009). By doing so, the difference in gender attitudes when adolescents obtain a particular educational degree is assessed. Furthermore, it controls for time-constant variables like gender and ethno-religious groups and does not estimate regression coefficients for them. Random-effects models, however, consider both within- and between-individual variation and can estimate regression coefficients of time-constant variables (Allison, 2009). By modeling random-effects models it is furthermore possible to estimate regression coefficients for time-constant variables like gender as well as ethno-religious group.

First, some descriptive statistics of the sample (Table 1) are shown, and random- and fixed-effects models for majority-group members, Muslim and non-Muslim minorities in a pooled sample are estimated to investigate the relationship between educational attainment and gender attitudes. Then, interaction terms between ethno-religious groups and educational attainment are added to the pooled models in order to analyze if potential disparities between the ethno-religious groups exist. In the last step, the gendered effects of education on gender attitudes are tested by including an interaction term between educational attainment and gender in the pooled models.

## Results

**Descriptive results**. Figure 1 illustrates the development of average gender attitudes across waves dependent on ethno-religious groups and gender.

With regard to ethno-religious differences in our dependent variable gender attitudes, both Fig. 1 and Table 1 demonstrate that majority-group members hold, on average, the most egalitarian and Muslim minorities the least egalitarian gender attitudes. The mean for non-Muslim minorities lies in-between these two groups. With regard to differences between females and males (Fig. 1), females tend to have more egalitarian gender attitudes than males within all ethno-religious groups, which resembles previous findings (Davis and Greenstein, 2009; Fan and Marini, 2000; Idema and Phalet, 2007; Röder and Mühlau, 2014).

**Table 1 Descriptive statistics.**

| | Majority | Non-Muslim minority | Muslim minority |
|---|---|---|---|
| | Mean/(SD) | Mean/(SD) | Mean/(SD) |
| Gender attitudes | 3.04 (1.24) | 2.92 (1.27) | 2.37 (1.37) |
| *Educational attainment* | | | |
| No degree | 0.69 | 0.69 | 0.68 |
| Lower secondary | 0.05 | 0.07 | 0.09 |
| Intermediate secondary | 0.16 | 0.15 | 0.15 |
| Higher secondary vocational | 0.02 | 0.02 | 0.02 |
| Upper secondary | 0.08 | 0.07 | 0.05 |
| Religiosity | 2.05 (0.85) | 2.28 (0.97) | 3.46 (0.77) |
| German friends | 4.24 (0.91) | 3.61 (1.21) | 2.73 (1.21) |
| Female | 0.51 | 0.53 | 0.55 |
| *Parental education* | | | |
| No certificate | 0.01 | 0.05 | 0.15 |
| Below upper secondary | 0.60 | 0.56 | 0.62 |
| Upper secondary | 0.22 | 0.23 | 0.16 |
| University | 0.17 | 0.16 | 0.06 |
| *Year* | | | |
| 2010/11 | 0.29 | 0.30 | 0.30 |
| 2011/12 | 0.30 | 0.30 | 0.31 |
| 2014 | 0.23 | 0.23 | 0.22 |
| 2016/17 | 0.18 | 0.18 | 0.16 |

Source: CILS4EU/CILS4EU-DE, own calculations.
Waves 1–6 pooled. Number of observations: majority = 4892, non-Muslim minorities = 3520, Muslim minorities = 2060; Number of individuals: majority = 1487, non-Muslim minorities = 1085, Muslim minorities = 660.

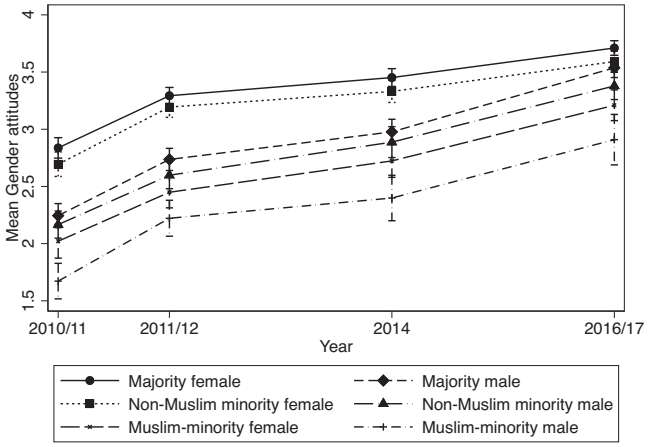



**Fig. 1** Gender attitudes across waves by gender and ethno-religious group.

Overall, however, it can be revealed that these two groups - ethno-religious origin and gender - intersect. Females belonging to the majority group have the most egalitarian and Muslim-minority males have the least egalitarian gender attitudes.

Furthermore, the figure demonstrates a liberalizing trend for all groups regardless of their minority status with all groups holding more egalitarian attitudes at the end of the observation period - visible in an upward trajectory of means. The within-individual variation of gender attitudes over the observed waves is about 0.81 (see Table A.1 in the appendix). Accordingly, these findings indicate that gender attitudes are dynamic during adolescence.

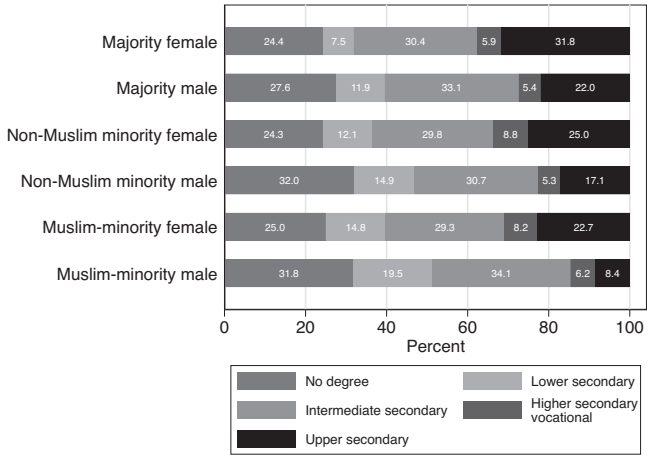



**Fig. 2** Highest educational attainment by gender and ethno-religious group.

Figure 2 presents the distribution of the highest educational attainment across the different groups.

Interestingly, the rank order observed for gender attitudes is also largely reflected in the educational levels, which suggests that education and gender attitudes go hand in hand. First, the figure shows that majority females have the highest and Muslim-minority males have the lowest educational attainments[7]. Other groups are somehow in between these two groups. Second, it further demonstrates that within all ethno-religious groups, females have higher educational levels than their male counterparts. However, while females are descriptively more egalitarian, this does not allow any conclusion on the effect of education on gender attitudes. The following analyses will delve deeper into this question.

**Random- and fixed-effects models**. Table 2 reports random- and fixed-effects models of the pooled samples including all ethno-religious groups in order to test the direct effect of educational attainment on gender attitudes as well as interaction effects, first between ethno-religious group and educational attainment, and second, between gender and educational attainment on gender attitudes[8].

First of all, Muslim minorities ($b = -0.388$, $p < 0.001$) hold, on average, less egalitarian gender attitudes in comparison to majority-group members (Table 2, Model 1). Non-Muslim minorities also have less egalitarian attitudes than the majority, however, this effect is only marginally statistically significant ($b = -0.071$, $p < 0.10$). Second, the model moreover reveals that females tend to have more egalitarian gender attitudes than males ($b = +0.468$, $p < 0.001$), indicating that females have higher interests in gender equality. All in all, the random-effects model replicates the descriptive results shown above and the findings of previous studies.

With regard to the impact of educational attainment on gender attitudes, both random- and fixed-effects models reveal that this relationship is statistically significant and positive for all possible secondary school degrees (Table 2, Models 1 and 2)[9]. The estimated coefficients of educational attainment are largely comparable in the fixed-effects and random-effects models and hover between 0.08 and 0.22 for all secondary school degrees. The coefficients are significant on at least a 5 percent significance level. This finding is controlled for potential peer effects. However, the impact of the different degrees on gender attitudes is not linear (i.e., the higher the degree, the more egalitarian the gender attitudes). Accordingly, there is only partial evidence for the first hypothesis stating that adolescents belonging to an

**Table 2 Gender attitudes among majority, Muslim- and non-Muslim minority-group members.**

| | Model 1 (RE) | Model 2 (FE) | Model 3 (RE) | Model 4 (FE) | Model 5 (RE) | Model 6 (FE) |
|---|---|---|---|---|---|---|
| *Educational attainment (ref.: no degree)* | | | | | | |
| Lower secondary | 0.158** | 0.195** | 0.194* | 0.199* | 0.174* | 0.151+ |
| | (0.052) | (0.066) | (0.076) | (0.101) | (0.073) | (0.091) |
| Intermediate secondary | 0.083* | 0.091* | 0.116* | 0.119* | 0.169** | 0.176** |
| | (0.040) | (0.045) | (0.049) | (0.056) | (0.051) | (0.057) |
| Higher secondary vocational | 0.167* | 0.221** | 0.275** | 0.316** | 0.336** | 0.392** |
| | (0.073) | (0.081) | (0.098) | (0.116) | (0.107) | (0.124) |
| Upper secondary | 0.151** | 0.133* | 0.111* | 0.099 | 0.382*** | 0.374*** |
| | (0.048) | (0.052) | (0.056) | (0.061) | (0.065) | (0.073) |
| *Ethno-religious group (ref.: majority)* | | | | | | |
| Non-Muslim minority | −0.071+ | | −0.048 | | −0.070+ | |
| | (0.038) | | (0.043) | | (0.038) | |
| Muslim minority | −0.388*** | | −0.399*** | | −0.388*** | |
| | (0.055) | | (0.060) | | (0.055) | |
| Female | 0.468*** | | 0.468*** | | 0.522*** | |
| | (0.033) | | (0.033) | | (0.038) | |
| *Ethno-religious group × Educational attainment* | | | | | | |
| Non-Muslim minority × Lower secondary | | | −0.201+ | −0.135 | | |
| | | | (0.116) | (0.146) | | |
| Non-Muslim minority × Intermediate secondary | | | −0.041 | −0.056 | | |
| | | | (0.064) | (0.074) | | |
| Non-Muslim minority × Higher secondary vocational | | | −0.246* | −0.241+ | | |
| | | | (0.121) | (0.145) | | |
| Non-Muslim minority × Upper secondary | | | 0.029 | 0.006 | | |
| | | | (0.064) | (0.074) | | |
| Muslim minority × Lower secondary | | | 0.140 | 0.165 | | |
| | | | (0.117) | (0.152) | | |
| Muslim minority × Intermediate secondary | | | −0.094 | −0.047 | | |
| | | | (0.084) | (0.094) | | |
| Muslim minority × Higher secondary vocational | | | −0.083 | −0.037 | | |
| | | | (0.198) | (0.222) | | |
| Muslim minority × Upper secondary | | | 0.212* | 0.225* | | |
| | | | (0.094) | (0.109) | | |
| *Gender × Educational attainment* | | | | | | |
| Female × Lower secondary | | | | | −0.030 | 0.098 |
| | | | | | (0.097) | (0.123) |
| Female × Intermediate secondary | | | | | −0.170** | −0.170* |
| | | | | | (0.058) | (0.066) |
| Female × Higher secondary vocational | | | | | −0.296* | −0.298* |
| | | | | | (0.127) | (0.147) |
| Female × Upper secondary | | | | | −0.376*** | −0.389*** |
| | | | | | (0.063) | (0.073) |
| Religiosity | −0.118*** | −0.049* | −0.118*** | −0.049* | −0.117*** | −0.047* |
| | (0.016) | (0.021) | (0.016) | (0.021) | (0.015) | (0.021) |
| German friends | 0.033** | 0.004 | 0.032** | 0.003 | 0.034** | 0.005 |
| | (0.012) | (0.015) | (0.012) | (0.015) | (0.012) | (0.014) |
| *Parental education (ref.: no certificate)* | | | | | | |
| Below upper secondary | 0.119 | | 0.128 | | 0.118 | |
| | (0.080) | | (0.080) | | (0.080) | |
| Upper secondary | 0.233** | | 0.242** | | 0.231** | |
| | (0.085) | | (0.085) | | (0.084) | |
| University | 0.419*** | | 0.428*** | | 0.414*** | |
| | (0.088) | | (0.088) | | (0.088) | |
| *Year (ref.: 2010/11)* | | | | | | |
| 2011/12 | 0.456*** | 0.448*** | 0.456*** | 0.449*** | 0.456*** | 0.449*** |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) |
| 2014 | 0.597*** | 0.592*** | 0.597*** | 0.592*** | 0.595*** | 0.591*** |
| | (0.032) | (0.033) | (0.032) | (0.033) | (0.032) | (0.033) |
| 2016/17 | 0.911*** | 0.902*** | 0.911*** | 0.902*** | 0.912*** | 0.904*** |
| | (0.046) | (0.049) | (0.046) | (0.049) | (0.046) | (0.049) |
| Constant | 2.230*** | 2.503*** | 2.218*** | 2.506*** | 2.198*** | 2.496*** |
| | (0.103) | (0.076) | (0.104) | (0.076) | (0.103) | (0.076) |
| $R^2$ within | 0.1782 | 0.1803 | 0.1796 | 0.1817 | 0.1823 | 0.1846 |
| $R^2$ between | 0.1722 | 0.0699 | 0.1735 | 0.0633 | 0.1723 | 0.0514 |

**Table 2 (continued)**

| | Model 1 (RE) | Model 2 (FE) | Model 3 (RE) | Model 4 (FE) | Model 5 (RE) | Model 6 (FE) |
|---|---|---|---|---|---|---|
| $R^2$ overall | 0.1744 | 0.1007 | 0.1758 | 0.0986 | 0.1761 | 0.0942 |
| Number of observations | 10,472 | 10,472 | 10,472 | 10,472 | 10,472 | 10,472 |
| Number of individuals | 3232 | 3232 | 3232 | 3232 | 3232 | 3232 |

Source: CILS4EU/CILS4EU-DE, own calculations.
Robust standard errors are in parentheses.
*FE* fixed-effects model, *RE* random-effects model.
$+p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

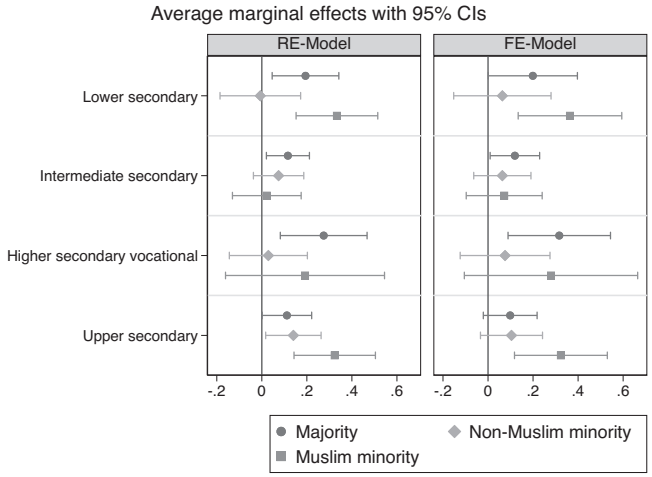



**Fig. 3** Secondary school degree-ethno-religious group average marginal effects.

ethno-religious minority and the majority develop more egalitarian gender attitudes with higher levels of secondary school degrees.

The interaction terms between educational attainment and ethno-religious background on gender attitudes in the random- and fixed-effects models (Table 2, Models 3 and 4) reveal that the regression coefficients of the interaction between Muslim minorities and upper secondary school degree are positive and statistically significant, which is partly in line with the second hypothesis[10]. This implies that an upper secondary school degree has a stronger (in RE-Model: $b = +0.212$, $p < 0.05$, see Table 2, Model 3; in FE-Model: $b = +0.225$, $p < 0.05$ see Table 2, Model 4) effect on the gender attitudes of Muslim minorities than majority-group members. Comparing the effects, the random- and fixed-effects models are again very close to each other. All other secondary school degrees, however, do not have a stronger impact on the gender attitudes among Muslim minorities. Education furthermore does not have a systematically more positive effect for non-Muslim minorities compared to the majority; the interactions with higher secondary vocational school degree (in RE-Model: $b = -0.246$, $p < 0.05$, see Table 2, Model 3; in FE-Model: $b = -0.241$, $p < 0.10$, see Table 2, Model 4) and lower secondary school degree (in RE-Model: $b = -0.201$, $p < 0.10$, see Table 2, Model 3) are even negative and the coefficients are to a great extent only marginally statistically significant. Furthermore, the latter effect becomes statistically insignificant in the fixed-effects model (Table 2, Model 4) that controls for potential unobserved time-constant factors.

Figure 3 illustrates the above-mentioned findings. It can be interpreted in the following way: If an estimate along (dot) is to the left of the vertical line (0), estimates are negative (a lower support for gender equality), if they are to the right, they are positive (a stronger support for gender equality). If the lines attached to the estimates (confidence intervals measuring the degree of statistical uncertainty) do not overlap with the vertical line, the results are statistically significant. In most cases, the impact of secondary school degrees seems to be positive for all groups, even though not all degrees are statistically significant. The figure shows that only for the majority group members, nearly all secondary school degrees have a positive and statistically significant impact on gender attitudes. Upper secondary school degree is only statistically significant in the random-effects model. Once controlling for potential time-constant unobserved traits in the fixed-effects model, the impact of upper secondary school degree is not statistically significant anymore. For non-Muslim minorities, only upper secondary school degree tends to be statistically significant in the random-effects but not in the fixed-effects model indicating again that time-constant unobserved traits seem to be crucial here. For Muslim minorities, only lower secondary and upper secondary school degrees are statistically significant. The statistically non-significant effect of a higher secondary vocational school degree might be partly evoked by rather low case numbers of Muslims who obtained this degree, as indicated by the wide range of confidence intervals. Again, the impact of the different educational attainment on gender attitudes is not linear. Thus, the various secondary school degrees seem to affect the gender attitudes of the three ethno-religious groups differently, and some effects in the random-effects models disappear in the fixed-effects models.

In order to test the different impacts of higher levels of education on more egalitarian gender attitudes for females and males, we estimated an interaction term of gender and educational attainment on gender attitudes (Table 2, Models 5 and 6). Both random- and fixed-effects models show that the interaction term is negative and statistically significant for all but lower secondary school degree. The coefficients are significant on at least a 5 percent significance level. This suggests that the effect of higher levels of secondary school degrees on gender attitudes differs between females and males. Achieving, for instance, an upper secondary school degree has a significantly lower impact (in RE-Model: $b = -0.376$, $p < 0.001$, see Table 2, Model 5; in FE-Model: $b = -0.389$, $p < 0.001$, see Table 2, Model 6) on the gender attitudes among females than males.

Figure 4 illustrates this relationship between the random- and fixed-effects models, and it shows that the effect of higher levels of educational attainment on more egalitarian gender attitudes is stronger for males than for females. Moreover, the effect sizes of lower secondary and intermediate secondary school degrees on gender attitudes for males are similar. The same is true for higher secondary vocational and upper secondary school degrees. Comparing these effect sizes with each other, the effect sizes for lower degrees are smaller than for higher degrees. Thus, the influence of education on gender attitudes is only partly linear. For females, Fig. 4 shows that only lower secondary school degree in both the random- and fixed-effects models is positive and statistically significant. Therefore, education seems to be more important for the gender attitudes of males than females, which partly supports our third hypothesis.

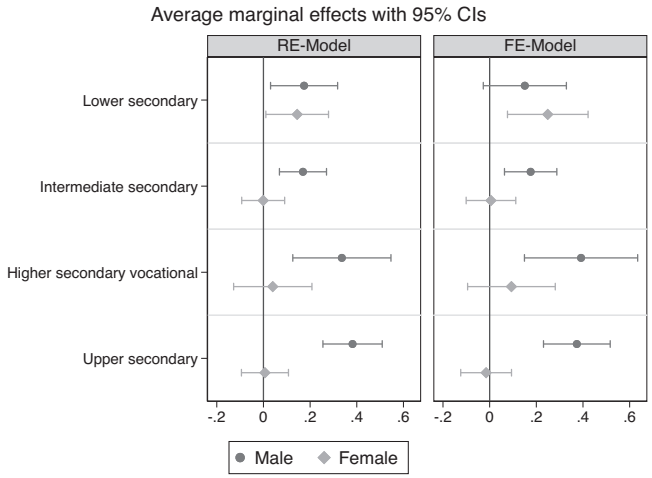



**Fig. 4** Secondary school degree-gender average marginal effects.

## Discussion and conclusion

The aim of this paper was to investigate the role of education on gender attitudes of immigrant and native youth in Germany during adolescence by analyzing novel longitudinal data. We stressed the neglected role of temporal dynamics, particularly during adolescence, when assessing changes in gender attitudes. Furthermore, we asked if this association between education and gender attitudes is different for majority, non-Muslim, and Muslim-minority youth, as well as for females and males. Our findings are threefold. First of all, adolescents' gender-related attitudes are more egalitarian once they obtain a secondary school degree. Second, the analyses have revealed that ethno-religious minorities and particularly Muslim minorities hold, on average, less egalitarian gender attitudes than majority-group members, and the influence of education on gender attitudes works to some extent differently for these various ethno-religious groups. Similarly, and third, substantial gender differences emerge with regard to gender attitudes, and education has a stronger effect on the gender attitudes of males than for females.

Starting with our first insight, overall, our analyses revealed that secondary education is related to egalitarian gender attitudes in general. The liberalizing effect of education on gender attitudes among adolescents is in line with previous studies on young people in the U.S. (e.g., Davis, 2007; Fan and Marini, 2000). Obtaining a secondary school degree is, on average, associated with more egalitarian gender attitudes. Thus, besides family socialization emphasized in previous studies (e.g., Cunningham, 2001; Idema and Phalet, 2007; Kretschmer, 2018; Kulik, 2002; Spierings, 2015), schools might also matter in the development of gender attitudes among adolescents. As interethnic contacts can also act as socializing agents, particularly for minorities (e.g., Maliepaard and Alba, 2016), this effect is controlled for German friends to account for peer effects. The impact of educational attainment on attitudes might rather be evoked by teaching, gaining knowledge, or cognitive skills (see Bobo and Licari, 1989; Phelan et al., 1995; Stubager, 2008). While German friends do matter to some extent, its impact was less systematically associated with more egalitarian gender attitudes in the different models. Particularly in the fixed-effects models, this effect was absent, which controls for unobserved time-constant heterogeneity and considers solely within-individual variation.

Unfortunately, our analyses were not able to detect the actual mechanisms behind the relationship between education and gender attitudes. We have argued that this association might be evoked by exposure to feminist ideas through social interactions and teachings in education and cognitive skills (Bobo and Licari, 1989; Bolzendahl and Myers, 2004; Phelan et al., 1995; Stubager, 2008). Even though recent studies found that classmates' gender attitudes in schools are associated with adolescents' gender attitudes in different European countries (Sánchez Guerrero and Schober, 2021), peers play a crucial role, particularly for minorities (Ali and Fokkema, 2015) and cognitive skills are important for the gender attitudes of adolescents (Ullrich et al., 2022), we do not know much about the mechanism of this relationship. Therefore, further research is needed to analyze the effect of teaching, peer interaction in school classes, and cognitive skills on gender attitudes among youth.

Our second key finding concerns ethno-religious differences. First, the majority of youth develop more egalitarian gender attitudes by achieving lower levels of secondary school degrees. An upper secondary school degree does not affect their gender attitudes. Thus, other socializing agents like parents (e.g., Cunningham, 2001) might be more crucial for the development of gender attitudes among adolescents belonging to the majority group. This can be explained when considering that the majority of youth are, on average, the most egalitarian, and their parents are, on average, the most educated in this sample. As higher educated parents have more egalitarian children and the impact of obtaining an upper secondary school degree on gender attitudes is weaker among the youth of highly educated parents, it might be possible that youth belonging to the majority group at upper secondary school tracks already have adopted relatively egalitarian views at home. Thus, schooling does not affect their gender attitudes anymore.

Second, Muslim minority youth, by contrast, develop more egalitarian gender attitudes once they achieve lower secondary and upper secondary school degrees. Thus, spending one or three years more in secondary school relative to the lowest track does not matter for Muslim minorities' gender attitudes. With an upper secondary school degree, changes in attitudes into a more egalitarian direction are possible again. Therefore, for those Muslim minority students who achieve educational attainments that are in between lower and upper secondary school degrees, no educational effect on gender attitudes can be observed. This might be partly explained by the finding that only a small number of Muslims in this sample obtained a secondary vocational school degree leading to a non-significant finding. However, this absent effect of intermediate and higher secondary vocational school degrees might also be explained by the concept of "reactive ethnicity" (Portes and Rumbaut, 2001, p. 284). As minority youth seem to have high educational expectations, which is particularly visible among youth in general who attend higher school tracks than the lowest track (Rudolphi and Salikutluk, 2021; Salikutluk, 2016), Muslim minority youth who achieve intermediate and higher secondary vocational school degrees might be confronted with unmet expectations. In turn, unmet expectations might end in higher perceptions of discrimination (see Schaeffer, 2019). Consequently, Muslim minority youth with unmet expectations might withdraw from the prevalent gender attitudes conveyed by secondary education. Moreover, Muslim minorities, in general, face high levels of exclusion in Europe (Alba, 2005; Foner and Alba, 2008), which might additionally reinforce the withdrawal of the prevalent gender attitudes (Glas, 2022). Thus, socialization agents like parents (Cunningham, 2001) may be more important for them. Furthermore, only an upper secondary school degree has a stronger impact on the gender attitudes among Muslim minorities in comparison to majority-group members. Other secondary school degrees do not significantly differ between Muslim minority and majority youth. As Muslim minorities have the least egalitarian gender attitudes in this sample, they have, however, the biggest gains in terms of more egalitarian gender attitudes by obtaining an upper secondary school degree in

comparison to majority-group members who are the most egalitarian. Thus, Muslim minority youth's gender attitudes benefit the most from obtaining the highest level of secondary school degree in Germany. Education might, therefore, have a compensatory effect on them (see Campbell, 2008; Hoskins et al., 2017; Neundorf et al., 2016), meaning that Muslim minorities might catch up with majority youth in terms of their gender attitudes when achieving upper secondary school degrees.

Third, non-Muslim minority youth, however, do not systematically differ from majority youth regarding the effect of any secondary school degree on gender attitudes, and they do not develop more egalitarian gender attitudes by obtaining any secondary school degrees. Again, other socialization agents like parents (Cunningham, 2001) might be more important than schools for non-Muslim minorities, indicating that "selective assimilation" might explain their situation (Portes and Zhou, 1993). Accordingly, non-Muslim minority youth could be influenced by their parental ethnic communities and culture rather than by education in the development of their gender attitudes. Therefore, future research should analyze this relationship between parents and their children's education on gender attitudes jointly - not only among non-Muslims but also among Muslim minorities and the majority group. Alternatively, the group of non-Muslim minorities might be too heterogeneous, resulting in a null finding. Future research should also dedicate more attention to heterogeneity within the various ethno-religious groups. However, religion seems to be a more salient category than ethnicity, as we observed less heterogeneity within than between our groups. In the next step, it would be important to distinguish between different streams if data became available. A recent cross-sectional study has already found that different subgroups within Islam show different gender attitude patterns (Glas, 2021), and attitudes vary with different types of gender-related attitudes among Muslims in Europe (Glas, 2023).

Future studies should also investigate the transmission of gender attitudes in schools across countries and groups because gender attitudes differ also across countries (e.g., Knight and Brinton, 2017), as does the composition of the immigrant population. Yet, we could expect a similar pattern for other European countries: with structural assimilation - meaning minorities catching up in education with majority youths and obtaining upper secondary degrees - they will develop more egalitarian attitudes (see e.g., Maliepaard and Alba, 2016), particularly, among those minorities who initially had less egalitarian gender attitudes. Our study revealed that education plays a central role in the shape of gender attitudes of youth, and for Muslim minorities, it is even more important.

Coming to our third central finding: our analyses revealed that the effect of secondary school degree has a stronger impact on the initially lower gender attitudes of males than on females, indicating that education might compensate for their initial less egalitarian gender attitudes (see Campbell, 2008; Hoskins et al., 2017; Neundorf et al., 2016). This, in turn, suggests that education needs to shift more attention to males in the education system and expose them to egalitarian ideas in schools (Bolzendahl and Myers, 2004; Taraszow et al., 2023) and the development of empathy (Batanova and Loukas, 2012) to make them more responsive to women's disadvantaged situation in society, no matter what their ethno-religious origin is. Our finding also speaks to studies on the educational achievements of males being left behind (Buchmann et al., 2008).

From an immigrant integration perspective and gender perspective, our findings are highly interesting. With regard to the three factors - educational attainment, ethno-religious groups, and gender - examined in this study, we tentatively conclude that gender is a stronger predictor than education, given that its effect is stunningly consistent across all groups. According to this study, however, educational attainment can change gender attitudes, in a more liberal direction, especially for those who initially had less egalitarian gender attitudes. This study could fill an important gap in previous research by addressing intra-individual changes through education during the formative years of youth and underscoring its importance in achieving a more egalitarian society.

## Data availability

The secondary datasets analyzed in this study are available at the GESIS Leibniz Institute for the Social Sciences. Access can be requested via the following website: https://www.gesis.org/en/home.

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## Notes

1 The project surveyed one refreshment sample in wave six (CILS4EU-DE, 2019). This refreshment sample is dropped from the analytical sample as the analyses comprise individuals for whom we have information in at least two waves.
2 Individuals are observed at different time points.
3 The life history calendar was conducted by the survey in wave six in order to gain retrospective information about different life events since 2011 of the survey participants (CILS4EU-DE, 2019).
4 Information on educational attainment in the life history calendar is only available for those respondents who participated in the long version of the survey in wave six. For those respondents who participated in the short version of the survey in wave six, information on educational attainment is therefore gained from each wave (see CILS4EU-DE, 2019).
5 We also investigated in-group variation. Overall, Turkey and MENA, both predominately Muslim countries, have the least egalitarian gender attitudes, but they do not differ significantly from each other when controlling for other relevant variables. Among non-Muslim minorities, only minorities from the Former Soviet Union hold less egalitarian attitudes than Polish minorities after controlling for other relevant variables (results available upon request).
6 We used the generation variable that is available in the dataset (Dollmann et al., 2014).
7 With regard to parental education, parents of majority youth are, on average, more educated than parents, particularly of Muslim minority youth (see Table 1).
8 We have also estimated models adding one control variable at a time, but results remained relatively stable (results available upon request).
9 Model 1 in Table 2 moreover shows that higher educated parents have more egalitarian children. The regression coefficients for upper secondary education ($b = +0.233$, $p < 0.01$) and university education ($b = +0.419$, $p < 0.001$) are positive and statistically significant. The effect of education on gender attitudes is also moderated by parental education (see Table A.2 in the appendix). The interaction terms between parental university degree and upper secondary school degree are negative and statistically significant (in RE-Model: $b = -0.423$, $p < 0.05$, see Table A.2, Model 1; in FE-Model: $b = -0.487$, $p < 0.05$, see Table A.2, Model 2). Both models (Models 1 and 2) reveal that the impact of upper secondary school degrees on gender attitudes is smaller among youth whose parents have university degrees. By contrast, the impact of a lower secondary school degree on gender attitudes is marginally stronger among youth whose parents have an upper secondary school degree (only in FE-Model: $b = +0.501$, $p < 0.10$, see Table A.2, Model 2).
10 Overall, the effect of education on gender attitudes is not systematically moderated by the immigrant generation (see Table A.3 in the appendix). The interaction terms between 2nd generation and higher secondary vocational school degree ($b = -0.254$, $p < 0.10$, see Table A.3, Model 2) and between 3rd generation and upper secondary degree ($b = +0.159$, $p < 0.10$, see Table A.3, Model 2) are only marginally significant.

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## Author contributions

HY developed the research question and theoretical framework, prepared the data, conducted the analyses, and drafted the manuscript. SC commented on and edited different versions of the manuscript. SC wrote the introductory paragraph of "Theoretical background" and the section "The German context"; HY wrote the other sections of "Theoretical background". Both authors were involved in the conceptualization of the study and the revisions of all parts of the different versions of the manuscript.

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## Competing interests

SC was a member of the Editorial Board of this journal at the time of acceptance for publication. The manuscript was assessed in line with the journal's standard editorial processes, including its policy on competing interests.

## Ethical approval

Access to the secondary datasets analyzed in this study was requested from and granted by GESIS Leibniz Institute for the Social Sciences. The collection of the German part of the CILS4EU data was organized at the University of Mannheim and was subject to the respective ethical approval boards and guidelines.

## Informed consent

Informed consent was obtained from all adolescents and their parents participating in the survey (see technical reports of the CILS4EU/CILS4EU-DE data).

## Additional information

**Supplementary information** The online version contains supplementary material available at https://doi.org/10.1057/s41599-024-03222-y.

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