The relationship between mothers' and their daughters' family size emerged in the United States during the 19th century

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Abstract

For more than a century, a key question of the social sciences has been whether daughters' family sizes relate to their mothers' family sizes. Contemporary evidence confirms that, in developed countries, women from larger families indeed tend to have more children themselves. There is considerable doubt, however, whether intergenerational continuity in childbearing constitutes a universal feature of human societies. Based on a large-scale web-harvested collection of online memorials, we show that intergenerational continuity in childbearing in the U.S. emerged only in the first half of the 19th century, paralleling the country's marked fertility decline. Furthermore, we show that statewide differences in intergenerational continuity in childbearing coincide with statewide differences in abortion laws. This suggests that control over individual fertility was a major driver of the emergence of intergenerational continuity in childbearing. This finding suggests that, although intergenerational continuity in childbearing has appeared only relatively recently in the history of humankind, it will eventually become relevant worldwide.

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Daughters from larger families tend to have more children. The earliest study empirically testing *intergenerational continuity in childbearing (ICIC)* dates back more than 120 years and was one of the first applications of the Pearson product-moment correlation coefficient (Pearson, Lee & Bramley 1899). Analysing aristocratic mother–daughter pairs from Great Britain and Ireland, their “unquestionable result [was] that fertility in woman is an inherited character” (Pearson et al. 1899: 286). Since then, ICIC has become a generally accepted, almost self-evident social-demographic tenet. Many recent analyses have confirmed ICIC. More specifically, studies consistently find a correlation between mothers’ and their daughters’ number of children between 0.1 and 0.2 in developed countries in the 20th century (e.g. Beaujouan & Solaz 2019; Murphy 1999, 2013; Murphy & Wang 2001).

Evidently, ICIC has become a widely researched and discussed topic for it being a consequential societal phenomenon that profoundly affects the shape and composition of societies. The reason is that high fertility, which governs the tendency of larger families to reproduce into larger families, is not equally distributed within society (Westoff 1954). The resulting differential fertility has been shown to reinforce inequalities in almost all areas of everyday life, such as life chances and economic growth, ethnic and religious segregation, opinion polarization on conservative values, and even the distribution of rare genetic diseases (Austerlitz & Heyer 1998; de la Croix & Doepke 2003; Mare 1995; Sobotka 2008; Vogl & Freese 2020). To explain ICIC, several theoretical mechanisms have been proposed. These include differences in family values, status transmission affecting opportunity structures, psychological effects of parent–child relations in different positions of the family structure and shared genetic dispositions—the latter of which, however, have lost importance in recent debates (Murphy 2013; Fasang 2015; Fasang & Raab 2014; Booth & Kee 2009; Barber 2000; Rotering 2017; Kohler et al. 1999).

Importantly, research on ICIC has predominantly focused on developed countries with low overall fertility levels and on the last 50 years, repeatedly confirming ICIC. While ICIC has consistently been demonstrated for developed countries with low fertility levels, recent research suggests that ICIC is much lower or even absent in developing countries with higher overall fertility (Fasang 2015; Murphy 2012). These differences between developed and developing countries have questioned the universality of ICIC in human societies. A key argument that reconciles these differences concerns women’s agency in the fertility decision-making process. This argument highlights that agency in the fertility decision-making process is strongly related to the availability of birth control, which provides women with the means to effectively control the number of children they give birth to. Take, for example, a woman who wishes to have three children just like her mother. The availability of sophisticated means of birth control today, such as efficient contraceptives to

prevent or medical abortion to terminate a pregnancy, allows this woman to fulfil her plan by effectively limiting her family size. Placed in a context with less efficient pre- or post-conceptive means (e.g. when conception occurs more naturally), however, that woman's number of children would more likely exceed the preferred number of children and therefore deviate more strongly from her mother's fertility. As contraceptive use in developing countries still remains at rather low levels (Ahmed et al. 2019), the extent of agency in the fertility decision-making process most likely is a key factor in explaining ICIC differences between countries (Murphy & Wang 2001; Murphy 2013).

Research comparing countries in contemporary times suggests that ICIC is low in settings of high fertility and high in settings of low fertility. Importantly though, the countries that show low fertility today did not always do so. In fact, settings of low overall fertility are a comparatively recent phenomenon in human history. This shift from high to low fertility has been termed the “first demographic transition” (Coale 1989) and has been completed by almost all developed countries (Lee 2003; Bongaarts 2009). To illustrate, in the United States, the transition started around 1800 from a total fertility rate of more than six children per woman declining to around three children per woman until 1920 (Hacker 2003; Haines 2008).

Taken together, there are good reasons to assume that ICIC is only a recent social-demographic phenomenon. However, to date, apart from tentative findings of very selective and small samples (see Murphy & Wang 2001), the conjecture that ICIC emerged during the first demographic transition has not been investigated empirically. As such, it is unclear when ICIC emerged and by which speed it evolved during the demographic transition. The most likely reason for this neglect is a lack of data: for the United States, official statistics started to provide the necessary fertility information only in 1933 and the number of children ever born only for birth cohorts of women born after 1918 (Human Fertility Database 2020). Accordingly, basic descriptions of fertility patterns during the first demographic transition remain scarce.

In this study, we comprehensively trace the emergence of ICIC over the entire period of the United States' first demographic transition. To do so, we introduce a unique data set comprising web-harvested information from an online gravesite collection. This data set not only provides a large number of historical memorials for deceased people, but also provides information on the kinship between these memorials. This unique data feature enables us to connect mothers and their daughters and investigate the development of ICIC on a large scale, going back more than 120 years.

Results

Declining Cohort Fertility during the United States' First Demographic Transition

The emergence of ICIC marks a change in fertility behaviour that may be traced based on the number of children women gave birth to (i.e., completed fertility) over a sequence of birth cohorts. Thus, a precondition for a meaningful analysis of ICIC is a valid estimate of the number of children women gave birth to. Figure 1 shows the estimates of completed fertility for one-year birth cohorts based on our data and other estimates from previous research. Our estimate of cohort fertility during the 19th century corroborates previous findings showing an overall trend of decreasing numbers of children born to women during the first demographic transition (Bailey & Hershbein 2018; Festy 1979; Ryder 1986). Besides validating our data, Figure 1 already provides a contribution in two respects. First, previous studies on cohort fertility used five- or ten-year cohort intervals (e.g., Ryder 1986; Festy 1979). By contrast, our large-scale data allow applying one-year cohorts, thus providing an unprecedented temporal granularity. Second, previous completed cohort-fertility estimates only reached back until 1825, with estimates varying substantially between sources. By contrast, we estimate completed cohort fertility for all birth cohorts that could have been born since the declaration of independence of the United States in 1776. We find that our cohort fertility estimates smoothly position between previous estimates. Taken together, Figure 1 contributes to the scarce evidence of the drop in cohort fertility for the *entire period* of the first demographic transition in the US (i.e., converted in historical time from around 1800 to around 1920).

Figure 1. Cohort Fertility for Birth Cohorts 1750 to 1950. Depicted are cohort fertility estimates derived from our data (gravestone data) and from previous research.

Please note that Figure 1 also depicts two limitations of our empirical approach. First, since we determine fertility based on deceased individuals and their deceased children, we may only estimate cohort fertility until around the 1900 birth cohort. The younger the birth cohort, the more likely it is that their offspring is still alive (i.e., not present in our gravestone data), leading to an underestimation of their number of children. Figure 1 signals this in the deviation of our estimate from the other estimates after birth cohort 1900. Second, compared to previous period estimates in 1830 with about seven children per woman, our data seems to underestimate fertility levels (Ajus, Lindgren & Rosling 2015). These differences are most likely due to an underreporting of child mortality (i.e., children not reaching their 5th birthday) in our data. Around 1800, child mortality has been estimated to between 30% and 50% of a birth cohort (Our World in Data 2020). Our data hardly include cases of child mortality during this time. We can think of two reasons why this is the case. First, children dying that young were potentially not given a permanent memorial and are, thus, not included in the online collection of gravestones. Second, descendants that update information on findagrave.com today might simply not know about their ancestor that died at a very young age. Taken together, when interpreting Figure 1, note that the depicted cohort fertility should

be viewed as approximations of family size, and therefore the number of children that grew up together, rather than children ever born.

The Emergence of Intergenerational Continuity in Childbearing

We used the Pearson product-moment correlation coefficient between a woman's number of children and her mother's number of children in a cohort design to investigate the emergence of ICIC over the course of the first demographic transition (Pearson, Lee & Bramley 1899). Specifically, we calculated the correlation for 24 birth cohorts spaced five years for women born between 1780 and 1899.

Figure 2. Intergenerational Continuity in Childbearing for Birth Cohorts 1780 to 1894. Depicted are correlation coefficients for ICIC for birth cohorts of women born between 1795 and 1899. Lines indicate 95%-CI intervals.

The results shown in Figure 2 confirm both, the expectation that ICIC was smallest (around 0.04) at the onset of the first demographic transition (i.e., birth cohorts 1780–1804) and that it was highest (around 0.13) after the first demographic transition (i.e., birth cohorts 1885-1899). In addition, Figure 2 visualizes that between the transition's onset and completion there was a steady, almost linear increase in ICIC. Interestingly, our results suggest that for birth cohorts of as early as 1870, levels of ICIC (i.e., around 0.13) were only slightly below the levels of ICIC consistently reported for modern day societies (i.e., around 0.16, see Murphy & Wang 2001). In addition, ICIC estimates in pre-transitional times in the United States range around what has been documented for developing countries (i.e., between 0.01 and 0.05) in more recent years (Murphy 2012).

Taken together, Figure 2 shows that (a) ICIC was non-existent, or at least much smaller, in the pre-transitional United States and that (b) ICIC consistently increased over the course of the first demographic transition. This provides evidence that ICIC is not a universal feature of human societies but rather a relatively recent phenomenon in human history. We conducted several tests to scrutinize the robustness of this consequential conclusion. We found that it (a) replicates when using the alternative correlation measures of Kendall's τ and Spearman's ρ (see Figure A1), (b) generalizes geographically over all nine census divisions of the United States (see Figure A2), and (c) further speaking to the validity of our data additionally replicates the established finding that first-born daughters show stronger ICIC than later-born daughters (e.g., Jennings, Sullivan & Hacker 2012; Morosow & Kolk 2020; see Figure A3).

The Evolution of Differential Fertility during the First Demographic Transition

So far, we have shown that ICIC increased using the condensed information of correlation coefficients. To more substantively grasp the sorting in childbearing that lies behind them, Figure 3 shows the average number of children within a cohort of women grouped by their mothers' fertility. For cohorts born between 1780 to around 1840 we observed no rank-order stability between a mother's and their daughters' number of children. That is, the number of a mother's children was no strong predictor of the number of the daughter's children (see lines cutting across each other). However, for generations from 1880 onwards, there was almost perfect rank-order stability. That is, daughter's fertility levels were almost perfectly sorted by their mothers' fertility levels (see lines are stapled above each other). Importantly, Figure 3 also highlights that increasing ICIC does *not* mean increasing reproduction of *exact* fertility levels (e.g., women with four children had mothers with four children). Rather, increasing ICIC means the reproduction of relative fertility levels (e.g., women who have comparatively more children than the average had mothers with more children than the average). While overall fertility levels decline over birth cohorts, the predictive power of the mother's number of children for their daughters' number for children gets stronger.

Figure 3. Completed daughters' fertility over time given their mothers' fertility. Plotted is the number of children per woman between 1795 and 1899, as a function of the number of children born to their mothers. Lines depict the groups according to the number of children born to the mother, the x-axis depicts the cohort timeline and the y-axis depicts the average number of children per woman.

Fertility Control as a Driver of Intergenerational Continuity in Childbearing

How may we explain the emergence of ICIC over this historical time? We argue that being able to realize fertility preferences by controlling fertility behaviour has been a main driver of the emergence of ICIC. Contrary to today's times in which fertility may be controlled very effectively using the pill (invented in the 1950s) or latex condoms (invented in 1912), methods available in the first half of the 19th century were essentially the same as in ancient Roman times (e.g., abstinence, reduced frequency of coitus, coitus interruptus, extended breastfeeding, chewing of cotton roots, or the use of linen or skin-based condoms; Collier 2007; Handwerker 1983; Lahey 2014b; Perrin 2001). Importantly though, fertility control does not only include the prevention of pregnancies in the first place but also the prevention of bearing children after a conception. While self-induced abortion (e.g., through herbal remedies, membrane rupture, or curettage) has been used to prevent giving birth ever since (with great risks for the women's lives) the frequency of professional abortions greatly increased from the 1840s onwards (Degler 1980). Numbers are estimated to have risen from one abortion for every 30 live births in 1840 to one for every three to six in the later part

of the 19th century (Mohr 1978; Lahey 2014a; Gordon 1976; Busey 1890). This increase in abortions was countered by a rise in anti-abortion laws starting from the 1830s until the turn of the century (Lahey 2014a, b). Parallel to this, over the second half of the 19th century, especially in the fourth quarter, improvements in pregnancy prevention became available to the public through the spread of vaginal douches, rubber condoms, and increased knowledge of birth control (Collier 2007; Westoff 1954). These more efficient contraceptive methods, however, spread especially by masking their use in the advertising of rubber manufacturers and in black markets, respectively under the counter, because the obscenity laws after the Comstock Act of 1873 made advertising for and circulation of contraceptives illegal (Tone 2000; Engelman 2011; Gamson 1990). Thus, taken together, we argue that first the use of methods of (professional) pregnancy termination instigated the emergence of ICIC and then the uptake of more effective methods of pregnancy prevention further increased and then settled ICIC at levels just below those we see today (Murphy & Wang 2001).

Figure 4. Intergenerational Continuity in Childbearing as a Function of the Variation in Abortion-Law Introduction. Depicted are in a) correlation coefficients for ICIC and in b) predictions of state-based correlation coefficients for ICIC (based on a growth curve model) for birth cohorts of women born between 1795 and 1899. Lines in a) and shades in b) indicate 95%-CI intervals.

To test this argument empirically, we make use of the fact that the U.S. states introduced anti-abortion laws at different points in time. Broadly speaking, states in the Northeast and Midwest have introduced anti-abortion laws earlier than did those in the South and the West (Lahey 2014a). The different timing of abortion laws means that at the same point in time, women in some states had more control over their fertility than those in other states. Specifically, women that lived in those states that introduced abortion laws later had more control over their fertility than those living in states that introduced those laws earlier. This leads to the hypothesis that the later the introduction of abortion laws, the steeper the increase in ICIC. And indeed, a simple test suggests that the state-specific years of abortion law introduction and the state-specific ICIC for all birth

cohorts are positively correlated (Pearson's $r = 0.11$; $p < 0.01$; $n = 759$ combinations of state- and five-year birth cohort subgroups featuring at least 25 cases).

In two additional analytical steps, we sought to grasp the relationship between the timing of abortion laws and the emergence of ICIC more substantively. First, we grouped all observations by early, intermediate, and late introduction of anti-abortion laws (following Lahey 2014a: 492). We then separately plotted ICIC across cohorts for each of these three groups. Figure 4a reveals that for women born between 1820 and 1870 (i.e., when states differed in abortion laws and most effective contraceptives were not yet available), women making fertility choices in the presence of anti-abortion laws (i.e., lower fertility control) showed lower ICIC than women not living under such anti-abortion laws (i.e., higher fertility control). For the cohorts born from 1870 onwards, all women from all states were subject to anti-abortion laws during their fertile windows. This explains why we no longer see differences according to abortion laws for these later cohorts. Nevertheless, the levels of ICIC did not go down again, as for the cohorts from 1870 onwards, more effective methods of pregnancy prevention were becoming increasingly available, gradually replacing pregnancy termination with pregnancy prevention as a means to realize fertility preferences.

Second, we fitted a growth curve model (mixed effects model with cohorts nested in states) in which we tested statistically in a multivariate framework whether state-level ICIC trajectories differed according to when anti-abortion laws were introduced in states (allowing for random intercepts and random slopes of birth cohorts; Likelihood-ratio test against linear model $p < 0.001$). In addition to general positive effects of birth cohort (0.1774 , $p < 0.01$) and anti-abortion law introduction year (0.0016 , $p < 0.001$), we found a negative interaction between the two (-0.0001 , $p < 0.01$). This shows that the effect that differences in the timing of abortion law introduction had on ICIC was especially located at earlier birth cohorts, which then lost importance over time. To illustrate, Figure 4b plots the predicted trajectory of ICIC under the scenario of an early introduction (i.e., 1830) and a late introduction (i.e., 1880) of anti-abortion laws. The figure reveals how states that introduced anti-abortion laws earlier showed lower levels of ICIC at the beginning of the analysis period and then a subsequent increase in ICIC. By contrast, states that introduced anti-abortion laws later showed initially higher levels of ICIC with a much less steep increase afterwards. Importantly, the mixed effects model (underlying Figure 4b) deviates from the simple grouping (underlying Figure 4a) in the sense that it assumes equal weight for all cohort-state observations. This artificially raises the influence of smaller states showing early ICIC (such as Georgia or Tennessee). As such, in the vein of a thought experiment, this analysis suggests that nationwide ICIC in the U.S. (depicted in Figure 2) could have emerged much earlier if there were more or larger states without anti-abortion laws, not restricting fertility control.

Discussion

Based on a unique large-scale dataset of more than 7 million deceased people scraped from an online gravesite collection, we estimated fine-grained cohort-based fertility profiles for the United States spanning more than 120 years. We used these to trace the emergence of ICIC throughout the country's entire first demographic transition. We found that the United States witnessed a steady rise in the correlation between daughters' and their mothers' number of children. This means that the first demographic transition was paralleled by a transition in terms of the intergenerational continuity in childbearing. In the pre-transitional United States, this correlation was rather non-existent, or at least very small and emerged slowly throughout the 19th century. Increasing steadily, it settled at a correlation of around 0.13 for those women giving birth around the turn to the 20th century, just below levels identified in today's developed societies. Temporal covariation in the extent of ICIC and the introduction of anti-abortion laws provided tentative empirical evidence for the importance of fertility control in the emergence of ICIC.

The current study has implications for both social-demographic research on fertility decision-making in general and the use of big data in the social sciences. Traditionally, research on the decision on how many children women give birth to during their lifetime centers on economic arguments, assuming individuals to rationalize in a social vacuum (Becker 1950; Balbo, Mills 2016). In this sense, this study contributes to the growing, only recently formalized field of "social demography". It highlights how important including "the social" (e.g., the behaviour of parents, friends, colleagues, or siblings) is for the scientific explanation of fertility decision-making and demographic change (e.g., Bernardi 2003; Bongaarts & Watkins 1996; Balbo & Barban 2014; Pink 2017). The emergence of ICIC during the first demographic transition shows that the inclusion of "the social" was long overdue, as it had been present during one of the world's greatest transformations and has repercussions for the demographic phenomena studied today.

Generating these insights was only possible based on the unconventional data source of an online gravesite collection and the recent advancements in the computational social sciences. As such, especially for this historical account, where no census, let alone survey information was available, this analysis demonstrates how the modern social data sciences may provide empirical answers to long-standing research questions. Accordingly, this analysis joins the scarce but increasing applications of big data in the social and demographic sciences (e.g., Salganik 2019).

Lastly, the finding that ICIC emerged during the first demographic transition adds the missing piece to the idea that ICIC will most likely also become a feature of current developing countries that have yet to undergo their demographic transition. There is large global interest in developing

countries reducing their fertility levels, especially those of Sub-Saharan Africa. This global interest is illustrated by programs such as the Family Planning 2020 programme, which aims at increasing the use of contraceptives to increase women's autonomy and control in fertility decision-making (FP2020 2019; May 2017; Tsui et al. 2017). Overall, the foreseeable transition from high to low fertility levels, and therefore the transition from low to high ICIC, in developing countries might be comparable to the first demographic transition in the US. However, the speed, at which this transition will unfold, might be much faster. For example, Ethiopia as a forerunner in contraceptive uptake decreased its total fertility rate by one third from 6.4 to 4.3 children per woman within only the last 30 years. Thus, compared to the United States' first demographic transition, a regional distribution of highly effective contraceptives would strongly suggest for a much-accelerated transition. Taken together with the aforementioned, this highlights differential fertility due to ICIC to emerge much more quickly, putting strong pressure on developing countries. A quickly emerging differential fertility alters countries' social-demographic structures, such as their distribution of household sizes, the regional variation in population density, and the consequences for social inequality, necessitating working on these issues in a much shorter time window.

Materials and Methods

Data Source. The data include deceased people based on gravestone information from the United States obtained from the online repository www.findagrave.com – a website that features more than 190 million memorials of deceased people (primarily U.S. residents). The website's content is based on its community's contribution in which users register and then add new or change existing information about memorials. Memorials on findagrave.com usually contain the deceased person's name, a photo of their gravestone, date and place of birth and death, name and place of cemetery, and occasionally a short biography. Importantly, the data additionally contains kinship links (i.e., links to the memorials of family members such as parents, children, spouses, siblings, or half siblings). It is these kinship links that make the data suitable for the study of ICIC. Specifically, from the kinship links "parent" and "child" we can infer the number of children born to a woman and compare this number to the number of children of that woman's mother.

Sample Selection. We departed from a sample of 500,000 randomly scraped memorials. We then scraped all of their kin relations, amounting to additional 691,074 people. These again featured information about yet unknown kin, which made up for another 2,149,211 memorials in the third round. Lastly, then from 5,001,646 new relations, we scraped the subset of child and parent relations, which amounted to 2,663,863 people. In total, our gross sample comprised 5,968,394 people (i.e., distinct memorials) born between the years 1000 a. D. and 2020. These memorials

featured 43,826,567 kin relations between them. In the first step, we restricted the sample to 2,770,477 women. As the data lacked information on gender, we combined the name data with national data on the relative frequency of given names in the population of U.S. births based on Social Security records between 1880 and 2017 (Social Security Administration 2018). People born before 1880 were applied the list of 1880.

Second, we restricted the sample to 738,226 mothers who were born between 1780 and 1899 and who completed their fertile window (i.e., reached the age of 45). The restriction on women who had at least one child was owed to the fact that calculating a woman's number of children by counting the number of kin relations of the type "child" precluded to distinguish between childlessness and missing information about children. The cut-off at 1780 was chosen as those women were closely born after the United States had declared independence in 1776. The cut-off at 1900 followed from the logic that counting the number of children was only meaningful if it was sufficiently likely that none of the children were still alive. As such, the oldest child of a woman born in 1900 would have been 75 in 2020 if that woman had given birth at the end of her fertile window in 1945. However, more probably this woman had her last child ten years earlier, making this child 85 in 2020, an age at which having passed away is common. For this reason, the estimates of the average number of children by birth cohort (as shown in Figure 1) start diverging from previous estimates after 1900.

Thereafter, we restricted the sample to 363,057 women for whom we did not only know their but also their mothers' fertility. The number of women per birth cohort in our data increased over time (with 1,100 cases available for birth cohort 1780, 2,200 cases available for birth cohort 1795, 4,000 for birth cohort 1810, and more than 30,000 cases for each birth cohort after 1870). To ensure sufficient statistical power to estimate correlation measures, we further restricted the sample to those cohorts born from 1795 that featured more than 2,000 mother-daughter dyads. A further reason for this restriction was that data checks showed artefacts in cohorts two of the three preceding five-year cohorts with unexpectedly high shares of mothers and daughters having both only one child (cohort 1780-1784 was unaffected). Taken together, this reduced the final sample to 358,584 women born between 1795 and 1899, based on which the analysis of ICIC was carried out. However, please note that even the sample size in our earliest (and smallest) cohort alone is already greater than the total sample size (i.e., sample size across all cohorts) typically used in previous studies on ICIC, both in historic times and developing countries (e.g., Pearson, Lee & Bramley 1899; Langford & Wilson 1985; Murphy 2012).

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Appendix

Figure A1. Comparison of Measures of Correlation

Figure A2. Intergenerational Continuity in Childbearing across the United States. Estimates with width of 95% confidence intervals larger than 0.25 removed. State-Cohort combinations have a least 25 cases.

Figure A3. Comparison between First-Born and Later-Born Daughters

Data availability

The data reported in this paper are available from the corresponding author upon request.

Code availability

The code reported in this paper are available from the corresponding author upon request.