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Worldwide Census Data Reveal Prevalence of Educational Homogamy and Its Effect on Childlessness

Susanne Huber and Martin Fieder*

Department of Anthropology, University of Vienna, Vienna, Austria

In a former study based on US census data, we found that educational homogamy is common and reduces the odds to remain childless. This study takes the next step and examines the prevalence of educational homogamy and its association with childlessness as well as the number of children on a worldwide basis. We analyzed census data from 41 different countries encompassing a total of 2,179,736 married women. In all investigated countries, the prevalence of educational homogamy is high. Furthermore, educational homogamy is not associated with a woman's average number of children, which generally increases with decreasing education. This is not the case as regards childlessness, however, which is usually reduced by a combination of moderate female hypergamy and homogamy. We conclude that educational homogamy is a universal phenomenon. We discuss that, together with its effects on childlessness, this may have consequences going beyond the individual to include the level of society and population genetics.

Keywords: homogamy, reproduction, education, hypergamy, childlessness, number children

Edited by:
Lee Ellis,
Retired (formerly affiliated with the University of Malaya, Malaysia)

Reviewed by:
Danielle Sulikowski,
Charles Sturt University, Australia
Anthony Wells Hoskin,
Idaho State University, USA

****Correspondence:***
Susanne Huber
susanne.huber@univie.ac.at

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INTRODUCTION

Homogamy, also known as assortative mating, refers to mating based on similarity of characteristics. Already in 1903, assortative mating had first been reported, analyzing correlations in height between spouses (Pearson, 1903). Since then, homogamy has been shown for a great variety of traits including ethnicity, age, religious background, educational attainment, physical characteristics such as height, or weight, personality traits, or psychiatric conditions (e.g., Merikangas, 1982; Mascie-Taylor, 1988; Susanne and Lepage, 1988; Qian, 1998; Penton-Voak et al., 1999; Bisin et al., 2004; Schwartz and Mare, 2005; Speakman et al., 2007).

Homogamy based on education is particularly relevant because it concerns many areas of life, primarily status, and income but also lifestyle, taste, and values (Kalmijn, 1991). Studies differ as regards the degree and trends of educational homogamy (Birkelund and Heldal, 2003; Halpin and Chan, 2003; Schwartz and Mare, 2005; Domański and Przybysz, 2007). In the US, for instance, Fu and Heaton (2008) report a slightly declining trend for educational homogamy between 1980 and 2000, being more pronounced in the best and least educated than those with intermediate education.

Although educational homogamy has been widely investigated, and it is broadly recognized that education is negatively associated with average fertility (Kravdal and Rindfuss, 2008; Skirbekk, 2008) with a stronger depressing effect of higher education on reproductive outcome found in women than in men (Skirbekk, 2008), only few studies are available on the association between educational homogamy and reproductive success. In a former study, we examined the effects of educational homogamy on reproduction by analyzing US-census data. We found that educational homogamy reduced the odds to remain childless, but there was no effect on average number of children (Huber and Fieder, 2011). Based on these findings, the present study examines educational homogamy on a worldwide basis by analyzing census data from 41 different countries. In addition to examining the prevalence of educational homogamy, we analyze whether the association between educational homogamy and childlessness is also present on a global level and whether any association between educational homogamy and the number of children exists.

MATERIALS AND METHODS

We used census data from 41 countries provided by IPUMS International[1] (Table S1 in Supplementary Material). We used the most recent census data available for each country (encompassing 1990–2011) and only included a census in the analysis if sample size is at least 10,000. We used the data of a total of 2,179,736 married women aged between 46 and 50 years (who have thus completed or almost completed reproduction), and for whom spouse's characteristics were provided. Spouse's characteristics had been associated by IPUMS International on basis of presence in the same household. We therefore do not know whether the spouse is the biological father of the woman's children.

We included the following variables in the analyses: census identifier of the samples (an eight digit number); age of the women in years; highest educational attainment (internationally homogenized by IPUMS International) of the woman and her spouse encoded as E1 = less than primary completed, E2 = primary completed, E3 = secondary completed, and E4 = university completed; the women's total number of biological children; as well as the women's childlessness (encoded as 0 = childless, 1 = one or more biological children).

For each possible combination of a woman's and her spouse's educational category, totaling the following 16 combinations (E1:E1, E1:E2, E1:E3, E1:E4, E2:E1, E2:E2, E2:E3, E2:E4, E3:E1, E3:E2, E3:E3, E3:E4, E4:E1, E4:E2, E4:E3, and E4:E4) that yielded a sample size of ≥10 (to test the robustness of our results, additionally, we performed analyses where we only included combinations that yielded a sample size of ≥100 and ≥500, respectively), we calculated (i) mean number of children, and (ii) percentage of childless women. We analysed the prevalence of educational homogamy on the basis of sample sizes per woman's educational category by counting (i) the number and percentage of censuses where samples sizes for each woman's educational category are highest in homogamous couples (i.e., same educational category in woman and her spouse), and (ii) the number and percentage of censuses where sample sizes are lowest in most heterogamous couples (i.e., spouse's educational category is two or three categories above or below the woman's). We further counted the number of censuses for each combination of women's and spouse's educational categories where (i) mean number of children, and (ii) percentage of childlessness are maximum and minimum, respectively. In addition, for each woman's educational category, we calculated a separate generalized mixed model (GLMM) for (a) developed countries and (b) non-developed countries (see Table S1 in Supplementary Material), in each case regressing the woman's age and her spouse's educational category on (i) the women's number of children, based on a Poisson error structure, and (ii) women's childlessness, based on a binomial error structure, using glmmPQL from the MASS library[2] in R 3.1.3. We performed all analyses per woman's educational category and used the combination of the respective woman's education and lowest spouse's education as reference.

[1] https://international.ipums.org/international/

RESULTS

We find a very high prevalence of educational homogamy in all investigated countries irrespective of the women's education (Table S1 in Supplementary Material). In almost all censuses, peak sample sizes occurred in homogamous and minimum sample sizes in the most heterogamous mating patterns, particularly in the highest and lowest educated women (**Table 1**).

As is the case in the US sample, educational homogamy has no effect on a woman's average number of children. With the exception of highly educated women from developed countries, generally, the mean number of children rises both with decreasing woman's and her spouse's educational attainment. The highest average number of children in censuses (with one exception) occurs in the least educated women (i.e., educational category E1), and in most censuses (28 from a total of 38) if both spouses have the lowest education (Table S1 in Supplementary Material). The lowest average number of children, on the other hand, occurs in most censuses (35 from a total of 40) in the highest educated women (i.e., educational category E4), and in 22 of 39 censuses if both spouses are of educational category E4 (note that the total number of census varies because educational

[2] https://cran.r-project.org/web/packages/MASS/MASS.pdf

TABLE 1 | Number and percentage of censuses with (a) the highest sample sizes per woman's educational category found in homogamously and (b) the lowest samples sizes per woman's educational category found in the most heterogamously mated couples (sample sizes for each census see Table S1 in Supplementary Material).

Woman's education: spouse's education (homogamous mating)	Number (%) of censuses with highest sample size found in homogamously mated couples
E1:E1	36 (94.7%)
E2:E2	36 (87.8%)
E3:E3	37 (90.2%)
E4:E4	40 (97.6%)
Woman's education: spouse's education (most heterogamous mating)	**Number (%) of censuses with lowest sample size found in most heterogamously mated couples**
E1:E4	37 (97.4%)
E2:E4	33 (80.5%)
E3:E1	33 (86.8%)
E4:E1/E2[a]	35 (85.4%)

[a] *In countries without E1.*

TABLE 2 | Number of censuses with maximum and minimum mean number of children, respectively, for each combination of women's and spouse's educational categories (only included if more than two spouse's categories per woman's category yielded $n \geq 10$).

Women' education	E1		E2		E3		E4	
	Number of censuses with max/min mean number of children							
Spouse's education	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
E1	28	1	36	1	28	4	12	4
E2	7	0	5	1	9	2	9	2
E3	3	7	0	3	2	3	4	3
E4	1	22	0	32	1	26	5	9

Mean number of children for each census see Table S1 in Supplementary Material.

category E1 does not exist in each census). Moreover, within a woman's educational category, her average number of children rises with decreasing spouse's education (**Table 2**). In the most highly educated women (i.e., category E4) from some developed (3 of 7) and few non-developed (2 of 34) countries, however, the highest number of children occurs in homogamously married women, i.e., those women married to an equally highly educated spouse (**Table 2**). Nevertheless, in the GLM, a woman's number of children is always significantly lower if she is married to a spouse of any educational category higher than the reference, both in non-developed and developed countries (**Table 3**). This also holds true if we limited the analysis to reproducing individuals, i.e., if we excluded childless individuals from the analysis (data not shown).

A different picture emerged by analyzing the percentage of childless women in relation to their own and their husband's educational attainment (Table S1 in Supplementary Material). Here, the combination of homogamy with moderate female hypergamy has a clear pro-fertile effect (**Table 4**): in most countries and irrespective of the woman's own education, the odds to remain childless is lowest in women married to a slightly higher educated spouse (i.e., if the spouse's educational level is one category above the woman's: E1:E2, E2:E3, E3:E4), whereas the highest risk to remain childless occurs in the most heterogamously mated women (i.e., if the spouse's educational level is two or three categories above or below the woman's: E1:E4, E2:E4, E3:E1, E4:E1). In the highest educated women, hypergamy is not possible. In these women, we find the lowest percentage of childlessness most frequently in homogamously mated women (E4:E4) (**Table 4**). These findings are supported by a GLM, where in non-developed countries, a significantly higher chance to ever reproduce is found in moderately hypergamously married women of educational categories E1 and E2 and in homogamously married women of educational category E2, E3, and E4 than in those women married to a spouse of the lowest educational category E1 (**Table 5**). In developed countries, in women of educational category E2 and E3, childlessness is significantly higher if they are married to a spouse of the highest educational category E4 than the lowest category E1. Conversely, in the highest educated women (E4), childlessness is significantly lower in homogamously married women than those married to spouses of educational category E1.

TABLE 3 | General linear mixed model of a woman's age and the combination of the woman's and her spouse's educational categories on the woman's number of children, based on a Poisson error structure, for (a) non-developed countries ($n = 34$), and (b) developed countries ($n = 7$).

	B	Std. error	*t*-value	*p*-value
(A) NON-DEVELOPED COUNTRIES				
Women E1				
Age	0.0058	0.0004	14.1962	<0.0001
E1:E2 (ref. E1:E1)	−0.0835	0.0014	−59.0872	<0.0001
E1:E3 (ref. E1:E1)	−0.2080	0.0036	−57.5666	<0.0001
E1:E4 (ref. E1:E1)	−0.2359	0.0096	−24.5285	<0.0001
Residual deviance: 1425207 on 807651 df; NagelKerkes pseudo $R^2 = 3.44E{-}02$				
Women E2				
Age	0.0108	0.0004	24.2217	<0.0001
E2:E2 (ref. E2:E1)	−0.1131	0.0017	−68.2900	<0.0001
E2:E3 (ref. E2:E1)	−0.2179	0.0021	−102.2337	<0.0001
E2:E4 (ref. E2:E1)	−0.3017	0.0040	−76.0007	<0.0001
Residual deviance: 844327 on 714052 df; NagelKerkes pseudo $R^2 = 4.58E{-}02$				
Women E3				
Age	0.0163	0.0005	30.2633	<0.0001
E3:E2 (ref. E3:E1)	−0.0930	0.0044	−21.2110	<0.0001
E3:E3 (ref. E3:E1)	−0.1735	0.0042	−41.2599	<0.0001
E3:E4 (ref. E3:E1)	−0.2278	0.0045	−50.5812	<0.0001
Residual deviance: 484728 on 527037 df; NagelKerkes pseudo $R^2 = 1.28E{-}02$				
Women E4				
Age	0.0155	0.0010	15.3436	<0.0001
E4:E2 (ref. E4:E1)	−0.1249	0.0096	−13.0141	<0.0001
E4:E3 (ref. E4:E1)	−0.1824	0.0091	−20.1339	<0.0001
E4:E4 (ref. E4:E1)	−0.1908	0.0089	−21.4445	<0.0001
Residual deviance: 130146 on 155098 df; NagelKerkes pseudo $R^2 = 4.14E{-}03$				
(B) DEVELOPED COUNTRIES				
Women E2				
Age	0.0152	0.0012	12.2186	<0.0001
E2:E3 (ref. E2:E2)	−0.0775	0.0040	−19.2916	<0.0001
E2:E4 (ref. E2:E2)	−0.0779	0.0100	−7.7706	<0.0001
Residual deviance: 87953 on 91674 df; NagelKerkes pseudo $R^2 = 1.16E{-}02$				
Women E3				
Age	0.0282	0.0009	32.8417	<0.0001
E3:E3 (ref. E3:E2)	−0.0886	0.0034	−26.1744	<0.0001
E3:E4 (ref. E3:E2)	−0.1390	0.0042	−33.4557	<0.0001
Residual deviance: 182610 on 207292 df; NagelKerkes pseudo $R^2 = 1.36E{-}02$				
Women E4				
Age	0.0266	0.0018	15.0935	<0.0001
E4:E3 (ref. E4:E2)	−0.0651	0.0132	−4.9424	<0.0001
E4:E4 (ref. E4:E2)	−0.0592	0.0127	−4.6546	<0.0001
Residual deviance: 53618 on 59306 df; NagelKerkes pseudo $R^2 = 4.95E{-}03$				

Relationships as regards number of children as well as childlessness remain unaffected if we only included cells in the analysis that yielded a sample size of ≥100 or ≥500, respectively (data not

TABLE 4 | Number of censuses with minimum and maximum percentage of childlessness, respectively, for each combination of women's and spouse's educational category (only included if more than two spouse's categories per woman's category yielded $n \geq 10$).

Women' education	E1		E2		E3		E4	
	Number of censuses with max/min% childlessness							
Spouse's education	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
E1	6	9	6	13	7	22	2	13
E2	13	1	10	3	13	1	9	2
E3	12	6	16	2	7	7	7	2
E4	12	14	13	16	17	3	14	1

Percentages of childlessness for each census see Table S1 in Supplementary Material.

shown), with the exception of childlessness in higher educated women (i.e., E3 and E4) of developing countries using cells ≥500, as in this case only very few cells remain.

DISCUSSION

Educational homogamy is a universal phenomenon, which is equally ubiquitous in developing and developed countries as well as in women of all educational categories. This finding supports our earlier report based on US census data, also demonstrating a high prevalence of educational homogamy (Huber and Fieder, 2011). The data further emphasize the strong effect of a woman's education on her family size, a finding that is well established in demographic research (e.g., Drèze and Murthi, 2001; Basu, 2002; Kravdal and Rindfuss, 2008; Skirbekk, 2008). Both in developing and developed countries, lower woman's own and her spouses education is associated with a higher number of children. For developing countries, this finding underlines the importance of higher education in order to curtail population growth, whereas for developed countries, it confirms that higher education is associated with lower fertility. Interestingly, the most highly educated women in some developed countries are an exception in having more children if they are married to an equally highly educated spouse.

Only recently, we demonstrated that religious homogamy decreases the chances to remain childless and is also positively associated with a woman's number of children in most but not all analyzed countries, the association strengthening as a woman's education increases (Fieder and Huber, 2016). In that study, where we likewise analyzed worldwide census data together with data form the Wisconsin Longitudinal Study, also educational homogamy was positively associated with number of children. Contrary to the present study, however, educational homogamy was analyzed as a binary variable without considering educational level. If educational level is considered, however, as is the case in the present study, the effect of lower education on the number of children outperforms the effect of educational homogamy.

As regards childlessness, we find a pro-fertile effect of a combination of homogamy and moderate female hypergamy: both in developed and non-developed countries, women married to a one-category-higher educated spouse usually have the lowest risk of childlessness. Only in the most highly educated women, childlessness is rarest if they are in a homogamous marriage. This is probably because these women do not have the option

TABLE 5 | General linear mixed model of a woman's age and the combination of the woman's and her spouse's educational categories on whether the woman has ever reproduced (encoded as 0 = childless, 1 = one or more children), based on a binomial error structure, for (a) non-developed countries (n = 34), and (b) developed countries (n = 7).

	B	Std. error	t-value	p-value
(A) NON-DEVELOPED COUNTRIES				
Women E1				
Age	−0.0823	0.0043	−19.2348	<0.0001
E1:E2 (ref. E1:E1)	0.0956	0.0159	6.0251	<0.0001
E1:E3 (ref. E1:E1)	−0.0077	0.0340	−0.2257	0.8215
E1:E4 (ref. E1:E1)	−0.1262	0.0802	−1.5739	0.1155
DF = 807603; NagelKerkes pseudo R^2 = 7.90E−03				
Women E2				
Age	−0.0309	0.0048	−6.4841	<0.0001
E2:E2 (ref. E2:E1)	0.0724	0.0193	3.7523	0.0002
E2:E3 (ref. E2:E1)	0.1018	0.0233	4.3739	<0.0001
E2:E4 (ref. E2:E1)	−0.0287	0.0391	−0.7328	0.4637
DF = 714003; NagelKerkes pseudo R^2 = 3.32E−03				
Women E3				
Age	−0.0147	0.0041	−3.5346	0.0004
E3:E2 (ref. E3:E1)	0.1021	0.0372	2.7425	0.0061
E3:E3 (ref. E3:E1)	0.0771	0.0355	2.1756	0.0296
E3:E4 (ref. E3:E1)	0.0249	0.0374	0.6642	0.5066
DF = 526987; NagelKerkes pseudo R^2 = 1.23E−03				
Women E4				
Age	−0.0007	0.0066	−0.1050	0.9163
E4:E2 (ref. E4:E1)	0.0699	0.0668	1.0466	0.2953
E4:E3 (ref. E4:E1)	−0.0150	0.0615	−0.2437	0.8075
E4:E4 (ref. E4:E1)	0.1299	0.0608	2.1373	0.0326
DF = 155048; NagelKerkes pseudo R^2 = 1.94E−03				
(B) DEVELOPED COUNTRIES				
Women E2				
(Intercept)	2.1481	0.5346	4.0184	0.0001
Age	0.0184	0.0106	1.7347	0.0828
E2:E3 (ref. E2:E2)	−0.0235	0.0350	−0.6721	0.5015
E2:E4 (ref. E2:E2)	−0.3044	0.0742	−4.1040	<0.0001
DF = 91668; NagelKerkes pseudo R^2 = 5.82E−04				
Women E3				
(Intercept)	2.0903	0.3609	5.7919	<0.0001
Age	0.0149	0.0061	2.4240	0.0154
E3:E3 (ref. E3:E2)	−0.0387	0.0258	−1.5032	0.1328
E3:E4 (ref. E3:E2)	−0.1759	0.0301	−5.8400	<0.0001
DF = 207286; NagelKerkes pseudo R^2 = 4.99E−04				
Women E4				
(Intercept)	1.3365	0.5080	2.6310	0.0085
Age	0.0210	0.0092	2.2765	0.0228
E4:E3 (ref. E4:E2)	−0.0114	0.0713	−0.1600	0.8729
E4:E4 (ref. E4:E2)	0.1821	0.0694	2.6232	0.0087
DF = 59300; NagelKerkes pseudo R^2 = 1.45E−03				

of hypergamous marriage. In contrast, the most heterogamously married women typically have the highest risk of childlessness, again both in developing and developed countries.

These data support our former study based on the US census data, where we also found a clear effect of educational homogamy on the odds to remain childless without an effect on average number of children (Huber and Fieder, 2011). Bauer and Jacob (2010) likewise reported that educationally and occupationally homogamous couples have a higher chance to become parents. Evidence for a pro-fertile effect of educational homogamy also comes from Mascie-Taylor (1986), who reported lower fertility as educational homogamy decreased.

In contrast to our finding, Tsou et al. (2011) found fewer children in reproducing women married to less educated versus equally or more highly educated husbands. If we excluded childless individuals from the analysis, however, our results remain unchanged. So on the whole, our data indicate that the pro-fertile effect of marrying a spouse of lower education on the number of children usually outperforms the effect of homo- and slight hypergamy on increasing the chance to ever reproduce, a finding that holds true for both developed and non-developed countries.

A possible reason for the lower odds of childlessness in moderately hypergamous as well as homogamous couples found in the present study lies in the advantages associated with homogamy and hypergamy. A major advantage of homogamous mating is its stabilizing effect on the marriage. Generally, satisfaction with the partnership is higher in spouses similar to one another, which partly reflects the conformity of the spouses' preferences (Kalmijn, 1991; Weisfeld et al., 1992; Lutz-Zois et al., 2006). Similarity of values and tastes enhances mutual understanding and thus the quality of the partnership. This specifically applies to educational homogamy because education to a large extent determines values and interests (Kalmijn, 1991, 1998). Similarity between spouses therefore fosters marital stability and relationship satisfaction (Weisfeld et al., 1992; Lutz-Zois et al., 2006). Accordingly, several studies have reported more relationship conflicts and hence higher family stress in heterogamous couples, which can also impair the well-being of the children (Heaton and Pratt, 1990; Curtis and Ellison, 2002; Petts and Knoester, 2007). Although religious homogamy seems to be particularly important for marital quality and stability (Call and Heaton, 1997; Myers, 2006), a stabilizing effect is known for educational homogamy as well (Weiss and Willis, 1997). Some argue, though, that marital stability is less a matter of similarity of educational attainment than whether or not spouses are highly or poorly educated (Finnäs, 1997; Charles and Stephens, 2004): the divorce risk is higher if at least one of the spouses is poorly educated (Weiss and Willis, 1997; Kraft and Neimann, 2009).

Status preservation may be another benefit. This holds true particularly for assortative mating with respect to educational attainment and status background (Hillmert, 2013). Historically, homogamy combined with restricted heirship was already a strategy for status preservation. It has, for instance, been described by historical demographers for elite and bourgeois families of Western Europe (MacFarlane, 1986; Johansson, 1987). With respect to the attainment of socioeconomic status, however, hypergamy, i.e., marrying a partner of higher socioeconomic status, expectedly pays off to a higher degree than homogamy, which holds true for both men and women (Dribe and Lundh, 2010). Accordingly, educational hypergamy is associated with higher earnings than educational homogamy, although this effect already emerges prior to marriage, indicating that marital selection rather than an effect of a spouse's education explain later earnings (Dribe and Nystedt, 2013). Hypogamy, in contrast, namely marrying a lower educated partner, is associated with lower earnings, again in both sexes (Dribe and Nystedt, 2013).

Apart from possible effects of the advantages inherent in homo- or hypergamy, the high prevalence of educational homogamy may also be the result of marital selection constrained by local marriage markets. Local marriage markets arise from social segregation caused by non-random interaction among people. Most of our time, we usually interact with people in functional places, such as the neighborhood, school, or workplace (Kalmijn, 1998). These are thus considered to be the three most important local marriage markets (Kalmijn, 1998). As these markets are typically characterized by lower heterogeneity than the overall population, we usually select our partner among people more similar than expected by chance, which particularly applies to educational endogamy due to socializing with classmates (Blackwell, 1998).

In addition to the marriage market structure, marital selection also depends upon individual preference, e.g., for age, socioeconomic status and perspective, or physical attractiveness (Birkelund and Heldal, 2003). The realization of partner preferences, however, still depends upon the available marriage market and the individual "market value." In this regard, mate competition further contributes to assortment of mating, if for example the highly preferred partners mate, leaving the less preferred mating amongst themselves (Courtiol et al., 2010). This holds especially true for educational homogamy. With the increased participation in higher education, education has become an increasingly important prerequisite to acquire social status. In addition, due to the continuous increase in the educational attainment and labor force participation of females, this applies increasingly for men and women, who now both benefit from their spouses resources (Becker, 1973). The result of this competition is that the highly educated and hence most attractive candidates select their partner among those with similar educational attainment, leaving the less educated to mate among themselves (Kalmijn, 1998). This pattern is clearly reflected in our data as well. This phenomenon is not new. Dribe and Lundh (2005) reported that even back in nineteenth century Sweden, mate preferences of landowners left no other alternatives for the landless population than to marry other landless individuals.

On the level of society, educational homogamy is therefore a matter of concern because it may be a major source of social inequality (Smits, 2003). The reason is that highly educated couples will tend to produce highly educated offspring, uneducated ones will tend to have less educated children. Thus, over generations, educational homogamy generates a more diverse and unequal society. Whereas intermarriage is thought to be both a cause and indicator of social openness (Birkelund and Heldal, 2003), fostering more equal distribution of status and wealth within society. Though considering that intermarriages are less harmonious and more likely to end up childless, from a perspective of the individual, consequences of social openness are not necessarily desirable. In any case, because education is strongly associated with prestige and income (U.S. Bureau of the Census, 2000), assortative mating among the highly educated leads to socioeconomic stratification of society (Fu and Heaton, 2008). This leaves fewer opportunities for the less educated (Smits, 2003). Educational homogamy may thus promote social inequality, resulting in less social permeability and thereby increasing segregation of social strata. Importantly, parental education affects educational attainment of the children and also plays a role in their future mate choice, promoting social segregation across generations (Blackwell, 1998; Fu and Heaton, 2008). As Smits (2003) pointed out, the end result is an even more stratified society, in which the upper segment of society consists of couples with two highly educated spouses. This leaves those with less education to mate among themselves: such a double educational disadvantage means these persons are likely to remain in the lower segment of society.

Finally, by reducing the risk of reproductive failure, educational homogamy might even affect individual and population genetics by altering allele frequencies. Even though homogamy *per se* does not alter gene frequencies, the frequency of alleles for which spouses are homogmaous will eventually spread in the population if reproductive failure is more common in heterogamous couples. This could provide a basis for selection to act on, for instance *via* selection against recessive homozygotes (Relethford, 2012).

If homogamy has fitness effects, we may further assume that individuals choose mates also based on genetic similarity. Is there any evidence that phenotypic homogamy is accompanied or at least partially caused by genetic assortment? Guo et al. (2014) only recently pursued this question, arguing that if any phenotypic trait is somehow associated with genetic variation, then some degree of genomic assortment would also be expected. We know of no evidence for an association between education and genetic variation. Nonetheless, overall, by analyzing genome-wide genotype data from the Framington Heart study and the Health Retirement Survey, Guo et al. (2014) found in married couples positive and – to a much lesser extent – also negative genomic assortment based on all available autosomal single-nucleotide polymorphism (SNPs). The positive assortment was in the range of genomic correlation among second cousins. An even higher genetic similarity between spouses has been reported by Domingue et al. (2014). According to Guo et al. (2014), genetic assortment may really occur at a higher level than found in their study. This is because genetic similarity depends upon the magnitude of genetic influence on a certain phenotypic trait (Bereczkei et al., 2002). Furthermore, assortative mating is based on phenotypes that, even if similar, may result from different sets of genes. Although genetic assortment may be adaptive because it augments the number of shared genes (Thiessen and Gregg, 1980; Rushton, 1989), keeping in mind, the potentially negative consequences of inbreeding (Bittles et al., 2002), however, genetically too similar mates should be avoided.

We conclude that educational homogamy is a universal phenomenon that together with its positive effects on childlessness may have consequences on an individual, society, and possibly even population genetics level.

AUTHOR CONTRIBUTIONS

SH wrote the manuscript, MF analyzed the data.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at http://journal.frontiersin.org/article/10.3389/fsoc.2016.00010

REFERENCES

Basu, A. M. (2002). Why does education lead to lower fertility? A critical review of some of the possibilities. *World Dev.* 30, 1779–1790. doi:10.1016/S0305-750X(02)00072-4

Bauer, G., and Jacob, M. (2010). Fertilitätsentscheidungen im Partnerschaftskontext. Eine Analyse der Bedeutung der Bildungskonstellation von Paaren für die Familiengründung anhand des Mikrozensus 1996-2004. *Kolner Z. Soz. Sozpsychol.* 62, 31–60. doi:10.1007/s11577-010-0089-y

Becker, G. S. (1973). A theory of marriage: part I. *J. Polit. Econ.* 81, 813–846. doi:10.1086/260084

Bereczkei, T., Gyuris, P., Koves, P., and Bernath, L. (2002). Homogamy, genetic similarity, and imprinting; parental influence on mate choice preferences. *Pers. Individ. Diff.* 33, 677–690. doi:10.1016/S0191-8869(01)00182-9

Birkelund, G. E., and Heldal, J. (2003). Who marries whom? Educational homogamy in Norway. *Dem. Res.* 8, 1–30. doi:10.4054/DemRes.2003.8.1

Bisin, A., Topa, G., and Verdier, T. (2004). Religious intermarriage and socialization in the United States. *J. Pol. Econ.* 112, 615–664. doi:10.1086/383101

Bittles, A. H., Grant, J. C., Sullivan, S. G., and Hussain, R. (2002). Does inbreeding lead to decreased human fertility? *Ann. Hum. Biol.* 29, 111–130. doi:10.1080/03014460110075657

Blackwell, D. L. (1998). Marital homogamy in the United States: the influence of individual and paternal education. *Soc. Sci. Res.* 27, 159–188. doi:10.1006/ssre.1998.0618

Call, V. R. A., and Heaton, T. B. (1997). Religious influence on marital stability. *J. Sci. Study Relig.* 36, 382–392. doi:10.2307/1387856

Charles, K. K., and Stephens, M. (2004). Job displacement, disability, and divorce. *J. Labor Econ.* 22, 489–522. doi:10.1086/381258

Courtiol, A., Raymond, M., Godelle, B., and Ferdy, J.-B. (2010). Mate choice and human stature: homogamy as a unified framework for understanding mating preferences. *Evolution* 64, 2189–2203. doi:10.1111/j.1558-5646.2010.00985.x

Curtis, K. T., and Ellison, C. G. (2002). Religious heterogamy and marital conflict: findings from the National Survey of Families and Households. *J. Fam. Issues* 23, 551–576. doi:10.1177/0192513X02023004005

Domański, H., and Przybysz, D. (2007). Educational homogamy in 22 European countries. *Eur. Soc.* 9, 495–526. doi:10.1080/14616690701314119

Domingue, B. W., Fletcher, J., Conley, D., and Boardman, J. D. (2014). Genetic and educational assortative mating among US adults. *Proc. Natl. Acad. Sci. U.S.A.* 111, 7996–8000. doi:10.1073/pnas.1321426111

Drèze, J., and Murthi, M. (2001). Fertility, education, and development: evidence from India. *Popul. Dev. Rev.* 27, 33–63. doi:10.1111/j.1728-4457.2001.00033.x

Dribe, M., and Lundh, C. (2005). Finding the right partner: rural homogamy in nineteenth-century Sweden. *Int. Rev. Soc. Hist.* 50, 149–177.

Dribe, M., and Lundh, C. (2010). Marriage choices and social reproduction: the interrelationship between partner selection and intergenerational socioeconomic mobility in 19th-century Sweden. *Dem. Res.* 22, 347–382. doi:10.4054/DemRes.2010.22.14

Dribe, M., and Nystedt, P. (2013). Educational homogamy and gender-specific earnings: Sweden, 1990–2009. *Demography* 50, 1197–1216. doi:10.1007/s13524-012-0188-7

Fieder, M., and Huber, S. (2016). The association between religious homogamy and reproduction. *Proc. R. Soc. Lond. B* 283. doi:10.1098/rspb.2016.0294

Finnäs, F. (1997). Social integration, heterogeneity, and divorce: the case of the Swedish-speaking population in Finland. *Acta Sociol.* 40, 263–277. doi:10.1177/000169939704000303

Fu, X., and Heaton, T. B. (2008). Racial and educational homogamy: 1980 to 2000. *Soc. Perspect.* 51, 735–758. doi:10.1525/sop.2008.51.4.735

Guo, G., Wang, L., Liu, H., and Randall, T. (2014). Genomic assortative mating in marriages in the United States. *PLoS ONE* 9:e112322. doi:10.1371/journal.pone.0112322

Halpin, B., and Chan, T. W. (2003). Educational homogamy in Ireland and Britain: trends and patterns. *Br. J. Soc.* 54, 473–495. doi:10.1080/0007131032000143546

Heaton, T. B., and Pratt, E. L. (1990). The effects of religious homogamy on marital satisfaction and stability. *J. Fam. Issues* 11, 191–207. doi:10.1177/019251390011002005

Hillmert, S. (2013). "Analyzing inter-generational transmissions: from social mobility to social reproduction," in *Class and Stratification Analysis (Comparative Social Research 30)*, ed. G. E.Birkelund (Bingley, UK: Emerald Group Publishing Limited), 131–157.

Huber, S., and Fieder, M. (2011). Educational homogamy lowers the odds of reproductive failure. *PLoS ONE* 6:e22330. doi:10.1371/journal.pone.0022330

IPUMS: Minnesota Population Center. (2015). *Integrated Public Use Microdata Series, International: Version 6.4 [Machine-readable database]*. Minneapolis: University of Minnesota.

Johansson, S. R. (1987). Status anxiety and demographic contraction of privileged populations. *Popul. Dev. Rev.* 13, 439–470. doi:10.2307/1973134

Kalmijn, M. (1991). Status homogamy in the United States. *Am. J. Sociol.* 97, 496–523. doi:10.1086/229786

Kalmijn, M. (1998). Intermarriage and homogamy: causes, patterns, trends. *Annu. Rev. Sociol.* 24, 395–421. doi:10.1146/annurev.soc.24.1.395

Kraft, K., and Neimann, S. (2009). "Impact of educational and religious homogamy on marital stability," in *IZA Discusion Paper No. 4491* Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1493867

Kravdal, Ø., and Rindfuss, R. R. (2008). Changing relationships between education and fertility: a study of women and men born 1940 to 1964. *Am. Soc. Rev.* 73, 854–873. doi:10.1177/000312240807300508

Lutz-Zois, C. J., Bradley, A. C., Mihalik, J. L., and Moorman-Eavers, E. R. (2006). Perceived similarity and relationship success among dating couples: an idiographic approach. *J. Soc. Pers. Rel.* 23, 865–880. doi:10.1177/0265407506068267

MacFarlane, A. (1986). *Marriage and Love in England: Modes of Reproduction, 1300–1840*. New York: Blackwell.

Mascie-Taylor, C. G. (1986). Assortative mating and differential fertility. *Biol. Soc.* 3, 167–170.

Mascie-Taylor, C. G. (1988). "Assortative mating for psychometric characters," in *Human Mating Patterns*, eds C. G.Mascie-Taylor and A. J.Boyce (Cambridge: Cambridge University Press), 61–82.

Merikangas, K. R. (1982). Assortative mating for psychiatric disorders and psychological traits. *Arch. Gen. Psychiatry* 39, 1173–1180. doi:10.1001/archpsyc.1982.04290100043007

Myers, S. M. (2006). Religious homogamy and marital quality: historical and generational patterns, 1980–1997. *J. Marr. Fam.* 68, 292–304. doi:10.1111/j.1741-3737.2006.00253.x

Pearson, K. (1903). Assortative mating in man. *Biometrika* 2, 481–489. doi:10.2307/2331510

Penton-Voak, I. S., Perrett, D. I., and Peirec, J. W. (1999). Computer graphic studies of the role of facial similarity in judgements of attractiveness. *Curr. Psychol.* 18, 104–118. doi:10.1007/s12144-999-1020-4

Petts, R. J., and Knoester, C. (2007). Parents' religious heterogamy and children's well-being. *J. Sci. Study Relig.* 46, 373–389. doi:10.1111/j.1468-5906.2007.00364.x

Qian, Z. (1998). Changes in assortative mating: the impact of age and education, 1970–1990. *Demography* 35, 279–292. doi:10.2307/3004036

Relethford, J. H. (2012). *Human Population Genetics*. Hoboken, NJ: Wiley-Blackwell.

Rushton, J. P. (1989). Genetic similarity theory, human altruism, and group selection. *Behav. Brain Sci.* 12, 503–517. doi:10.1017/S0140525X00057320

Schwartz, C. R., and Mare, R. D. (2005). Trends in educational assortative marriages from 1940 to 2003. *Demography* 42, 621–646. doi:10.1353/dem.2005.0036

Skirbekk, V. (2008). Fertility trends by social status. *Dem. Res.* 18, 145–180. doi:10.4054/DemRes.2008.18.5

Smits, J. (2003). Social closure among the higher educated: trends in educational homogamy in 55 countries. *Soc. Sci. Res.* 32, 251–277. doi:10.1016/S0049-089X(02)00049-2

Speakman, J. R., Djafarian, K., Stewart, J., and Jackson, D. M. (2007). Assortative mating for obesity. *Am. J. Clin. Nutr.* 86, 316–323.

Susanne, C., and Lepage, Y. (1988). "Assortative mating for anthropometric characters," in *Human Mating Patterns*, eds C. G.Mascie-Taylor and A. J.Boyce (Cambridge: Cambridge University Press), 83–99.

Thiessen, D., and Gregg, B. (1980). Human assortative mating and genetic equilibrium: an evolutionary perspective. *Ethol. Sociobiol.* 1, 111–140. doi:10.1016/0162-3095(80)90003-5

Tsou, M.-W., Liu, J.-T., and Hammitt, J. K. (2011). Parental age difference, educational assortative mating and offspring count: evidence from a contemporary population in Taiwan. *Biol. Lett.* 7, 562–566. doi:10.1098/rsbl.2010.1208

U.S. Bureau of the Census. (2000). *Census SF1, Table DP-1 "Profiles of General Demographic Characteristics: 2000"*. Suitland-Silver Hill.

Weisfeld, G. E., Russell, R. J. H., Weisfeld, C. C., and Wells, P. A. (1992). Correlates of satisfaction in British marriages. *Ethol. Sociobiol.* 13, 125–145. doi:10.1016/0162-3095(92)90022-V

Weiss, Y., and Willis, R. J. (1997). Match quality, new information, and marital dissolution. *J. Labor Econ.* 15, S293–S329. doi:10.1086/209864

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