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Cohort Fertility and Couple Educational Pairing

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HIGHLIGHTS

- Cohort fertility rates are decomposed by couples' educational pairing using Finnish register data.
- Most births occur in educationally homogamous and hypogamous unions.
- Most births occur in unions in which at least one partner has tertiary education.

ABSTRACT Educational disparities in cohort fertility rates (CFRs) often serve as the starting point for analyzing socioeconomic drivers of fertility. Because most children are born to couples, the relationship between education and fertility is the compound of both partners' education. Measuring both partners' educational levels is generally considered superior to measuring one partner's educational level. Yet, no study has comprehensively analyzed cohort fertility by couples' educational pairing. Using Finnish register data, we provide the first analysis of CFRs from the perspective of educational pairings. For the female birth cohorts of 1969–1975, we decompose the CFR by the educational pairing of the union in which the births occur. This novel measure complements previous work focusing on the incidence or instantaneous birth risks by educational pairing, as it draws on lifetime exposure to unions by educational pairings and birth rate within such unions. Our analysis reveals that the CFR in Finland, for the most recent cohorts from which such measures can be derived, is predominantly the result of births in educationally hypogamous or homogamous unions and in unions where at least one partner has tertiary education. In particular, the CFR of highly educated women is composed of births to couples in which the male partner is also highly educated.

KEYWORDS Cohort fertility • Assortative mating • Homogamy • Sweden • Education

Introduction

Educational attainment is strongly related to economic, sociocultural, and structural factors predicting childbearing (Lutz and KC 2011). Consequently, educational differentials in fertility have received considerable attention across the social sciences and are likely the most widespread "stylized fact" of within-population differences

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in fertility (Vasireddy et al. 2023). However, the process leading up to childbearing primarily occurs in the context of a couple union—about 95% of children are born to parents who are in a coresidential partnership (Aassve et al. 2006; Andersson 2023). Therefore, the relationship between fertility and education is, for many purposes, better understood by analyzing the educational pairing of both partners within a couple union.

An essential motivation within the voluminous literature on the role of education in childbearing is to understand how education level relates to or influences the completed cohort fertility rate (CFR). Empirical research on educational differentials in CFR based on one partner's education abounds (Jalovaara et al. 2019; Schoen 2022; Zeman et al. 2018). In contrast, the literature on educational pairing almost exclusively analyzes fertility from a period perspective, focusing on the childbirth of a given parity (Bueno and García-Román 2021; Jalovaara 2003). To the best of our knowledge, there are only two studies of couples' educational pairing from a cohort perspective (Bagavos 2017; Monteiro da Silva et al. 2022). This situation is unfortunate because the extant literature has carefully studied the dynamics of educational pairing on distinct events, such as first childbearing, but cannot be drawn upon to reconstruct the differentials between the educational pairing of couples in terms of completed fertility, nor could the literature say much about the implications of such differentials at the population level.

This study seeks to contribute to the literature on educational pairings and fertility by addressing this research gap. To which educational pairings are children born and raised today? How is cohort fertility by educational pairing related to theoretically relevant patterns of union composition, such as the degree of human capital within the couple and whether the woman (hypogamy) or the man (hypergamy) has the highest level of education within the couple? How does this differ between subpopulations of women of low, medium, and high educational attainment? Finally, how feasible is it to use cohort fertility rates (a reference to the sum of individual lifetime fertility) by educational pairing—a time-variant and couple-level feature?

The lack of research on cohort perspectives on educational pairing and demographic outcomes is understandable because of the related data demands and methodological and conceptual concerns. Cohort fertility uses information on the sum of individuals and their childbearing, whereas educational pairing is the feature of a couple (Preston et al. 2000). A useful denominator for calculating cohort fertility by educational pairing should, therefore, distinguish individual exposure time to distinct unions and the educational level of each partner or apply strong assumptions about these parameters. We use Finnish registers with data on coresidence and fertility covering the reproductive period (ages 18–47). Specifically, we study the 1969–1975 female birth cohorts' lifetime fertility and exposure to unions of a given educational pairing and the state of singlehood. We then decompose the CFR into births occurring in a union of a given educational pairing, including the singlehood state. We calculate (1) estimates on the share of births of the CFR that occur in each educational pairing and singlehood and (2) a decomposition of the contribution of each educational pairing (including singlehood) to the CFR, differentiating between the effect of the proportion of each pairing and its rate of childbirth.

Our results demonstrate that it is possible and feasible to introduce educational pairings into population-level measures of cohort fertility, and the findings both

indicate and extend the extant picture of the relationship between fertility and education. For example, we show that completed cohort fertility of recent cohorts in Finland is mainly driven by births to unions in which at least one individual has tertiary education (roughly 60% of all births). Moreover, we show that the CFR of highly educated women, particularly, is composed of births to couples in which the male partner is also highly educated (roughly half of births to tertiary-educated women occur in homogamous unions). Furthermore, we offer various measurements of educational pairings (e.g., at each birth, at the end of each respective union, at the end of the reproductive life span) and demonstrate that our results are robust across specifications. These summary results add to the understanding of the relationship between education and fertility and speak to the usefulness of an educational pairing CFR approach. These results could not have been derived from hazard models or from cohort fertility analyses drawing on the educational level of only the index cohort.

Theory and Background

Educational Pairing of Couples and Fertility

Different perspectives on the relationship between educational pairings and fertility follow from various fertility theories, and it is possible to discern at least two distinct features of explanations. One considers educational pairing to influence fertility through the same mechanisms as an individual's educational level. In such frameworks, the rationale for analyzing educational pairing is precision; adding the educational level of the partner to that of the index person is a matter of increasing reliability in operationalizing educational effects (Gustafsson and Worku 2006; Kreyenfeld 2002; Trimarchi and Van Bavel 2017). For example, it is often argued that highly educated individuals are selective on characteristics that beget stable relationships, and union stability facilitates childbearing. Information about the educational level of both partners, compared with only one partner, affords a better model of education as an omnibus measure of unobserved characteristics (Vogl 2016). Similarly, the income effect argument states that childbearing is costly for the household and, therefore, higher income positively influences fertility. To the extent that education is a measure of earnings potential, we can better estimate the household income effect with information on both partners' educational levels (Jones et al. 2008). For example, this additive effect has been described as a way of decreasing the financial risks and uncertainties related to childbearing by pooling resources from two earners (Oppenheimer 1997). A key institutional pathway by which educational level influences fertility is through childbearing postponement until the age of educational completion (Blossfeld and Huinink 1991). Here, both partners' educational levels may also have additive effects on postponement. Because these effects relate to age and the window of reproductive years remaining, second and higher parity progressions are, on the one hand, particularly affected by postponement based on the educational attainment of both couples. On the other hand, first birth postponement among homogamous tertiary-educated couples may be followed by a faster progression to second birth, owing to a time squeeze effect (Kreyenfeld 2002). Although various studies have indicated elevated second birth rates among tertiary-educated homogamous

couples relative to other educational pairings, it remains an open debate whether this finding represents a quantum or a timing effect, or potentially both (Nitsche 2024; Nitsche et al. 2018). The additive effects of educational pairing are relative measures. A complementary view, taken from the population perspective of this study, is how many births ultimately take place in unions of a given combined educational level.

The other set of explanations assumes that dynamic mechanisms apply to different educational pairings. Several theories emphasize the role of specialization and division of labor between couples for childbearing (Jones et al. 2008). A common feature, however, is that educational composition is a proxy for earnings potential and the gains for specializing in either the labor market or the household. Couples consisting of two highly educated partners have higher opportunity costs of childbearing and are thus predicted to have lower fertility. For couples in which one is highly educated and the other is not, the opportunity costs are more aligned to a division of labor into earned work and (unpaid) household work, which is theorized as more accommodating of childbearing (Becker et al. 1977).

Specialization models often incorporate gender differences in norms, values, and expectations toward unpaid housework, (unpaid) care work, and paid work (Nitsche and Brückner 2021). Specifically, if women's labor market commitment increases to that of men's, while men's housework and care work increase to that of women's, high fertility can prevail, in theory, also in a couple of two tertiary-educated partners with high earnings capacity. However, contemporary societies are sometimes described as being in a state of a "stalled gender revolution" in which only the former transition has occurred: women have entered full-time employment despite disproportionately remaining responsible for unpaid labor (England 2010; Goldscheider et al. 2015). This disharmony is often considered the reason for the common observation of high childlessness among highly educated women (Wood et al. 2014). Thus, measures of fertility by educational pairing, and cohort measures in particular, are valuable empirical knowledge for evaluating theories about gender relations (Goldin 2006).

Finally, according to the cultural matching perspective, education is a proxy for social background, social values, and cultural practices (Schwartz 2013). It is theorized that heterogamy in education may represent heterogamy along sociocultural dimensions, such as religion, nationality, social value orientation, or social background, which in turn leads to less stable unions. Differences in couples' educational levels may thus have a negative effect on childbearing if such unions, more often than homogamous unions, dissolve before childbearing or otherwise compromise the quality of the union.

Cohort Perspectives on Couples' Educational Pairing and Fertility

Partial empirical support for each of the various mechanisms is documented in empirical studies on fertility and couples' educational pairing, whereas the gendered effects have been found to vary across countries (Nitsche et al. 2018; Trimarchi and Van Bavel 2020). General additive income effects are supported, for example, by the observation that in high-income countries, higher order births (second and third) are more common among couples with two tertiary-educated individuals than among heterogamous couples in which only one partner has a tertiary education, as well as

among couples in which neither has a tertiary education (Bueno and García-Román 2021; Dribe and Stanfors 2010; Nitsche et al. 2021; Trimarchi and Van Bavel 2020). Similar patterns are found for the postponement effect; the age at the transition to parenthood is higher when both partners have higher education (Nitsche et al. 2018). Findings suggest effects of the cultural matching perspective in that couples of different educational levels and those who differ in ethnic, religious, or cultural backgrounds (Schwartz 2013) have a higher risk of union dissolution (Kalmijn et al. 2005; Mäenpää and Jalovaara 2015) and lower progression to first birth (Nitsche 2024) and marriage (Trimarchi and Van Bavel 2018).

To conclude, the empirical literature that accounts for both partners' educational levels is dominated by a focus on predicting the hazard of events or transitions, such as parity progression or divorce rates. A separate literature analyzes educational assortative behavior in its own right, including period measures of the incidence of households by educational pairing. Broadly, these approaches provide insights into how educational pairing might relate to fertility by testing hypotheses regarding specific mechanisms. However, they do not provide evidence of fertility outcomes at the population level and cannot disentangle tempo from quantum effects. In contrast, population and cohort perspectives allow one to consider the result of lifetime exposure to partners of a given educational level and the summed rate of lifetime fertility within such unions.

Furthermore, a population approach is of particular significance from the perspective of children because it is useful to identify the family background into which children are born and raised. Entering into a partnership and the type of partnership formed affect the characteristics of the population of (potential) parents, with consequent repercussions for the offspring generation (Mare and Schwartz 2006). Children born to tertiary-educated homogamous couples will benefit from the higher availability of various resources relative to children born to non-tertiary-educated couples. For instance, a study from Germany showed that children are more likely to attain tertiary education if both parents are tertiary-educated than if only the mother is and the father has a lower level of education (Corti and Scherer 2022). Thus, examining differential fertility by patterns of educational assortative mating sheds light on the population distribution of children's family environments and helps illuminate conditions for the reproduction of social inequalities (Mare and Maralani 2006; Schwartz 2013; Wittemann and Yastrebov 2024).

The current study contributes to the literature by addressing this research gap. How large of a share of lifetime births of a given birth cohort occurs within educationally homogamous, hypergamous, or hypogamous unions? How large is the share of lifetime births of a given birth cohort within unions in which one or both parents have basic education, how large is the share in which both are highly educated, and so on? Moreover, rather than just estimating the CFR of the subpopulations of women who attain a university education and those who do not, we show the difference in the share of CFR of these subpopulations that is due to age-specific birth rates from partners with low, medium, and high education. One advantage of this approach is that the results can be interpreted in absolute terms. Rather than being a conditional rate of births, or a conditional relative ratio or probability of assortative mating, our estimates can be used to measure educational pairing as the share of births of a population taking exposure into account. Hence, we estimate age-specific birth rates for all educational pairings and sum these to a population-level education composition CFR.

We know of two studies that analyze CFR by educational pairing. Monteiro da Silva and colleagues (2022) used Brazilian census data to show that cohort fertility is highest among couples without tertiary education and, on average, is lower in hypergamous unions. Bagavos (2017) used Greek census data to show similar CFR levels across education composition except for low-educated couples, who have markedly higher completed fertility. The method of constructing CFR by educational pairing from cross-sectional census data used by both studies draws on information on the number of children born, the partners at the time of the census, and the educational level at the time of the census. Thus, there is no denominator regarding lifetime exposure to unions of a given educational pairing. This carries two implications. First, one must assume that the derived CFR is driven by births in the union observed at measurement (or a union with the educational pairing of that union). Second, because the union is not distinguished as a unit of analysis, it is impossible to estimate the total population of CFR as a result of births in unions of various educational pairings. Thus, our study makes methodological contributions within the literature by engaging with cohort fertility and educational pairing. We empirically derive exposure to partners of a given educational level across the reproductive years, allowing for novel ways to analyze cohort fertility by educational pairing.

The Finnish Context

Educational gradients in fertility and family dynamics have changed substantially across the twentieth century and have been fairly variable within contemporary OECD countries (Kravdal and Rindfuss 2008; Lazzari et al. 2021; Lutz and KC 2011). Educational pairing itself is structured by the degree of educational expansion and attainment in the population, and most models assume that fertility is structured by the context-specific returns to education and gender. Finland is characterized by a rather early onset of educational expansion and has high enrollment in higher education relative to most OECD countries. The percentage of 35–44-year-olds with tertiary education in Finland has increased from 36% to roughly 50% since the turn of the millennium (Statistics Finland 2021).

The country was among the first to see the so-called reversal of gender inequality: tertiary-educated women in their reproductive ages have outnumbered tertiary-educated men since the 1980s (Van Bavel 2012). The average ages at college graduation (age 27) are higher than in most OECD countries (OECD 2016). The birth cohorts in this study are among the last not to be influenced by the recent fertility decline (Hellstrand et al. 2021); average completed cohort fertility rates are about 1.9, somewhat higher for highly educated men and low-educated women (Jalovaara et al. 2019). Fertility in Finland is characterized by relatively high levels of childlessness. Childlessness at age 45 is about 19% for women and 28% for men (Jalovaara and Miettinen 2024).

Finland has a welfare system with generous childcare provisions and parental leave schemes, as well as very high levels of female labor market participation (Nelson et al. 2020). Couples' sharing of housework and childcare work is relatively less gender equal than in other Nordic countries (Moreno-Colom 2017). Although Finland has a profile as a gender-equal country (Kurzman et al. 2019), the level of

gender egalitarianism is considered somewhat lower than in the other Nordic countries. For example, paternal use of parental leave is markedly lower than in Sweden, particularly among couples with non-tertiary-educated women (Eydal et al. 2015).

In summary, in comparison to the average OECD country, Finland represents a context in which cohort fertility rates across educational pairing might be expected to be less strongly gendered (e.g., the relevance of specialization effects and fertility differentials across hypergamous or hypogamous unions might be less salient). Rather, we may expect, in comparison to other OECD countries, patterns to be strongly driven by "income effects," for example, a positive relationship between fertility and the pooling of couples' human capital as measured by their educational composition.

Data and Methods

Data

We use anonymized, individual-level data from Statistics Finland on childbirth, coresidential partners, and educational levels. Coresidential data exist from 1987 onward, and the data we use run until 2022. Therefore, we analyze the female birth cohorts of 1969 to 1975 to observe, by and large, the entire reproductive period of individuals aged 18 to 47. We thus consider exposure time to unions of a given educational pairing as a feature of these index birth cohorts rather than constructing marriage or couple cohorts. We base our concept of a couple's romantic union on either residing together as a couple or being married (although almost all married couples in our data share a dwelling). We limit our analysis to women born in Finland and registered from their 18th birthday until age 45 to obtain complete histories of partnerships and education. Cohabitation union status is assigned to individuals who share a dwelling with a nonrelative of the opposite sex for more than 90 days and are no more than 20 years apart in age (unless married or have common children). This approach is commonplace in statistical agencies internationally (Kennedy and Fitch 2012) and often used in register-based research (Jalovaara and Kulu 2018).

Educational Pairing

We use the 2011 International Standard Classification of Education (ISCED) schema (UNESCO 2012) sorted into three educational levels: low, or basic (ISCED 1 and 2, corresponding to nine years or less of schooling), medium (ISCED 3 and 4, corresponding to 11–12 years of schooling, matricular examinations from upper secondary school, and postsecondary vocational qualifications), and high (ISCED 5–8, corresponding to tertiary education).

Our data contain yearly information on the highest educational level of individuals, and so we can observe yearly changes in the education of the index women and their partners. Our measurement of educational pairing is constructed so that the educational pairing of the unique union is fixed over time. The measure of educational pairing takes the highest observed level of education observed within the unique

union, for example, the highest level of each individual during the time they are observed as a married or cohabiting couple. Thus, the measure of educational pairing is a time-varying individual measure describing the educational pairing of women's unions but does not differ within the duration of the unique unions. Likewise, suppose a woman had two unions in sequence, both of which achieved the same highest educational composition within the duration of each unique union. In that case, both unions contribute to the same exposure in terms of the educational composition, but the exposure differs by the woman's age.

Our educational pairings measure encompasses 10 values: the nine possible combinations of couple educational pairings and the category of single. We consider this definition useful because the latest measured educational pairing of each distinct union corresponds to the educational pairing prevailing for the longest time within that union and the modal (within-union) composition for childbearing (referred to as definition a). The definition is also in line with our analysis, which is not concerned with the effect of the timing of educational attainment on childbirth but with completed fertility.

To explore the sensitivity of results to the time of measurement of education, we contrast our preferred estimate (described above) to three alternative measures of educational composition. Definition b measures education at the time of birth, definition c measures it at age 45 for either parent, and definition d measures it at December 31 of each calendar year. Definition b assesses education at the time of union-specific first childbirth for those unions that experience a birth and, for those unions that do not experience a birth, the highest observed level of education within the specific union (the denominator comprises those couples who have a child and not those who do not have a child). The intuition behind definition b is to come as close as possible to what characterizes the educational compositional environment into which a child is born. Definition c constructs educational composition from the last observation point of the index person and the last observation point of the partner, regardless of their union trajectories, which is age 45. The logic behind definition c is that unobserved aspects related to childbearing in a given union are, for all intents and purposes, entirely endogenous for the final educational level that each partner arrives at. Definition c also practically reflects the basis of educational measures available in many data sources from which cohort fertility is constructed—the educational level at the time of measurement, which for cohort fertility is usually sometime after age 40. Finally, alternative definition d measures time-varying union composition, taking the educational levels of the index person and the partner observed at a given year. The assumption implied by this measurement is that the educational levels at a specific year influence fertility and that these are unrelated to the educational trajectories of the partners. We argue that the actual function of educational composition is somewhere in between these four definitions.

Finally, Table A1 (shown in the online appendix, along with all other tables and figures designated with an "A") further differentiates the single (nonpartnered) category by education of the index woman. Less than half a percent of cohort fertility is due to births that occur before age 18. We have no coresidential data for individuals younger than 18, and these births are attributed to age 18 for parsimony and are sorted under the "single births" category.

Analytic Approach

Educational Pairing–Specific CFR

We use the above-mentioned couple-states to differentiate between the risk of birth outside a union (single births) and within a union of a particular educational pairing. First, we analyze in which educational pairings these birth cohorts have children. To do so, we decompose cohort fertility by the sum of births within unions of a particular educational pairing. Births to women without a registered coresiding or marital partner (referred to as "single") are included but collapsed into one category. Equation (1) takes the sum of the age-specific fertility rates f_{nx} for age n and union educational pairing state x multiplied by the share of women at each age and in each union educational pairing p_{nx}. In subsequent analyses, we let $\left(f_{nx}\right)$ and $\left(p_{nx}\right)$ reflect collapsed versions of the nine educational pairing categories: homogamous, hypergamous, and hypogamous unions on the one hand, and unions with low, medium, and high education as the highest level of education on the other hand. Equation (1) is also applied to subgroup analyses, where we consider the CFR of women on the basis of their highest attained education (i.e., the subpopulations of women with basic, medium, or high education at age 45). Here, we analyze, for example, the share of CFR of highly educated women that is due to births with partners who had low, medium, or high education during their couple union. Furthermore, Eq. (1) is equally applied to the analyses using the alternative educational pairing measurements described earlier as definitions b, c, and d. In sum, our approach displays the contribution of the subgroup to total cohort fertility through the combined effects of the fertility of the subgroup and the share of that subgroup in the total population, formally:

$$CFR = \sum_{n=18}^{n=47} f_{nx} \cdot p_{nx}. \tag{1}$$

Decomposing the CFR in Educational Pairing Size and Rate Effects

We also want to obtain an idea of the relative contribution of the size and the fertility rate of each educational pairing. We let each educational pairing x share of person-years times the observed total CFR, $p_x \times CFR$, indicate the group's contribution to CFR under average fertility. A rate effect contribution of each educational pairing x can then be expressed as $p_x \times \left(CFR_x - CFR_{total}\right)$, the group's observed fertility added to or subtracted from the average. This calculation allows for an approximation of each educational pairing group's size and rate effect on cohort fertility.

Parity Progression Approach

We study the extent to which CFR by educational composition can be derived from cross sections or data without union histories. We study parity progression ratios of subpopulations using ever-observed educational pairings. Individuals can appear in more than one subpopulation if they have had more than one unique union

composition by age 47. For each subpopulation x, we condition that the birth of parity k is within the educational pairing x (see Eq. (2)). We compare parity progressions on the basis of all births of parity k to births within unions of the educational pairing *x that defines the group*. The gap between these two parity progression ratios is used to approximate the error in educational composition measures of completed fertility and the bias in this error across educational composition:

$$PPR_{(k,k+1)x} = \frac{parity_{(k+1)x}}{parity_{kx}}. \quad (2)$$

We focus on the female birth cohorts because these give good approximations of CFR within the years for which we have data (e.g., corresponding to ages 18–47), because of comparability to previous research, and because the overarching approach is built on one-sex index cohorts to avoid double counting.

Results

We begin by describing the lifetime exposure by union composition type in the birth cohorts by summarizing the share of person-years spent across union types from age 18 to age 47. Table 1 describes the sample of unions by educational pairing and their exposure. For instance, we observe that the low incidence of basic education (corresponding to ISCED 1 and 2) results in very low lifetime exposure to such unions in the population at large. The total time in the union of a given educational pairing is, of course, the sum of many underlying factors, from the share of individuals with a given education (educational level of men and women) and their assortative mating to the timing of union formation and dissolution. After describing the distribution of the time in unions in which people spend their time, we analyze the results of birth rates within these unions. Further descriptive statistics on unions are shown in Tables A1–A3.

Cohort Fertility and Couple Educational Pairing

Specifically, we describe the contribution to CFR by women's and their partners' education. In other words, in the population of Finnish women followed for their entire reproductive life, we focus on unions, not individuals, as the unit of analysis for which we estimate aggregate fertility measures. Panel a of Figure 1 shows that out of all lifetime births to the cohorts born in 1960–1975, the most common union to give birth in is the homogamous union in which both partners have tertiary education (29.4%; panel b provides the corresponding age-specific rates, for reference). Slightly less than one third of CFR is due to births in such unions. The contribution to CFR of this modal union form is followed by homogamy in which both have medium education (20.9%) and next by hypogamy in which the woman has tertiary education and the man medium education (19.7%). The fourth most common educational union context of birth, corresponding to about 7% of CFR, is hypergamous unions in which the woman has medium and the man has tertiary education. All

Table 1 Descriptive statistics of unique couples among Finnish women born in 1969–1975, at ages 18–47

	Exposure to Unions by Educational Pairing	
	% of Person-years in Union	% of Person-years Total
She high – He high	32	20
She high – He medium	22	13
She high – He basic	4	3
She medium – He high	8	5
She basic – He high	1	0
She medium – He medium	21	13
She medium – He basic	6	4
She basic – He medium	4	2
She basic – He basic	2	1
Single	—	39
Total	100	100
	Educational Level at Age 45	
	Women	Men
Basic	6.1	13.0
Medium	36.2	48.5
High	57.7	38.5

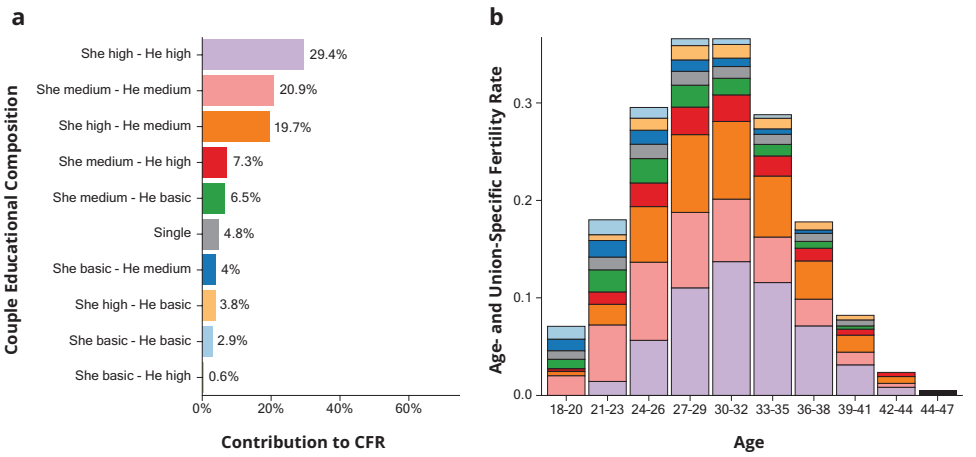

Fig. 1 (a) Contribution to completed cohort fertility rate (CFR) by age 47 of Finnish women born in 1969–1975 and (b) age-specific contribution to CFR, both by couple educational composition

other educational pairings are combinations in which at least one partner has a low education or births to single women. Figure A1 further shows the "single" category for women of basic, medium, and high education (0.0%, 2.4%, and 1.8%, respectively). A closer inspection of when these births occur shows, in agreement with previous research, that highly (low) educated union births are overrepresented in later (early) ages.

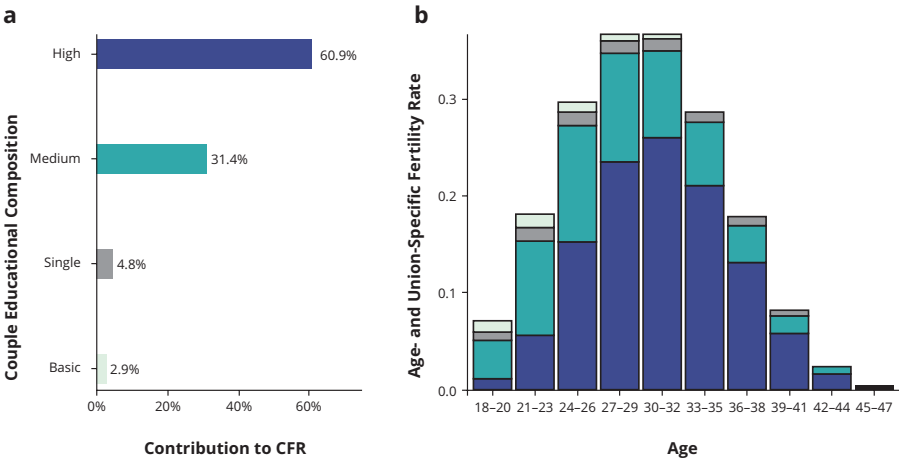

Fig. 2 (a) Contribution to completed cohort fertility rate (CFR) by age 47 of Finnish women born in 1969–1975 and (b) age-specific contribution to CFR, both by highest level of education in union

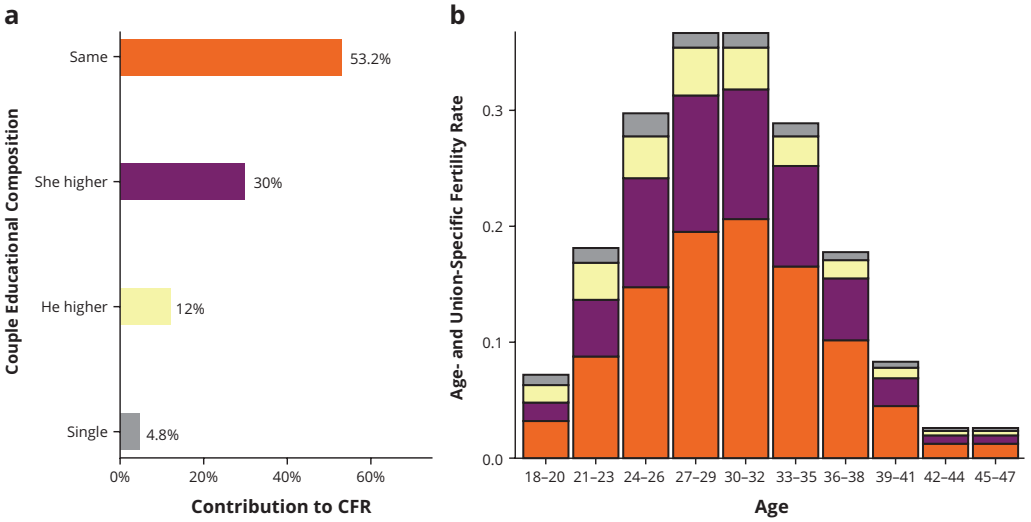

Fig. 3 (a) Contribution to completed cohort fertility rate (CFR) by age 47 of Finnish women born in 1969–1975 and (b) age-specific contribution to CFR, both by simplified couple educational composition

Figures 2 and 3 collapse the results of Figure 1 to ease interpretation. Panel a of Figure 2 shows that about two thirds of CFR is due to births in unions with at least one tertiary-educated partner. About one third of the CFR contribution is due to births in unions in which the highest educational level of at least one spouse is medium education. Three percent of births are to couples that both have low education. This finding reflects the low prevalence of men and, in particular, women with low education and also likely reflects the documented high childlessness among men with low education and the instability of unions in which couples have low education. Panel a of Figure 3 shows that more than half of births are to homogamous unions, a third

to unions in which the woman is more highly educated, and only 12% to unions in which the man is more highly educated. About 5% of cohort fertility is due to births of women not coresiding with a partner. Thus, regardless of sorting single births within a low, medium, or highly educated composition, we would see the same educational assortative pattern of births with respect to CFR.

One important decision when using educational level as a stratifying variable is the time of measurement, which is particularly poignant when considering the educational composition of unions. In the Data and Methods section, we concluded that it was reasonable to consider the highest educational level observed within the given union. How much does this decision impact results in comparison to other options? Column a in Table 2 represents our preferred estimate. Column b measures education at the time of the first union-specific birth. For unions without a birth, it uses the highest observed educational level. This measure aims to capture the educational environment into which a child is born. Column c uses the final observed educational levels of both partners, regardless of union dynamics. It assumes that educational outcomes are endogenous to childbearing and aligns with how many data sources measure education—typically after age 40. Column d captures fully yearly time-varying union composition. It assumes that education at that time influences fertility, independent of the partners' educational trajectories.

The order ranking between educational compositions in terms of contribution to CFR stays the same for the first five groups, which are dominant in that they comprise well more than 70% of CFR. The magnitude of these groups stays roughly the same across measurement types. The "she high—he high" category varies between panels c and b, by about five percentage points. For the smaller groups, we see a rank order shift, but these are due to very small differentials in group contributions to CFR; the group most sensitive to measurement is "she basic—he basic," ranging between 1.9% and 4.2%. Given that the definitions of when to measure educational composition are very different, we argue that the general picture we provide in our preferred model is robust to different educational composition measurement definitions, although these must be chosen wisely. Substantively, this speaks to two things. First, there is some degree of endogeneity between the education of partners and the education at the time of birth. Second, because education can only change upward over the life course owing to educational upgrading, the pairings involving low-educated partners are the most sensitive to measurement definitions. Third, although educational attainment is a lifelong process, there is not enough movement in terms of education level after the child's birth to have a substantive influence on the specific measurements in this study.

Rate and Size Effects in the Contribution to CFR by Educational Composition

To what extent are the contributions to CFR in different educational compositions the result of the share (size) and person-years of such unions, and to what extent are they due to differential levels of fertility? Figure 4 depicts the weighted contribution of each group size and rate effect to the total in the union cohort fertility. This representation gives a good idea of what this group would contribute if it had an average fertility of person-years within unions and how the group's fertility adds to or subtracts

Table 2 Contribution to completed cohort fertility rate by age 47 of Finnish women born in 1969–1975 by time of measurement of couple educational composition

	Time of Measurement of Couple Educational Composition (%)							
Rank	(a) Last Observation of Union		(b) Time of Birth[a]		(c) Age 45		(d) Every Year	
1	She high – He high	29.4	She high – He high	24.9	She high – He high	29.8	She high – He high	25.9
2	She medium – He medium	20.9	She medium – He medium	22.0	She medium – He medium	21.3	She medium – He medium	20.9
3	She high – He medium	19.7	She high – He medium	18.5	She high – He medium	20.5	She high – He medium	18.3
4	She medium – He high	7.3	She medium – He high	7.9	She medium – He high	7.2	She medium – He high	7.8
5	She medium – He basic	6.5	She medium – He basic	7.3	She medium – He basic	6.9	She medium – He basic	6.9
6	Single	4.8	She basic – He medium	5.7	Single	4.8	She basic – He medium	5.9
7	She basic – He medium	4.0	Single	4.8	She basic – He medium	4.1	Single	4.8
8	She high – He basic	3.8	She basic – He basic	4.2	She high – He basic	3.0	She basic – He basic	4.4
9	She basic – He basic	2.9	She high – He basic	3.9	She basic – He basic	1.9	She high – He basic	3.9
10	She basic – He high	0.6	She basic – He high	0.9	She basic – He high	0.5	She basic – He high	1.1

[a] Education measured in year of first union-specific childbirth or at last observation point of the union if no childbirth within union.

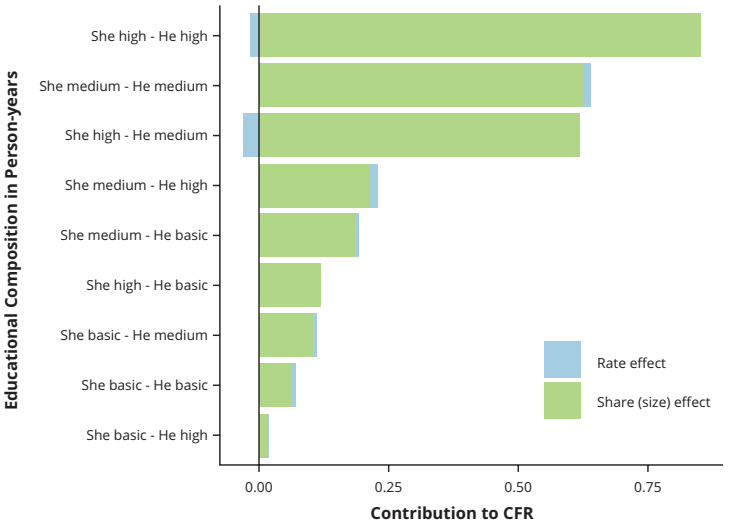

Fig. 4 Rate and size effects of the contribution to completed cohort fertility rate (CFR) by couples' educational pairing

from this size effect. We see that group size maps the rank order of contribution. Unions in which women have high education, regardless of whether the partner has high, medium, or basic education, have an adverse rate effect, meaning that their fertility level decreases cohort fertility. Although rate effect differences between these unions are small, the negative rate effect is largest among hypogamous unions with a high-educated woman and a medium-educated man. However, this negative effect is rather minuscule compared with the size effects of these large groups. Likewise, among union types with positive rate effects, size effects dominate entirely the influence of educational composition; the cohort fertility differential between educational groups is a minor factor.

Differentials in Cohort Fertility by Couple Educational Pairing by the Highest Attained Educational Level

It is common to measure cohort fertility by the individuals' highest attained educational level. In Figure 5, we apply the same approach but consider the couple's educational pairing by incorporating information on the partner's highest attained educational level. We differentiate the CFR of each subgroup of women by their highest level of education (low, medium, or high) by births to partners of any educational level. For partners, the educational level represents the highest level observed while in union with the index person. Among women with basic education, cohort fertility (1.89) is rarely due to births with highly educated partners (7.2%). As much as 16.6% of CFR is due to births outside unions; the corresponding shares are 8.5% and 4.2% for the medium- and high-educated subpopulations. About a third of the CFR of low-educated women is due to low-educated men, and 43.7%, the modal, to medium-educated men. For medium-educated women (CFR = 1.94), births to medium-educated men are the

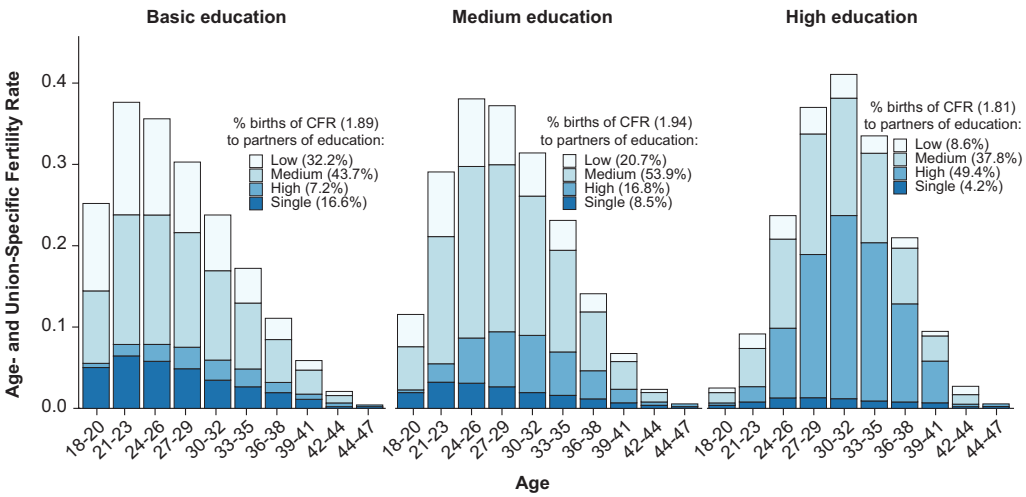

Fig. 5 Completed cohort fertility rate (CFR) by age 47 of Finnish women born in 1969–1975 by highest level of education of the woman, according to partner's low, medium, or high education during the union. Percentage totals vary on the margin because of rounding.

modal form. Among women with high education cohort fertility (1.81), the proportion of births occurring with partners with basic education is very small (8.6%); among these women, the modal form is homogamy, with births to highly educated partners making up 49.4% of CFR, which stands out in comparison to the other educational subpopulations.

Cohort Parity Progressions and Couple Educational Pairing

Next, we study the feasibility of drawing on cross-sectional data to infer CFR by educational composition. This aspect is important to assess because for many countries, union histories with partner-specific education are not available. For example, in the two previous studies that considered the influence of educational pairing on CFR, exposure time to unions of different educational attainment does not vary between individuals, and union composition is defined by the union composition at the cross section around the time of completed fertility (Bagavos 2017; Monteiro da Silva et al. 2022). The research design of these studies makes the assumption that union composition at the time of measurement roughly captures the union composition at earlier time points in childbearing ages. Furthermore, in instances where the approximated educational composition of CFR with some average degree of error is acceptable, the feasibility would depend on whether this error is biased across educational compositional groups. Figure 6 shows parity progressions for women who have ever been observed in a given educational composition, separately for each such education composition. Two estimates of parity progressions are shown. The first estimate takes only the (parity-specific) birth to the defining union composition as the numerator. The second estimate takes the (parity-specific) birth regardless of which union composition it occurs in. The percentage difference between these two parity progression

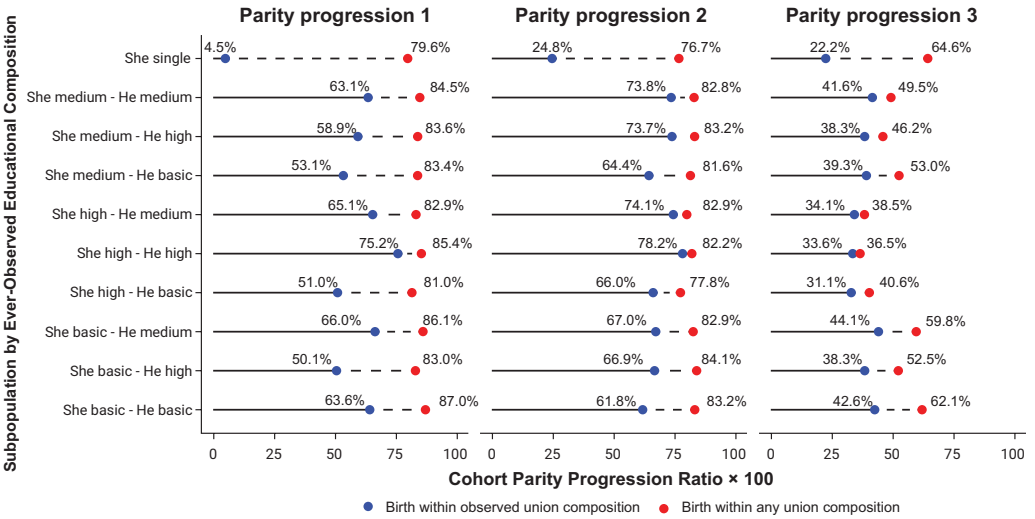

Fig. 6 Cohort parity progressions 1, 2, and 3 expressed in percentages by age 47 of Finnish women born in 1969–1975 and ever observed in a union of a given educational pairing. Parity progressions by any birth (red) and by birth within the union composition that defines the subpopulation (blue). Parity progressions 2 and 3 are conditioned on a preceding birth within the union composition that defines the subpopulation.

estimates gives an idea of how much educational composition–specific CFR can differ given how educational composition is measured, and how it differs across subpopulations ever observed in a given educational composition.

Second and third parity progressions would be erroneously inferred if based on cross-sectional data on educational composition. The bias is particularly large for couples with basic education and decreases at higher levels of educational compositions.

Discussion

Educational disparities in lifetime cohort fertility are a cornerstone in the discourse regarding fertility dynamics. Despite the advantages of knowing the educational level of partners, such knowledge is rarely applied to studies of cohort fertility. In particular, although a host of studies have estimated conditional probabilities of specific birth transitions (e.g., hazard rates), none has taken a population perspective to examine how the sum of childbearing patterns results in patterns of completed fertility by educational pairing. In employing Finnish register data, this study has delved into the relationship between the educational pairing of couples and cohort fertility. We conducted a comprehensive analysis of cohort fertility rates of seven female birth cohorts (1969–1975) disaggregated across the educational pairing of their unions across the life course.

We focused on four questions: How is CFR composed of births in different couples' educational pairings? How is cohort fertility by educational composition related to patterns of union composition, such as the degree of educational human capital within the couple and whether the union is hypogamous, hypergamous, or

homogamous? What is the educational composition context of births for women who attain basic, medium, and high education by age 45? Finally, we also assessed how feasible it is to use cohort fertility rates (a reference to the sum of individual lifetime fertility) by educational pairing (a time-variant and couple-level feature).

From our findings, it can be concluded, unambiguously and for the first time, that in the most recent cohorts who completed their childbearing in Finland, the majority of all lifetime fertility is due to births that take place in unions that are homogamous or hypogamous and in unions in which at least one partner has a tertiary education. Thus, previous research that spoke of the "end of hypergamy" by looking at cross sections of the prevalence of assortative mating and the instantaneous risk of parity progression is here vindicated from the perspective of lifetime fertility measures such as CFR (e.g., Esteve et al. 2016). The usefulness of the cohort approach to fertility by union composition is exemplified in our analysis, which contrasts subpopulations of women by their highest educational attainment.

Whereas previous research produced measures of the instantaneous risk of birth transitions by union composition, the final fertility achieved at a population level depends on far more factors, including education group sizes, union stability, multipartner fertility, and the composition of populations reaching a specific parity, as well as (re)partnering by education across the life course. To this end, we have presented a palpable summary measure. We show, for example, that the share of CFR from births with highly educated partners among basic-educated women is about the same as the share of CFR from births to basic-educated partners among highly educated women (7.2% and 8.6%, respectively). Moreover, we find that the educational pairings' share of the CFR hinges mainly on the distribution of unions, hence it is largely driven by differences in the proportion of educational pairings and the differential duration of the unions in the population, whereas rate differences in childbearing across educational pairings are negligible. Interestingly, this implies that single women with basic education contribute 0% to completed cohort fertility because the proportion of single women in the population is so small, even though the share of single births to the CFR of basic-educated women is four times higher (16.6%) than that of tertiary-educated women (4.2%) and twice as high as that of medium-educated women (8.5%). These estimates, and others presented earlier, provide a new quantification of how educational assortative behavior and population educational pairing, including time spent in each union type, translated into cohort fertility. Interestingly, the negligible birth rate differences of various educational pairings we find when decomposing the CFR indicate that the (parity-specific) educational pairing birth rate differences presented in prior studies using event-history methods may hinge on variation in union stability of the educational pairings to a larger extent than previously acknowledged. Studying how differences in relationship stability by education pairing contribute to variation in their (parity-specific) birth rates could be fruitful for future research.

Moreover, this population perspective provides an insight into children's family background at birth. Results clearly indicate that most children are born to couples with at least one tertiary-educated partner, a finding that is robust to different measurements of couples' educational composition. This result, combined with the fact that the tertiary-educated represent the largest group in the Finnish context, may imply growing inequalities in terms of social reproduction. Eventually, the number of children born to basic-educated partners will become fewer and fewer over the

generations, potentially leading to their social marginalization and growing social vulnerability.

We also find that only 12% of births in this 1969–1975 birth cohort occur in hypergamous unions, in which the man is more educated than the woman. This finding is remarkable and calls for future investigations into how this proportion has shifted from prior generations. Furthermore, maternal education is consequential for children's gender attitudes (Cano and Hofmeister 2023), although less is known about parental educational pairings and offspring's gender attitudes. It is interesting to consider what growing up predominantly with parents who are gender equal in educational level or where mom is better educated than dad may imply for gender attitudes and gendered behaviors of this generation of children, who are now in their adolescence or young adulthood. Our study, however, is limited because it does not consider child outcomes and does not investigate family background components beyond the education of the families in which these children were born and raised. To this aim, future studies would need to include additional measures of couples' resources (e.g., income) and provide population estimates of parental and infant mortality, couples' dissolution, educational transitions, and repartnering, processes that may alter the combined characteristics of the parents as children become older (Mare and Schwartz 2006). Despite this limitation, the main contribution of our study has been to complement the individual-level and hypothesis-testing approach, which dominates the literature on educational pairing and fertility, with a population perspective.

An auxiliary goal was to consider the best use of cohort measures that account for educational pairing. Individuals are exposed to the risk of birth in multiple unions across the life course. Therefore, measures of CFR of women decomposed by their and their partners' education reflect CFR as the aggregate of (women's) unions rather than the aggregate of individual women. Although this is an innate feature of the measure, in principle, the lifetime births of a woman's observed unions may equal the lifetime births of that woman. We quantified the extent of the discrepancy. We find that measures that incorporate educational pairings do not adequately approximate individuals' CFR unless conditioned on first births, particularly not for women of low educational level or women who have partnered with a man of low education. Although births outside of unions are marginal regarding their impact on population-level CFR, we find that births outside of unions are nonnegligible to cohort fertility in subpopulations such as the lowest educated category. This finding suggests that CFR measures accounting for educational pairings would benefit from being extended to reproductive partners regardless of union status. It also suggests that inequalities in reproductive experiences are even larger than previously acknowledged: not only do low-educated women experience childbirth most often without a partner by their side, but they also, on average, reproduce with partners who have much less human capital than medium- or high-educated women. Future population-level research into such "reproductive vulnerability" and its consequences for parents and children is needed.

These findings are based on the Finnish context, which is characterized by a high share of tertiary-educated people and a less gendered association between fertility and education. Our results align with previous studies on Finland based on individual-level cohort measures showing a polarization of fertility behaviors between individuals with tertiary education and those with less education (Jalovaara et al. 2022). This polarization is also observed when focusing on educational pairings. A key role is

played by partnership dynamics, such as lower union prevalence due to higher instability rates among low-educated individuals (Jalovaara and Andersson 2023).

Our decomposition of the contributions to total CFR in size and rate effects shows that size effects dominate while differential fertility across pairings plays a smaller role in the Finnish context. In other contexts, lower educated individuals are increasingly facing difficulties in finding a partner (Sturm and Van Bavel 2024), a situation exacerbated by structural constraints, entailing a smaller pool of similarly educated individuals to form homogamous unions (Trimarchi et al. 2024). Moreover, for more recent cohorts, there is evidence that the educational gradient in couples' dissolution is turning negative (Matysiak et al. 2014), contributing to higher levels of stepfamily formation among the lower educated in educationally heterogamous constellations (Trimarchi and Toulemon 2025). At varying paces, these trends in partnership dynamics are increasingly being observed across Europe. Still, countries vary in their educational pairing distribution, gender relations, and the education–fertility association. It is reasonable to expect similar patterns to those observed in Finland in other Nordic countries, which are characterized by significant educational expansion, an early reversal of the gender gap in education (Van Bavel 2012), and a shift of the educational gradient in fertility (Jalovaara et al. 2019). However, it is less likely that the findings from Finland can be generalized to Southern, Central, or Eastern Europe, where educational expansion has been relatively slower and the educational gradient in cohort fertility remains predominantly negative (Wood et al. 2014).

This study charts possibilities for cohort fertility analyses that attend to educational pairing and does so for a single country. Further studies could broaden to comparative work (e.g., with country-level variability of the rates of separation and repartnering, gender relations, and welfare regimes) or other forms of couple characteristics and other forms of measures of human capital than educational level. Most importantly, our findings support the possibility of novel perspectives on couple composition fertility from a population perspective. By curating existing sources for cohort analyses and as data emerge from younger cohorts who exit their reproductive years, analyses of the type demonstrated here can illustrate a bird's-eye perspective on how educational expansion, the reversal in the educational gender gap, and differential fertility play out across the life course. ■

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Author Contributions All authors contributed equally to this manuscript.

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