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Exploring choices in higher education: Female and male first-generation students' trajectories from study aspiration to study satisfaction in Germany

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Previous studies have pointed out that first-generation students, continuing-generation students and female and male students differ concerning trajectories into and through higher education regarding study program choices and satisfaction. Studies focused on single time points in students' educational trajectories and mainly emanated from the United States. In order to facilitate a longitudinal comparison of students' study program aspirations and choices, as well as study satisfaction and dropout intentions, we analyzed panel data from the German National Educational Panel Study (NEPS), consisting of 1,694 students. We modeled the influence of gender (female, male) and generational status (first-generation, continuing-generation) with multinomial logit regression models. Results show that students' aspirations and choices did not significantly differ concerning generational status whereas gender differences were confirmed once again. Generational status did not reveal significant differences concerning study satisfaction and dropout intentions, whereas differences concerning gender revealed that female students were significantly more satisfied with their studies than male students. Based on our findings, we point out the importance of early counseling and other support to compensate gender differences in study program aspirations and choices. Further research is needed to explore reasons for our findings showing equal aspirations and choices of first- and continuing-generation students, which are opposed to previous studies' findings.

KEYWORDS

first-generation students, gender, study programs, study choice, higher education

Introduction

Students whose parents lack academic educational backgrounds, also called first-generation students, form a traditionally underrepresented group in higher education (Hauschildt et al., 2015). This underrepresentation extends to enrollment in programs of study with more promising career attainments, such as wages, growth in occupational

status, and job security (Roksa and Levey, 2010; Cataldi et al., 2018), when first-generation students are compared to their continuing-generation peers whose parents have earned academic degrees. The underrepresentation of first-generation students in higher education is connected to the worldwide phenomenon whereby success in education increases as students' socioeconomic status (SES) level increases (Elliott et al., 2011; Orr et al., 2011; OECD, 2012; Dräger, 2021). Gender constitutes another often discussed segregating factor in terms of the underrepresentation of women in specific areas of study, such as science, technology, engineering, and mathematics (STEM, Ceci and Williams, 2011; Hughes, 2011; Chen and Soldner, 2013; Yazilitas et al., 2013; Marsh et al., 2019), as well as the underrepresentation of women in fields associated with higher economic returns in the long-term in general (Quadlin, 2020). This phenomenon of underrepresentation according to generational status and gender contradicts the declaration of the Bucharest Communiqué (2012) in the course of the European Bologna Process, which states that "widening access to higher education is a precondition for societal progress and economic development" (p. 1), and therefore, "the student body entering and graduating from higher education should reflect the diversity of Europe's populations" (p. 1). In addition to the macrosocial consequences of inequalities in education, we know from prior research that they also produce individual drawbacks, including cognitive, health, social, and especially economic disadvantages (U.S. Bureau of Labor Statistics, 2014; Chan, 2016; Griffin et al., 2019).

Following this notion, a number of studies have investigated first-generation students' (1) knowledge about postsecondary education, (2) transition to postsecondary education, and (3) persistence and attainments in postsecondary education as Terenzini et al. (1996) have summarized already in the 1990s. As Wright et al. (2021) emphasize, research on the growing number of first-generation students in higher education and their transition into and through their postsecondary studies is critical to inform policy on enrollment gaps and attrition rates. Comparable research is needed on gender-related underrepresentation in order to support the sorely needed diversification of the workforce in STEM and other prospering fields (Hilts et al., 2018). In Germany, only about one third of all university graduates in STEM are female (German Federal Employment Agency, 2019), which is roughly the same share of women entering STEM bachelor's programmes across OECD countries (OECD, 2019). Therefore, women are expected to have a great potential of securing the STEM workforce (Anger et al., 2020).

As most related studies documented in the literature focus on the initial study program choice of a college major, we explored a longitudinal perspective of first-generation students' transition from secondary to postsecondary education. Thus, we focused on their study program aspirations and choices of programs of study during secondary education, as well as their persistence and attainments after transitioning to postsecondary education in terms of study satisfaction and dropout intentions. Since most studies regarding first-generation students in the literature emanated from the United States, our data from Germany may enrich the state-of-the-art regarding a European perspective and may allow for international comparisons of educational systems in the long term.

Theoretical background

First-generation students' pathways into and through postsecondary education: Study program aspirations, choices, study satisfaction, and dropout intentions

In general, first-generation students pursue postsecondary studies at lower rates than their continuing-generation peers in Germany (Authoring Group Educational Reporting, 2018) and in the United States (Cataldi et al., 2018). Those first-generation students that do pursue postsecondary education form the majority in other disadvantaged groups relative to their continuing-generation peers: they are more likely to be female, older, Black, or Hispanic, have dependent children, and come from low-income families (Engle, 2007; Ward et al., 2012). Related to this, they enter postsecondary education with limited financial resources and skills and with less information about the new environment than their peers possess (Wilbur and Roscigno, 2016). From a long-term perspective, as a result of these disadvantages, first-generation students may encounter certain challenges during their postsecondary studies which in turn may lead to higher dropout rates or lower study satisfaction. Thus, in the present study, we focused on describing students' aspirations and choices from a longitudinal perspective and related them to satisfaction with the chosen study program and dropout intentions.

Differences between first- and continuing-generation students' study aspiration and choice

Existing literature on first-generation students' transition to postsecondary education is mostly focused on the initial choice of a college major (Wright et al., 2021). Data from Germany suggest that a higher share of first-generation students tend to choose subjects related to social sciences than continuing-generation students, whereas a higher share of continuing-generation students major in subjects like human medicine or psychology than first-generation students do (Middendorff et al., 2013, p. 100). In the United States, first-generation students are associated with a higher share of the student population in subject areas like engineering and social sciences and a lower share in areas like arts and humanities (Trejo, 2016). A unique effect can be seen for "traditional study programs," such as law, medicine, or pharmacology, that in Germany require students to pass a state

exam to graduate: in these subjects compared to subjects without state exam, the proportion of first-generation students is particularly low (38%) compared to the proportion of their peers with parents who have academic backgrounds (Middendorff et al., 2017). An exception here is teacher education, which also requires state exams but has usually higher shares of first-generation students. These patterns are in accordance with evidence that shows first-generation students choose their majors from a more utilitarian point of view, leaning toward disciplines associated with more practical relevance, job-specific credentials, and better opportunities in the job market (Lehmann, 2009; Wilkins, 2014; Wright et al., 2021) but with potentially less prestige and fewer prospects for promotions (Pascarella et al., 2004; Roksa and Levey, 2010). This kind of choice leads to the immediate benefits of entering the job market after graduation; however, it can also lead to long-term drawbacks associated with lower levels of growth in occupational status (Roksa and Levey, 2010).

These findings point to differences between first-generation students' initial study program choices for postsecondary education and those of their continuing-generation counterparts and led us to the question at what point over the course of the student's educational career those aspirations are formed. Are students' aspirations during secondary schooling more independent from their generational status than at the actual moment of choice? Is there still an "open window," for instance, for counseling and informing students in a way that can equalize their choices? As stated at the outset, a deeper glance into the postsecondary transition process of first-generation students still awaits, as subject/major aspirations at the end of secondary school have not been investigated, despite the potential importance of this junction in students' pathways into postsecondary education. Secondary students aspiring to specific subject areas generally have a higher probability of initially choosing that subject area, which was shown in the STEM field (Schoon, 2001; Tai et al., 2006; Reinhold et al., 2018). However, recent research on first-generation students' aspirations tends to concentrate on general educational aspirations instead of aspirations to specific study programs or college majors (Rahim and Azman, 2010; Chesters and Smith, 2015). Thus, we examined both steps in the transition process and connected them to the subsequent step of study attainment regarding study satisfaction and dropout intentions.

Study satisfaction and dropout intentions

As Spiegler and Bednarek (2013) stated in their review, first-generation students' academic attainment is predominantly measured by grades and attrition rates in the United States, where they tend to "perform as well or only slightly—and not always significantly—poorer [*sic*] than other students" (p. 10). In the present study, we investigated first-generation students' satisfaction with their studies and dropout intentions as possible antecedents of cognitive outcomes and attrition. Existing research has shown that first-generation students generally report lower levels of study satisfaction than their continuing-generation peers (Janke et al., 2017). Moreover, even after controlling for generic factors, such as lower first-year grade point average (GPA) or working full-time, they are still more likely to drop out of college than their continuing-generation peers (Choy, 2001). U.S. data show that first-generation students drop out of their postsecondary studies without earning a degree at a higher rate (33%) than continuing-generation students (26%; Cataldi et al., 2018), whereas the initial 2 years of postsecondary study seem to bear the highest potential for attrition (Ishitani, 2006). This connection becomes even stronger with increases in the level of the target degree (Chen and Carroll, 2005), which can be confirmed by German data that indicate a decrease in the share of first-generation students from bachelor's (51%) to master's (46%) programs compared to their continuing-generation peers (Middendorff et al., 2017). Motives for dropping out of college have been found to be cumulative and interdependent (Tinto, 1988; Heublein et al., 2017; Hartl et al., 2022). However, a recent study using NEPS data could not confirm significant differences in dropout motives between students from homes with lower academic background levels and their counterparts from families with more advanced academic backgrounds; still, descriptive results pointed to the direction that they were more prone to drop out for financial reasons (Behr et al., 2021).

Again, existing research underlines differences between first- and continuing-generation students regarding their level of study satisfaction and dropout intentions. Thus, we wanted to add to the body of research by examining several phases of the transition process, starting with program of study aspirations during secondary school, followed by analyses of choices at the transition point, as well as analyses of study satisfaction and dropout intentions 1 year after enrollment in university programs, to determine any existing differences between first-generation students and their continuing-generation peers in these areas.

The influence of gender on study program choice

In addition to generational status, one of the most prominent issues in need of recognition related to underrepresentation in specific academic disciplines is gender and the ways in which being female or male may interact with being a first- or continuing-generation student. The gender gap is especially pronounced in the context of women's integration into STEM programs; thus, significant research on gender differences in study program choice has been placed within the STEM disciplines internationally (Mann and DiPrete, 2013), as well as in the German context. For the German system, Schwerter and Ilg (2021) confirmed that women do not only choose STEM subjects less often than men but even those who already own a STEM-related degree enter a STEM profession less often than their male peers. Mitigating the underrepresentation of women in STEM subjects is another research focus, where for instance

course-taking reforms in upper secondary school did not significantly compensate for the gender gap (Hübner et al., 2017; Biewen and Schwerter, 2022). To a lesser degree, men's integration into more female-dominated fields of study, such as the social sciences, has also attracted scholarly attention (DiPrete and Buchmann, 2013). Reasons for gender gaps in different programs of study can be manifold. One reason may be the existence of cultural beliefs and gendered socialization that considers men and women to be naturally different from each other and, therefore, to have distinct talents and preferences (Eccles, 2015). Other possible reasons for such gender gaps include differential family–work conflicts; college characteristics, such as offering "identity-based" majors (Charles and Bradley, 2009); or a campus culture that reinforces gendered career choices (Hamilton, 2014).

Gender can influence study choice in various ways. For example, Hamilton (2014) found, by means of longitudinal interviews with 59 female college students from a "moderately selective" midwestern United States university, that upper- and upper-middle class women tend to choose easy majors, characterized by "the ease of obtaining a high GPA" (Hamilton, 2014, p. 247) and little evidence of general skills improvement during college such as critical thinking, complex reasoning, and writing (Arum and Roksa, 2011). Easy majors include business (outside competitive business schools), communications, tourism, recreation studies, education, human development, fitness, fashion, and others (Arum and Roksa, 2011). In contrast, less privileged women strive for the more pragmatic careers that offer better chances for obtaining employment. But unless their choices may be more practical, they do not seem to be less gendered, as they remain in stereotypical female work (England, 2010; Quadlin, 2020). As Wright et al. (2021) asserted, they "pursue applied, pink-collar majors that ensure immediate returns in the labor market" (p. 5). Despite potentially reflecting a socioeconomic advancement beyond their parents' educational backgrounds, these applied female-dominated careers still pay less than male-dominated fields, even after considering differences in educational requirements, skill levels needed, and working conditions (England et al., 2002; Cohen and Huffman, 2003). Specifically, Ma (2009) found that women from lower SES homes were more likely to choose majors that are lucrative in the early career stages, such as nursing and education. However, as was suggested previously, such applied majors tend to be linked to relatively low wage growth over time (Roksa and Levey, 2010).

In sum, evidence has confirmed the intersection of gender and generational status on study choice (Wright et al., 2021). Existing research on underrepresentation in specific study choices by generational status and gender led us to expect what Wright et al. (2021) already concluded: female and male first-generation students are prone to choose majors that are (1) more practical or applied and (2) more normatively gendered than the majors typically chosen by their continuing-generation peers.

The German education system

In order to determine the relevance of examining generational status and gender on study program aspirations and choices in Germany, a glance at the German education system may be helpful. In Germany, secondary education is divided into three tracks with the "Hauptschule" as the lowest, the "Realschule" as the intermediate, and the "Gymnasium" as the highest track. According to the track, students achieve different entrance certificates to higher education, whereas absolvents of the highest track have immediate access to academic education. Tracking into these three school types takes place after 4 or 6 years of elementary school, with few exceptions. Higher education is mainly divided into general universities with a scientific focus and universities of applied sciences with a more vocational focus. The majority of German universities is state-financed and students are only required to pay an administrative fee for their studies.

The present study

To shed light on the reasons for differences in academic pathways between first- and continuing-generation students, as well as between female and male students, studies have mostly focused on single data points in the students' study program choice process. While these results have added much to the literature on antecedents and relationships between several factors concerning study choice and retention, with this study, we intended to explore students' pathways through their study choice process from upper secondary study aspirations to specific study program choices to study satisfaction and dropout intentions in postsecondary education as illustrated in Figure 1. While a vast body of research on first-generation students exists for the U.S. context, the German National Educational Panel Study (NEPS) offers the opportunity for a longitudinal examination of students' choice processes to establish a comparable body of research in the German context. The panel is representative of the German education system, in which children from higher economic backgrounds are 40% more likely than children living in less wealthy households to enroll in postsecondary studies (Dräger, 2021), which may particularly affect first-generation students and, therefore, should be studied more closely. With a longitudinal approach, our objective was to understand how the process of study orientation and choice works and the degree to which this process affects later study satisfaction and intentions to drop out for first-generation students and continuing-generation students. We sought to shed light on the question of whether and at what point in the process of first- and continuing-generation as well as female and male students' pathways should be facilitated and particularly supported. Throughout all analyses, we controlled for parents' SES. Our research was guided by the following research questions:

1. To what degree do students differ in their …

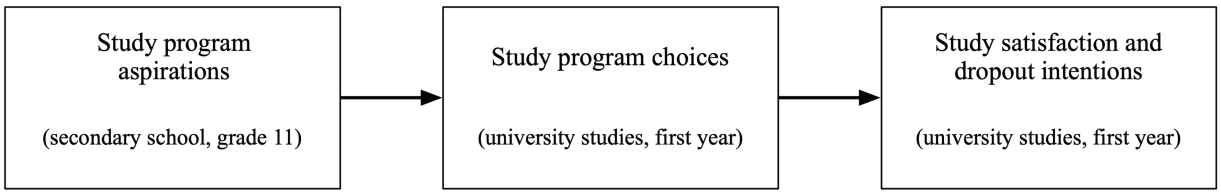

FIGURE 1
The study choice process.

a. Study program aspirations.
b. Study program choices.
c. Change behavior from aspiration to choice.

… according to generational status and gender?

2. Is there an interaction between generational status and gender regarding aspiration, choice, and change behavior?
3. To what degree do students differ in their study satisfaction levels and dropout intentions according to generational status and gender and depending on their change behavior?
4. Is there an interaction between (a) generational status and change behavior and (b) between gender and change behavior regarding study satisfaction and dropout intentions?

Materials and methods

Sample

This paper uses data from the National Educational Panel Study (NEPS; Blossfeld and Roßbach, 2019). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network. We selected two measurement points for starting cohort 4 (NEPS Network, 2021), namely, students in grades 11–13 in secondary school (i.e., wave 5, 7, and 8) and postsecondary study (i.e., waves 8–10), to analyze students' pathways from secondary school to academic studies. We only used the data of those participants which were surveyed at both measurement points, which resulted in 1,694 students. However, three of them did not indicate their gender and, hence, had to be excluded[1]. Thus, we analyzed a final sample of 1,691 students. From the final sample 1,103 were first-generation students (65%)[2] and 933 were female (55%). Within first-generation students, 57% were female and within continuing-generation students, 51% were female.

Compared to the original dataset (students which were surveyed during measurement point 1 in grade 11) in which 73% were first-generation students and 50% were female, there was a decrease of first-generation students to 65% and of male students to 45% in our final sample (students which were surveryed during measurement point 1 and 2). For detailed documentation on the measurement points and missing data, see NEPS Codebook for Starting Cohort 4, Version 9–1-0.

Measures

First- and continuing-generation student status

We defined first-generation students as those whose parents lacked academic degrees, such as a bachelor's, master's, or doctoral degrees, using International Standard Classification of Education (ISCED 97) levels lower than 9 and 10, as defined by NEPS. Continuing-generation students were defined as those with at least one parent holding at least a bachelor's degree, using ISCED 97 levels 9 and 10.

Study program aspirations during upper secondary education

To operationalize study program aspirations during upper secondary education, we used responses to the open question "What will you probably study?" (NEPS item te06010_g2), measured during grade 11–13 of secondary education. NEPS offers multiple classifications of areas of study; we used the categorization based on the German Federal Statistical Office (destatis 2010/11): (1) language and cultural studies, (2) sports, (3) law, economics, and social sciences, (4) mathematics and natural sciences, (5) human medicine and health sciences, (6) agricultural, forestry, veterinary, and nutrition sciences, (7) engineering, (8) arts, and (9) other. The category "other" includes comparatively small study program areas, such as sports, aesthetics, and agriculture.

Study program choice

To investigate study program choice, we focused on students' first major study subject, measured in students' first year of academic studies: "Which subjects have you been studying and are you studying at the moment?" (NEPS item ts15404_g2). We did not

1 We used the NEPS item t700031 (self-report) to assess gender.

2 The sample contains a high share of first-generation students as compared to the US where roughly one third of all college students are first-generation students (Whitley et al., 2018).

include any further or minor subjects in our analyses. We used the same categorization when assessing program of study aspirations.

Subject change

To compare students' pathways from aspirations to choices, we calculated a dichotomous variable (change, no change) that reflected whether students changed their subject area from aspiration to final choice.

Study satisfaction

We operationalized study satisfaction by means of six items from the NEPS survey, including "I enjoy my studies very much." The items were measured on a five-point Likert scale (1 = does not apply at all, 2 = applies a little, 3 = partly applies, 4 = mostly applies, and 5 = fully applies) with a reliability of Cronbach's $\alpha = 0.82$. See Supplementary material for the complete text of the items and NEPS item acronyms.

Dropout intentions

We operationalized dropout intentions using five items from the NEPS survey, including "I have often thought about dropping out of college." The items were measured on a four-point Likert scale (1 = does not apply at all, 2 = somewhat applies, 3 = mostly applies, and 4 = fully applies) with a reliability of Cronbach's $\alpha = 0.83$. See Supplementary material for the complete text of the items.

As satisfaction and dropout intentions were originally measured on different response formats, to achieve better comparability, we scaled satisfaction down to four points.

Socioeconomic status

We operationalized parents' SES by using the internationally comparable International Socio-Economic Index (ISEI-08) scale of students' parents which is offered by the NEPS data base. The ISEI-08 is based on the International Standard Classification of Occupations (ISCO) and Ganzeboom's (2010) proposals and integrates education, occupation and income. Based on the ISEI-08 we generated parents' highest socioeconomic status (HISEI) by using fathers' ISEI-08. When fathers' ISEI-08 was lower than mothers' ISEI-08 or not available, we replaced it with mothers' ISEI-08. Finally, the variable was categorized into 0 = low (0 to under 25 percent of HISEI values), 1 = medium (25 to under 75 percent of HISEI values), and 2 = high (75 to 100 percent of HISEI values) status groups (Authoring Group Educational Reporting, 2018).

In addition, the variables described above are case-specific variables, which means that they vary only across students.

Analyses

Due to the structure of the central dependent variables in this study (study program aspiration, study program choice, and change of study program), which are nominal variables with multiple unordered values (e.g., the different fields of study), we modeled the influence of gender and generational status with multinomial logit regression (MLR) models. MLR is used to estimate a categorical classification or the probability of belonging to a category ($x = 1, 2, 3, \ldots$) for a dependent variable based on multiple independent variables. We used maximum likelihood to estimate the parameters of the model. One important requirement in MLR is that the minimum number of valid cases for each explanatory variable is 10, and prefered case to explanatory variable ratio is at least 20 to 1 (Hosmer et al., 2013). In the selected model(s), the ratio is 543 cases to 1 explanatory variable.[3] However, running multinomial logit regression models has the crucial disadvantage of producing logistic regression coefficients that are difficult to interpret. Another way to assess the effect of covariates on the dependent variable in multinominal logit models is to examine the marginal effect of changing their values on the probability of observing an outcome.

In the following, we used the margins post estimation command in Stata 16 (Stata Corp, 2019) to estimate and interpret the Average Marginal Effects (AMEs) for each level of the dependent variables. In general, AMEs are a useful way to describe the average effect of changes in independent variables on the change in the probability of outcomes in logistic regression and provide a direct and easily interpreted answer to the research question of interest. In this approach, the marginal effect is first calculated for each individual (full sample) with their observed levels of covariates. The individual AMEs are then averaged across all individuals. Finally, we executed the contrast post estimation command to contrast the margins for the different factor levels of the independent variables, i.e., boys vs. girls (Williams, 2012).

Results

Research question 1: Differences concerning generational status and gender in students' aspirations, choices, and change behavior

Our first research question was concerned with differences according to generational status and gender in students' study program aspirations, choices, and change behavior.

Study program aspirations

With part one of our first research question, we sought to examine differences between first- and continuing-generation students', as well as between female and male students', aspirations. Frequencies and percentages of first- and continuing-generation students' aspirations, as well as of female and male students' aspirations, are displayed in Table 1.

3 For an introduction to multinominal logit models, see Hosmer et al. (2013).

TABLE 1 Frequencies of first-generation, continuing-generation, female, and male students' study program aspirations.

Aspiration	Total	First-gen. students		Continuing-gen. students		Male		Female	
		n	%	*n*	%	*n*	%	*n*	%
Humanities	201	146	13.2	55	9.4	59	7.8	142	15.2
Sports	55	39	3.5	16	2.7	31	4.1	24	2.6
Law, economics, and social sciences	551	353	32.0	198	33.7	182	24.0	369	39.5
Mathematics, natural sciences	315	203	18.4	112	19.0	181	23.9	134	14.4
Medicine, health sciences	145	87	7.9	58	9.9	46	6.1	99	10.6
Agriculture, forestry, nutrition, and veterinary	20	13	1.2	7	1.2	8	1.1	12	1.3
Engineering	276	172	15.6	104	17.7	223	29.4	53	5.7
Aesthetics	128	90	8.2	38	6.5	28	3.7	100	10.7

We conducted a multinomial logistic regression to create a model of the relationship between the student gender and student generational status predictor variables and the study program aspired to in grade 11, controlling for SES. The fit of the model containing only the intercept improved with the addition of the predictor variables, χ^2 (28, $N = 1{,}691$) = 298.23, Nagelkerke $R^2 = 0.05$, $p < 0.000$. In a further step, we calculated averaged marginal means based on this multinomial logit model for the gender and generational status independent variables, which are shown in Table 2. Each comparison/contrast highlighted any differences between the two categories, which were then tested for significance. Controlling for students' SES, no contrasts regarding generational status were significant, except for one: first-generation students had a 3% higher probability aspiring to study aesthetics than continuing-generation students. On the other hand, most contrasts related to gender were significant, with only those identified for sports, agriculture, forestry, nutrition, and veterinary medicine as non-significant. The margins confirmed the well-known and well-researched gender differences: women had a 7% higher aspiration probability for the humanities, 16 percent higher for law, economics, and social science study programs, 5% higher for medicine and health sciences study programs, and 7% higher for aesthetics programs than men. On the contrary, they had a 10% lower aspiration probability for mathematics and natural sciences, and 24% lower for engineering than men.

Study program choices

The second part of our first research question inquired about differences in students' choices according to generational status and gender. Frequencies of first- and continuing-generation students' choices, as well as of female and male students' choices, are displayed in Table 3.

We again conducted multinomial logistic regressions to create a model of the relationship between the predictor variables gender and generation status of students and the choice of study program, controlling for SES. The fit of the model containing only the intercept improved with the addition of the predictor variables, χ^2(28, $N = 1{,}693$) = 283.41, Nagelkerke $R^2 = 0.05$, $p < 0.000$. Next, we calculated predicted marginal means based on this multinomial logit model for the independent variables gender and generational status, which are shown in Table 4. Each comparison/contrast provided any differences between the two categories, which were then tested for significance. No contrasts associated with generational status were significant. As with aspiration of study program, all contrasts associated with gender were significant except those for sports, agriculture, forestry, nutrition, and veterinary medicine. Women had a 19 percent higher choice probability for the humanities, 6% higher for law, economics, and social sciences study programs, 3% higher for medicine and health sciences study programs, and 2% higher for aesthetics study programs than men. On the other hand, they had a 12 percent lower choice probability for mathematics, natural sciences and 20 percent lower for engineering study programs than men.

Students' subject change from aspiration to choice

With part three of our first research question, we sought to explore students' pathways from aspiration to choice: do they enroll in the study programs they aspired to in secondary school and study in those disciplines, or do they change their minds? Table 5 presents the frequencies of first- and continuing-generation students' and women's and men's subject change. Differences according to generational status, again, remained low: the share of first-generation students who changed their program of study from aspiration to choice was roughly the same as the share of continuing-generation students. Slightly larger differences become evident according to gender. A more detailed picture of first- and continuing-generation students' and female and male students' pathways from aspiration to choice can be seen in Supplementary Figures.

We performed a logistic regression to create a model of the relationship between the predictor variables gender and generation status of students and the binary dependent variable subject change. The fit between the model containing only the intercept and data did not improve with the addition of the predictor variables, χ^2(4, $N = 1{,}693$) = 3.69, Nagelkerke $R^2 = 0.002$, $p = 0.449$. Consequently, contrasts did not show any significant differences regarding generational status and gender and hence, we did not interpret any interactions (Table 6).

TABLE 2 Marginal means for study program aspiration predicted by gender and generational status (SES controlled).

Aspiration		Margin	*SE*	*z*	95% CI		*p*
					LL	*UL*	
Humanities							
Gender	Male	0.08	0.01	8.01	0.06	0.10	N/A
	Female	0.15	0.01	12.99	0.13	0.17	N/A
	Contrast	**0.07**	**0.02**	**N/A**	**0.04**	**0.10**	**<0.000**
Generational	First-generation students	0.13	0.01	12.79	0.11	0.15	N/A
status	Continuing-generation students	0.10	0.01	7.65	0.07	0.13	N/A
	Contrast	−0.03	0.02	N/A	−0.06	−0.00	0.09
Sports							
Gender	Male	0.04	0.01	5.68	0.03	0.05	N/A
	Female	0.03	0.01	4.96	0.02	0.04	N/A
	Contrast	−0.02	0.01	N/A	−0.03	0.00	0.089
Generational	First-generation students	0.04	0.01	6.36	0.02	0.05	N/A
status	Continuing- generation students	0.03	0.01	3.96	0.01	0.04	N/A
	Contrast	−0.01	0.01	N/A	−0.02	−0.01	0.456
Law, Economics, and Social Sciences							
Gender	Male	0.24	0.02	15.45	0.21	0.27	N/A
	Female	0.40	0.02	24.69	0.36	0.43	N/A
	Contrast	**0.16**	**0.02**	**N/A**	**0.11**	**0.20**	**<0.000**
Generational	First-generation students	0.32	0.01	22.57	0.29	0.35	N/A
status	Continuing- generation students	0.34	0.02	16.98	0.30	0.38	N/A
	Contrast	0.02	0.03	N/A	−0.03	0.07	0.424
Mathematics and Natural Sciences							
Gender	Male	0.24	0.02	15.40	0.21	0.27	N/A
	Female	0.14	0.01	12.51	0.12	0.17	N/A
	Contrast	**−0.10**	**0.02**	**N/A**	**−0.13**	**−0.06**	**<0.000**
Generational	First-generation students	0.18	0.01	15.60	0.16	0.20	N/A
status	Continuing-generation students	0.19	0.02	11.48	0.16	0.23	N/A
	Contrast	0.01	0.02	N/A	−0.03	0.05	0.567
Human Medicine and Health Sciences							
Gender	Male	0.06	0.01	7.00	0.04	0.08	N/A
	Female	0.11	0.01	10.53	0.09	0.13	N/A
	Contrast	**0.05**	**0.01**	**N/A**	**0.02**	**0.07**	**0.001**
Generational	First-generation students	0.08	0.01	9.58	0.06	0.10	N/A
status	Continuing-generation students	0.10	0.01	7.71	0.07	0.12	N/A
	Contrast	0.02	0.02	N/A	−0.01	0.05	0.316
Agriculture, Forestry, Nutrition, and Veterinary							
Gender	Male	0.01	0.00	2.84	0.00	0.02	N/A
	Female	0.01	0.00	3.49	0.01	0.02	N/A
	Contrast	0.00	0.01	N/A	−0.01	0.01	. 612
Generational	First-generation students	0.01	0.00	3.59	0.01	0.02	N/A
status	Continuing-generation students	0.01	0.00	2.60	0.00	0.02	N/A
	Contrast	0.00	0.01	N/A	−0.01	0.01	0.788
Engineering							
Gender	Male	0.29	0.02	17.72	0.26	0.33	N/A
	Female	0.06	0.01	7.57	0.04	0.07	N/A
	Contrast	**−0.24**	**0.02**	**N/A**	**−0.27**	**−0.20**	**<0.000**
Generational	First-generation students	0.16	0.01	14.82	0.14	0.18	N/A
status	Continuing-generation students	0.17	0.01	11.49	0.14	0.20	N/A
	Contrast	0.01	0.02	N/A	−0.02	0.05	0.481

(Continued)

TABLE 2 (Continued)

Aspiration		Margin	*SE*	*z*	95% CI		*p*
					LL	*UL*	
Aesthetics							
Gender	Male	0.04	0.01	5.40	0.02	0.05	N/A
	Female	0.11	0.01	10.61	0.09	0.13	N/A
	Contrast	**0.07**	**0.01**	**N/A**	**0.04**	**0.09**	**<0.000**
Generational status	First-generation students	0.09	0.01	9.84	0.07	0.10	N/A
	Continuing-generation students	0.05	0.01	6.20	0.04	0.08	N/A
	contrast	**−0.03**	**0.01**	**N/A**	**−0.05**	**0.00**	**0.043**

N/A, not applicable. Bold values are significant with $p < 0.05$.

Research question 2: Interaction effect of generational status and gender on aspiration and choice

With our second research question, we intended to examine the interaction between gender and generational status on aspiration and on choice. However, as main effects of generational status concerning aspiration and choice (as examined with research questions 1a and 1b) were not significant, we decided not to interpret any interaction effects.

Research questions 3 and 4: Differences in study satisfaction levels and dropout intentions according to generational status, gender, and subject change and interaction effect of generational status and gender

With research questions 3 and 4, we sought to predict differences in study satisfaction and dropout intentions during university studies by generational status, gender, and depending on subject change from aspiration to choice. The multinominal logistic regression model with the factors generational status, gender, and change behavior resulted in a small $R^2 = 0.01$ and did not reveal any significant main effect of generational status, and subject change on satisfaction and dropout intentions, as shown in Table 7. However, there was a significant main effect of gender, female students were significantly more satisfied with their studies than male students (no significant predictor for dropout intentions).

Given the insignificant main effects of generational status and subject change, we did not interpret any interaction effects, either.

Discussion

The present study was intended to add a longitudinal perspective on the representation of first-generation college students compared to their continuing-generation counterparts and on the representation of female students compared to male students in the German education system. Using data from the German National Educational Panel Study (Blossfeld et al., 2011), we explored students' study program aspirations during secondary education, their actual study program choices, their probability of changing the subject area from aspiration to study choice, and their satisfaction and dropout intentions during university studies. Overall, we can draw three overarching conclusions regarding all four research questions in this study. First, differences related to choice of study program between first- and continuing-generation students were, for almost all indicators, limited and insignificant. Second, well-established gender differences were reproduced. Third, study satisfaction levels and dropout intentions did not significantly differ between first- and continuing-generation students or between female and male students. In the following paragraphs, we embed these three main points into existing research to highlight implications for educational practice, after which we describe the limitations of the present study and conclude with essential messages based on our results.

Equal study program aspirations and choices of first- and continuing-generation students

Our first main conclusion is that first- and continuing-generation students did not differ in study program aspirations and choices, which was contrary to our expectations. Our expectations were based on the assumption that first-generation students may lack social and cultural capital as well as financial resources compared to their continuing-generation peers whose parents hold a postsecondary education degree (Pascarella et al., 2004; Wilbur and Roscigno, 2016). Therefore, they may tend to choose more practical fields of study with more secure job opportunities but less long-term benefits (Wright et al., 2021). More specifically, our data revealed no significant differences in aspirations and

TABLE 3 Frequencies of first-generation, continuing-generation, female, and male students' study program choices.

Choice	Total	First-gen. students		Continuing-gen. students		Male		Female	
	N	*n*	%	*n*	%	*n*	%	*n*	%
Humanities	314	208	18.9	106	18.0	59	7.8	255	27.3
Sports	14	10	0.9	4	0.7	7	0.9	7	0.8
Law, economics, and social sciences	517	353	32.0	164	27.9	204	26.9	313	33.5
Mathematics, natural sciences	349	222	20.1	127	21.6	208	27.4	141	15.1
Medicine, health sciences	92	55	5.0	37	6.3	29	3.8	63	6.8
Agriculture, forestry, nutrition, and veterinary	40	29	2.6	11	1.9	13	1.7	27	2.9
Engineering	320	198	18.0	122	20.7	228	30.1	92	9.9
Aesthetics	45	28	2.5	17	2.9	10	1.3	35	3.8

choices between first- and continuing-generation students except for the significant higher probability of first-generation students to aspire to study aesthetics. These results contrast with those of former studies that have uncovered considerable differences concerning first- and continuing-generation students' study choices. However, we would like to emphasize that we only examined differences concerning study program aspirations and choices, whereas differences concerning general participation in postsecondary education were not in focus.

Considering the longitudinal aspect of the data, we additionally analyzed whether any differences could be found in the change of study program according to generational status, gender, or even an interaction effect, but we found no significant differences. These insignificant results are encouraging: they indicate that first-generation students in transition to the German higher education system do not seem to differ from their continuing-generation peers. This may be an early hint that the problems and barriers they face are similar to those faced by their peers, which might be an interesting quest for future research: despite limited differences in study choices and satisfaction, do the problems faced by first-generation students in Germany differ from those faced by their continuing-generation counterparts at the point of transitioning into the postsecondary system? Especially from U.S. studies, we know that first-generation students face financial but also cultural problems (Wilson and Kittleson, 2013), which leads to another worthy research question regarding the differences between the U.S. and the German educational systems. For instance, American students face considerable university tuition and fees, whereas most German universities are funded by the German states. Therefore, at least, the financial barrier may be lower for students, especially first-generation students in the German system. Despite the insignificant differences from our study, which may be also due to some limitation we discuss in the following, we agree with Wright et al. (2021) that policy will profit from information around enrollment gaps and possible attrition by gender and generational status.

Study program choices of female and male students

The results that answer our first research question with regard to gender differences clearly confirmed well-researched and cross-nationally occurring (Buccheri et al., 2011) gender inequalities in both study program aspirations and study program choices during secondary education. Interestingly, those inequalities form a similar picture of students' aspirations and choices: female students stay overrepresented in the humanities and law, economics, and social sciences from aspiration to choice, whereas male students predominate mathematics and natural sciences as well as engineering—as in aspirations, so, too, in choices. The stability of gender differences from secondary to postsecondary education suggest that support and promotion of equal chances for female and male students must start as early as possible, during or even before the students are enrolled in secondary schooling. This suggestion agrees with prior research that showed the impact of school-based interventions on interest and utility values in early education (Eccles and Harold, 1991; Lesperance et al., 2022). Existing research shows that schools serve as important environments in which students form their motivation and orientation toward specific subject areas, such as the STEM programs, and examine multiple forms of support, such as the main curriculum or out-of-school activities that may be effective in reducing gender gaps (Reinhold et al., 2018; Holzberger et al., 2020). Supporting the perceived utility of a particular subject field may be another important aspect, as it was found to be a strong predictor of choice and enrollment in the study program (Buccheri et al., 2011).

Equal satisfaction and dropout intentions of first- and continuing-generation students, female students more satisfied than male students

With research questions 3 and 4, we sought to investigate whether unequal prerequisites, such as financial resources,

TABLE 4 Marginal means for study program choice predicted by gender and generational status (SES controlled).

Choice		Margin	*SE*	*z*	95% CI		*p*
					LL	*UL*	
Humanities							
Gender	Male	0.08	0.01	8.00	0.06	0.10	N/A
	Female	0.27	0.01	18.74	0.25	0.30	N/A
	Contrast	**0.19**	**0.02**	**N/A**	**0.16**	**0.23**	**<0.000**
Generational	First-generation student	0.19	0.01	16.20	0.16	0.21	N/A
status	Continuing-generation student	0.19	0.02	11.36	0.15	0.22	N/A
	Contrast	−0.00	0.02	N/A	−0.04	−0.04	0.949
Sports							
Gender	Male	0.01	0.00	2.65	0.00	0.02	N/A
	Female	0.01	0.00	2.65	0.01	0.01	N/A
	Contrast	−0.00	0.00	N/A	−0.01	0.01	0.651
Generational	First-generation student	0.01	0.00	3.09	0.00	0.02	N/A
status	Continuing-generation student	0.01	0.00	1.95	−0.00	0.01	N/A
	Contrast	−0.00	0.00	N/A	−0.01	0.01	0.491
Law, Economics, and Social Sciences							
Gender	Male	0.27	0.02	16.73	0.24	0.30	N/A
	Female	0.34	0.02	21.74	0.31	0.37	N/A
	Contrast	**0.06**	**0.02**	**N/A**	**0.02**	**0.11**	**0.004**
Generational	First-generation student	0.31	0.01	22.22	0.29	0.34	N/A
status	Continuing-generation student	0.29	0.02	14.91	0.25	0.33	N/A
	Contrast	−0.02	0.02	N/A	−0.07	0.03	0.362
Mathematics and Natural Sciences							
Gender	Male	0.27	0.02	16.90	0.24	0.31	N/A
	Female	0.15	0.01	12.88	0.13	0.17	N/A
	Contrast	**−0.12**	**0.02**	**N/A**	**−0.16**	**−0.08**	**<0.000**
Generational	First-generation student	0.20	0.01	16.59	0.18	0.23	N/A
status	Continuing-generation student	0.21	0.02	12.39	0.18	0.25	N/A
	Contrast	0.01	0.02	N/A	−0.03	0.06	0.554
Human Medicine and Health Sciences							
Gender	Male	0.04	0.01	5.50	0.02	0.05	N/A
	Female	0.07	0.01	8.24	0.05	0.08	N/A
	Contrast	**0.03**	**0.01**	**N/A**	**0.01**	**0.05**	**0.007**
Generation	First-generation student	0.05	0.01	7.50	0.04	0.07	N/A
status	Continuing-generation student	0.06	0.01	6.03	0.04	0.07	N/A
	Contrast	0.00	0.01	N/A	−0.02	0.03	0.818
Agriculture, Forestry, Nutrition, and Veterinary							
Gender	Male	0.02	0.00	3.63	0.01	0.03	N/A
	Female	0.03	0.01	5.27	0.02	0.04	N/A
	Contrast	0.01	0.01	N/A	−0.00	0.03	0.117
Generational	First-generation student	0.03	0.00	5.36	0.02	0.03	N/A
status	Continuing-generation student	0.02	0.01	3.25	0.01	0.03	N/A
	Contrast	−0.00	0.01	N/A	−0.02	0.01	0.562
Engineering							
Gender	Male	0.30	0.02	18.00	0.27	0.33	N/A
	Female	0.10	0.01	10.11	0.08	0.12	N/A
	Contrast	**−0.20**	**0.02**	**N/A**	**−0.24**	**−0.16**	**<0.000**
Generational	First-generation student	0.18	0.01	15.84	0.16	0.20	N/A
status	Continuing-generation student	0.20	0.02	12.39	0.17	0.24	N/A
	Contrast	0.02	0.02	N/A	−0.02	0.01	0.443

(Continued)

TABLE 4 (Continued)

Choice		Margin	*SE*	*z*	95% CI		*p*
					LL	*UL*	
Aesthetics							
Gender	Male	0.01	0.00	3.19	0.01	0.02	N/A
	Female	0.04	0.01	6.07	0.02	0.05	N/A
	Contrast	**0.02**	**0.01**	**N/A**	**0.01**	**0.04**	**0.001**
Generational status	First-generation student	0.03	0.01	5.31	0.02	0.04	N/A
	Continuing-generation student	0.02	0.01	4.09	0.01	0.03	N/A
	Contrast	−0.01	0.01	N/A	−0.02	0.01	0.851

N/A, not applicable. Bold values are significant with $p < 0.05$.

TABLE 5 Frequencies of first-generation, continuing-generation, female, and male students' changes from study program aspiration to study program choice.

	Total	First-gen. students		Continuing-gen. students		Male		Female	
	N	*n*	%	*n*	%	*n*	%	*n*	%
No change	761	499	45.2	262	44.6	358	47.2	403	43.2
Change	930	604	54.8	326	55.4	400	52.8	530	56.8

skills, and information about the academic environment (Wilbur and Roscigno, 2016), would lead to specific challenges during postsecondary studies, such as higher dropout rates or lower levels of study satisfaction. Our results here again communicate a positive message: generational status did not affect study satisfaction or dropout intentions. This finding conflicts with the findings of previous results: Choy (2001), for instance, found that first-generation students in the U.S. context are more likely to drop out of their studies than continuing-generation students, even after controlling for variables such as lower first-year GPA or working full-time. However, our findings point in a similar direction as those of Behr et al. (2021), who did not find any significant differences between dropout motives of students from more educated backgrounds and those from less educated backgrounds, examining cohort 5 of the German NEPS dataset. However, they differed concerning dropout reasons; for instance, students from less educated backgrounds were more prone to drop out because of financial reasons. The one significant finding from our analyses targets higher study satisfaction of female students compared to their male peers. Overall dropout intentions did not significantly differ between men and women. In light of existing research, differences may occur when examining for instance "gender atypical" fields of study, for example Riegle-Crumb et al. (2016) showed that men, entering female-dominated domains had a higher probability of switching majors than their male peers in other domains.

Limitations

Some limitations must be considered when interpreting the results of our analyses. First, we detected differences regarding gender and generational status shares comparing the original and the selected sample with a decrease of first-generation students from 73 to 65% and male students from 50 to 45%, which may cause biased results. Second, we decided to stay with a simple comparison of students whose parents had non-academic parents and students with at least one parent with an advanced education instead of adding more sub-groups as indicated by existing research (Ishitani, 2006; Spiegler and Bednarek, 2013). For instance, Ishitani (2006) used the categories (1) first-generation (i.e., parents with a high school diploma or less), (2) parents with some college experience (i.e., at least one parent attended college, but none earned a bachelor's degree), (3) one parent with a bachelor's degree, and (4) both parents with bachelor's degrees. However, we repeated our analyses with those categories and did not find any substantial differences compared to using the dichotomous solution. A theoretical limitation may be presented by the definition of first-generation students, a group on which researchers tend to take a "deficit perspective" (Valencia, 1997), or as Ives and Castillo-Montoya (2020) phrased it, an "assimilationist approach," defining first-generation students *per se* as a group at risk (Terenzini et al., 1996). This approach frames first-generation students as having a lack of social and cultural capital based on their parents' lack of academic experience instead of seeing them as "fully legitimate participants in higher education" (Spiegler and Bednarek, 2013). In turn, the students are assumed to need to assimilate to the structural characteristics of the academic institutions in order to succeed, instead of assigning deficits to institutional characteristics, such as classroom practices or information policies (Reay, 2009). We agree upon those theoretical considerations. Nevertheless, in our view, uncovering the unique needs of first- and continuing-generation students can be useful for informing the development of tailored supports, such as counseling for study choice. Methodologically, we must consider the fact that we only used data representing students who reported answers at all three measurement points. We did this to be able to directly compare aspirations during

TABLE 6 Marginal means for subject change predicted by gender and generational status.

Change or stay		Margin	*SE*	*z*	95% CI		*p*
					LL	*UL*	
Gender	Male	0.58	0.03	19.45	0.52	0.64	N/A
	Female	0.53	0.03	19.60	0.48	0.58	N/A
	Contrast	−0.05	0.04	N/A	−0.13	0.03	0.225
Generational status	First generation student	0.55	0.03	19.33	0.49	0.60	N/A
	Continuing-generation student	0.56	0.03	19.67	0.58	0.61	N/A
	Contrast	−0.01	0.04	N/A	−0.06	0.09	0.719

N/A, not applicable.

TABLE 7 Marginal means for dropout intentions and study satisfaction predicted by gender, generational status, and subject change (SES controlled).

Aspiration		Margin	*SE*	*t*	95% CI		*p*
					LL	*UL*	
Dropout intentions							
Generational status	First-generation students	1.94	0.02	128.84	1.91	1.97	N/A
	Continuing-generation students	1.93	0.02	92.25	1.89	1.98	N/A
	Contrast	−0.17	0.03	N/A	−0.07	0.04	0.54
Gender	Male	1.96	0.02	108.23	1.93	2.00	N/A
	Female	1.92	0.02	120.67	1.89	1.95	N/A
	Contrast	−0.04	0.02	N/A	−0.09	0.00	0.07
Subject Change	No change	1.93	0.02	107.98	1.89	1.96	N/A
	Change	1.95	0.02	121.10	1.91	1.98	N/A
	Contrast	−0.18	0.02	N/A	−0.03	0.07	0.46
Study satisfaction							
Generational status	First-generation students	3.71	0.02	151.72	3.66	3.75	N/A
	Continuing-generation students	3.71	0.03	109.17	3.64	3.78	N/A
	Contrast	0.00	0.04	N/A	−0.08	0.09	0.95
Gender	Male	3.59	0.03	121.92	3.53	3.67	N/A
	Female	3.80	0.03	147.23	3.75	3.85	N/A
	Contrast	**0.21**	**0.04**	**N/A**	**0.13**	**0.28**	**0.00**
Subject Change	No change	3.73	0.03	128.89	3.67	3.79	N/A
	Change	3.69	0.03	141.34	3.64	3.74	N/A
	Contrast	−0.04	0.04	N/A	−0.12	0.04	0.31

N/A, not applicable. Bold values are significant with $p < 0.05$.

secondary schooling and postsecondary choices of first-generation, continuing-generation, female, and male students. The drawback of this method is that we did not consider aspirations of those students who drop out before making a postsecondary choice. Last but not least, another limitation results from using different categorizations of study programs. For the sake of larger subgroup samples we used the categorization, in which for instance social sciences and law are in one category—two areas which may differ considerably regarding shares of first- and continuing-generation students. Other studies use different categorizations such as Middendorff et al. (2013) or Wright et al. (2021), who separately report law from social sciences. Another category with probably higher within variance may be mathematics and natural science because gender differences in life sciences such as biology differ significantly from for example physics or mathematics (Dicke et al., 2019). Consequently, we do not know whether students' aspirations would paint a different picture with the full sample or other categorizations of study programs and potentially would point to other directions concerning counseling for specific student groups. These points would be interesting for future research to pursue.

Conclusion

With the present study we were able to shed light on the process of study program choice of first- and continuing-generation,

as well as female and male students from secondary education to university studies in the German context. Through this research, we added to existing insights on first-generation students in the German educational system that have not been studied as extensively as in the American context, where considerable differences between first- and continuing-generation students have been consolidated over the past years. Additionally, we were able to obtain an understanding of the longitudinal process of study program choice, adding to our knowledge on critical time points where, for example, more specific and individual coaching or other support may be helpful for either first-generation or continuing-generation students or female and male students. Given our results and the minor differences from study choice to aspiration, we conclude that aspirations toward specific fields of study have already been formed before grade 11, indicating that counseling and other support may need to be implemented even earlier. This may be especially important to equalize gender differences, which predominated our findings. On the other hand, our findings point to the direction that first- and continuing-generation students in the German educational system do not differ regarding their study program aspirations, choices, study satisfaction levels, and dropout intentions. As this general finding is clearly opposed to findings from research on first-generation students in the United States, further research can shed light on the reasons: Which barriers and support factors differ in the two systems and how do they influence first-generation students' pathways through higher education? Through that, further steps toward achieving equal access and equal opportunities in education, as claimed by the Bucharest Communiqué (2012), can be accomplished.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://www.neps-data.de/Data-Center/Data-and-Documentation/Start-Cohort-Grade-9/105157-NEPSSC41200, National Educational Panel Study (NEPS).

Author contributions

SR did literature search, searched for and formulated research gap and research questions, and theoretical embedding, did data management, proposed methods, and conducted statistical analyses, embedded results in existing literature and discussed them, and mainly wrote the manuscript. DH was involved in setting up the theoretical framework of the study, proposed additional literature, discussed the direction of the research questions, and provided input concerning methods, interpretation, and presentation of results. CK proposed statistical methods, conducted them, and partly wrote the methods section and provided input concerning presentation of results. TS was involved in setting up the theoretical framework of the study, discussed the direction of the research questions, and provided input concerning the interpretation and discussion of the results. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.964703/full#supplementary-material

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