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Grandparental Effects on Fertility Vary by Lineage in the United Kingdom

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Abstract: Grandparental presence is known to influence the number of grandchildren born, and this effect may vary according to grandparental sex and lineage. However, existing studies of grandparental effects on fertility mostly concern traditional subsistence societies, while evidence from contemporary developed societies is both scarce and mixed. Here, we explore how grandparents affect the transition to second and subsequent children in the contemporary United Kingdom. The longitudinal Millennium Cohort Study (n = 10,295 families) was used to study the association between grandparental investment and parents' probability of having a new child within 4.5 years. Results show that contact with paternal grandparents is associated with higher probability of parents having a second child. In contrast, contact with maternal grandparents is associated with lower probability of having a third or subsequent child. Kin may have opposite effects on fertility even in contemporary societies, which may explain the lack of consistent effects of grandparental investment on fertility in previous studies.

Key words: fertility, genetic relatedness, grandparental investment, Millennium Cohort Study, reproduction, sex-specific reproductive strategies

A consequence of kin selection is that grandparents may increase their inclusive fitness by investing in their children and grandchildren, with whom they are genetically related (Hamilton, 1964). In many societies of the past, and in contemporary traditional societies (i.e. societies with high fertility and high child mortality), the presence of grandparents has been found to improve grandchild survival (e.g. Gibson & Mace, 2005; Lahdenperä, Lummaa, Helle, Tremblay & Russell, 2004; Sear & Mace, 2008; but see Strassmann, 2011). Grandparental presence may also influence parent's age at first birth and the number of children (e.g. Bereczkei, 1998; Lahdenperä et al., 2004; Tymicki, 2004). This study is interested in the associations between grandparental investment and parental fertility in contemporary United Kingdom.

Previous studies show that different types of grandparents may have a different impact on parents' fertility. In a recent review of the fertility benefits associated with the presence of parents and parents-in-law in pre- and post-demographic transition societies (Sear & Coall, 2011), an adult daughter's fertility increased in 7 of 21 cases in the presence of her mother and in 7 of 14 cases in the presence of her father. The presence of a mother-in-law correlated positively with female fertility in 4 of 6 cases and the presence of a father-in-law in 3 of 5 cases. No effect on fertility was observed in 7 of 21 cases for mothers, 4 of 14 cases for fathers, 2 of 6 cases for mothers-in-law and 2 of 5 cases for fathers-in-law. In addition, a mother's presence had a negative effect on her daughter's fertility in several cases. In these studies reproductive success was measured by, for example, a woman's age at first birth, the number of children born, and the length of birth intervals.

Life history theory predicts a trade-off between parental investment in either the offspring "quality" (i.e. child survival, development, health and well-being) or quantity (numbers of children born) (del Giudice & Belsky, 2011; Lawson, Alvergne & Gibson, 2012; Lawson & Mace, 2011). This trade-off can be differently solved depending on parental sex. In species with grandparental care, such as humans, quality-quantity trade-off can also be expected at the level of grandparental investment (Coall, Meier, Hertwig, Wänke & Höpflinger, 2009), i.e. in differential investments depending on the sex of the adult offspring. In the case of daughters, grandparents can be predicted to invest more in quality than quantity, while in the case of sons they may invest more in quantity than quality.

The ultimate reasons for these possible quantity-quality trade-offs between paternal and maternal grandparents stem from humans' sex-specific reproductive strategies and the fact that parents have

genetic relationship only with their own kin (Euler, 2011). Women are usually obliged to invest physiologically more in each infant (Trivers, 1972). Due to paternity uncertainty, women but not men are totally sure the child is genetically their own. Hence, the best reproductive strategy for a woman and her kin is often to maximaze maternal investment for each child born. For males and, by extension, male kin, parental investment is more facultative, and the cost of reproducing rapidly is smaller than for females. Furthermore, maternal grandparents are genetically related to the mother while paternal grandparents are not. The idea of daughter replaceability stresses that it may be more important for maternal grandparents to protect their daughter's and her already born children's health and well-being (i.e. through favouring grandchild quality over quantity). In contrast, paternal grandparents may achieve fitness benefits by, for example, exploiting the fertility of daughters-in-law even at the expense of her and her already born children's health and well-being (Mace & Sear, 2005). Thus, paternal grandparents are expected to increase parents' fertility, while maternal grandparents may even decrease it in some circumstances (Sear & Coall, 2011).

Some studies from pre-modern and traditional societies indirectly support this hypothesis and suggest that investments by matrilineal and patrilineal grandparents have different impacts on reproductive success (Sear & Coall, 2011). Matrilineal grandparents, and especially maternal grandmothers, may improve child survival and well-being but not to necessarily raise fertility (e.g. Sear, Mace & McGregor, 2000). In contrast, the presence of patrilineal grandparents can increase fertility while not improving child survival (e.g. Allal, Sear, Prentice & Mace, 2004; Sear, Mace & McGregor, 2003; see also Voland, 2007; Voland & Beise, 2005). It has even been suggested that paternal grandparents may have increased the fertility of their daughters-in-law at the expense of infant survival in traditional societies (see Voland & Beise, 2005; Leonetti, Nath & Hemam 2005; 2007).

Sex-specific reproductive strategies and paternity uncertainty may also explain the well-known biased grandparental investment pattern (Coall & Hertwig, 2010). Several studies have analysed the biased grandparental investment in modern societies and most studies have found that maternal grandparents usually invest more in their grandchildren than paternal grandparents do, and that grandmothers invest more than grandfathers (e.g., Bishop, Meyer, Schmidt & Grey, 2009; Danielsbacka & Tanskanen, 2012; Danielsbacka, Tanskanen, Jokela, & Rotkirch, 2011; Pollet, Nettle & Nelissen, 2006; 2007; Tanskanen, 2013; Tanskanen, Rotkirch & Danielsbacka, 2011; but

see Kaptjin, Thomese, Liefbroer & Silverstein, 2013; Pashos, 2000). Biased grandparental investment can also be explained by the matrilateral effect, the sex effect, local resource competition, and the older age of paternal than maternal grandparents (see e.g. Euler & Weitzel, 1996; Pashos & McBurney, 2008; Strassmann & Garrard, 2011; Tran, Fisher & Voracek, 2009).

While discriminative grandparental investment has been extensively studied (e.g. Coall, Hilbrand and Hertwig 2014; Tanskanen, Danielsbacka and Rotkirch 2014), fewer studies concern grandparental effects on parents' fertility in modern societies, although the question of kin effects on childbearing has received growing attention in recent years (e.g. Mathews & Sear, 2013a; 2013b). Existing evidence of investment outcomes is both scarce and mixed. Kaptijn, Thomese, van Tilburg and Liefbroer (2010a) studied the association between grandparental child care help and parents' reproductive success in the Netherlands. Grandparents who provided child care assistance to their children were more likely to have at least one more grandchild during a follow-up period of 8–10 years, compared to those who had not provided such help in child care. Maternal grandparents provided more care than did paternal grandparents, but their effect on fertility appeared to be equal, although the sample was too small to permit more detailed analyses of effects by lineage.

Thomese and Liefbroer (2013) also studied the association between grandparental child care support and parents' fertility in the Netherlands. They found that the support from both maternal and paternal grandparents increased parents' likelihood of having another child. In addition, Aassve, Meroni and Pronzato (2012) analysed the association between grandparental child care and parents' fertility using data from 11 European countries, but no correlation between grandparental care and parents' fertility in follow-up period of two years was detected. Waynforth (2011) studied the grandparent effect with a 1970 British Cohort Study and used several grandparental investment variables. Women at 30 who reported closeness to and frequent contact with their own parents displayed an increased probability of having a child during the follow-up period of four years. Similarly, frequent contact with his own parents increased a man's likelihood of having a child. Waynforth did not find any significant association between child care help or financial support from parents and the probability of having an additional child. Neither did he detect any relationship between parents-in-law investment and fertility.

One of the limitations of previous studies is that they did not distinguish between both grandparental sex and lineage. To our knowledge, no study has yet explored the association between grandparental investment and parents' fertility in modern societies with respect to all four grandparental types. Here, we separate grandparents by both sex and lineage, since we are especially interested in whether different types of grandparent have a different impact on child births.

Material and methods

Data

We used data from the British Millennium Cohort Study (MCS), which includes longitudinal information of children born at the beginning of the new millennium in England, Wales, Scotland and Northern Ireland. In the MCS cohort member children are targets and the information is collected by interviewing their parents or parent figures. The main respondents are, in almost all cases, biological mothers of the children (in the first survey wave, all but 37 of the main respondents were biological mothers). Partner respondents are usually the biological fathers of target children or mothers' new partners. In the MCS mothers and fathers are interviewed separately (see Hansen, 2010, for a full MCS description).

The baseline data were derived from the first wave of the MCS (2000–2001, the cohort member children were approximately 9 months old) and follow-up data from the third wave (2006–2007, the children were approximately 5 years old). The time between the first and third wave interviews was approximately 53 months (min. = 43, max. = 64, SD = 3.13).

Families with both biological parents in the same household with the cohort member child were included in the analysis. Families where the mother was over 40 years old were excluded because they were unlikely to have more children. In addition, households including a grandparent living together with their adult child and grandchild(ren) were excluded. This is because such arrangements are highly unusual in contemporary Britain and it is difficult to assess levels of involvement among co-residing kin compared to other families (Attar-Schwartz Tan, Buchanan, Flouri & Griggs, 2009). After these exclusions our sample consisted of 10,295 families.

Parental fertility variable

The dependent variable measures whether parents had additional children during the follow-up period. In both data collection waves, the main respondents reported their number of children, providing data on the birth of new children between the survey waves. The number of children born during the follow-up was categorized into two categories (0 = no new children, 1 = at least one new child). In the sample, 43.9 per cent of families had at least one additional child during the follow-up period. We also ran separate analysis for having a second or having a third or subsequent children.

Grandparental investment variable

The main independent variable is the baseline frequency of grandparental contact. Some have questioned contact frequency as a valid measure of the total amount of grandparental investment (e.g. Michalski & Shackelford, 2005). However, Pollet, Nelissen and Nettle (2009) showed with the first wave of the MCS that contact frequency was positively related to measures of grandparental financial investment. Furthermore, in the case of very young children physical contact between the child's parent and grandparent typically includes the child, and contact between child and grandparent typically include the parent (see Coall & Hertwig, 2010 and responses for discussion). In the MCS, the mother of a target child is asked to report how often she sees her parents (i.e. the child's maternal grandmother and grandfather) and the father is asked how often he sees his parents (i.e. the paternal grandmother and grandfather) by answering on an 8-point scale ranging from "never" to "every day". The contact frequency question is only asked of participants who have the respective parent alive. Grandparental contact was coded as a categorical variable: 0 = Never, 1 = 1–3 times a month or less often, 2 = Once or twice a week, 3 = 3–6 times a week, 4 = Every day. "Never" was chosen as the reference category because we are here focusing on the general effect of grandparental presence or absence in a parent's life.

In the analyses the four grandparent types are separated from each other. This is because different grandparents may have different impact on parental reproductive success (Sear & Coall, 2011; Sear & Mace, 2008) and grandparents may not invest equally in their offspring (see e.g. Coall & Hertwig, 2010; Euler, 2011; Strassmann & Garrard, 2011).

Control variables

Additional control variables included the number of children in the household, the mother's age, educational attainment (measured by National Vocational Qualification, NVQ; a higher level of NVQ level means higher qualification), ethnicity, the parents' combined labour force participation, and the financial situation of the family. Previous studies show that these factors are often associated with fertility (Liefbroer & Corijn, 1999; Rendall, Ekert-Jaffé, Joshi, Lynch, & Mougin, 2009). We controlled for the sex of the first child, which may influence the desire of parents to have more children. In addition, the existence of other grandparents was controlled, since the availability of different sources of grandparental care may affect parental decisions. All the control variables are from the first data wave. With the exception of maternal age and number of children, all the control variables are categorical and were transformed into dummy variables.

TABLE 1

Statistical analysis

We study the association between grandparental investment and the probability of parents' having another child with discrete-time survival analysis. The associations are estimated using a complementary log-log link function, and the strengths of associations are reported as hazard ratios. A hazard ratio above 1 indicates a greater likelihood of having a child compared to the reference category, while a hazard ratio below 1 indicates a lower likelihood. In addition to hazard ratios, the effect magnitudes concerning our main results are reported as probabilities of having a child by level of grandparental contact. These probabilities were calculated based on the model-predicted survival curves at the end of the total follow-up period (64 months). The effect on overall fertility is also separately studied for the second child and for the third and subsequent children. Having two children is the median number of children in the United Kingdom and siblings are typically born within a few years of each other. Around one in four women go on to have a third or subsequent children (Office for National Statistics 2013, 9). For the analyses we recoded the time variable into 4-month periods. Families are followed up to the data of the last interview (right-censoring) or the

date when a new child is born. We ran separate analyses for the different grandparental types (maternal grandmother, maternal grandfather, paternal grandmother, and paternal grandfather).

Results

Grandparental investment and control variables

We first provide descriptive statistics of grandparental contact by grandparental type. In line with previous studies on grandparental investment, maternal grandparents tended to invest more than paternal grandparents in grandchildren, and grandmothers also tended to invest more than grandfathers (Table 2). In addition, the investments within the same lineage were more highly correlated than between lineages (MGM / MGF $r = 0.66$, $n = 8{,}060$; MGM / PGM $r = 0.14$, $n = 8{,}299$; MGM / PGF $r = 0.12$, $n = 7{,}352$; MGF / PGM $r = 0.10$, $n = 7{,}560$; MGF / PGF $r = 0.09$, $n = 6{,}735$; PGM / PGF $r = 0.72$, $n = 7{,}381$; all correlations are statistically significant, $p < .05$).

TABLE 2

The associations between our control variables and parents' likelihood to have another child are presented in the electronic supplementary material (Table S1). Higher number of children and higher maternal age decreased parents' probability to have another child. Mothers' educational level correlated positively with the likelihood of having another child. Male breadwinner families, and families where both are unemployed, were more likely to have a family addition than do dual breadwinner households. Families where mothers assessed that they were living financially comfortably were more likely to have another child compared to families who found it quite or very difficult to cope financially. In addition, families where either one or both parents belonged to an ethnic minority group were more likely to have a new child than families belonging to the ethnic majority. Finally, having a particular grandparental type alive and the sex of the first child had no effect on subsequent births.

The effect of grandparental investment on probability of child birth

Our research questions concerned the association between grandparental contact frequency in the first wave and parent's reproductive success during the follow-up period of approximately 4.5 years. First, we investigated the association among all families and the progression to having one or more children. Table 2 shows that, "never" being the reference category, contact with paternal grandparents significantly increased the probability of a family having a subsequent child. Seeing each other a few times a month or less often (in the case of paternal grandmothers and grandfathers) or every day (in the case of paternal grandfathers) both significantly increased the likelihood of parents to have another child. In contrast, in the case of maternal grandparents, there was no such effect and one can observe a (statistically non-significant) trend to decrease subsequent fertility, especially among maternal grandmothers.

TABLE 3

Next, we studied the associations between grandparental contact and parity progression in more detail. We first explored whether grandparental contact frequency correlated with the probability of having a second child. Contact with all grandparental types tended to raise fertility. However, the associations reached statistical significance only among paternal grandparents. Among paternal grandparents, the hazard ratios were well above 1 in all categories. Thus, contact with the father's parents raised the chance of having a second child compared to those who never saw their paternal grandparents.

During the total follow-up period, the predicted probability of having a second child was 49% among those with no contact with paternal grandmothers compared to 59% among those with daily contact. The probability of having a second child was 50% among those with no contact with paternal grandfathers compared to 62% among those with daily contact.

We can compare the magnitude of grandparental investment of childbearing to that of socioeconomic variables. For instance the hazard ratio of daily contact with paternal grandparents (never being the reference category) was similar to that of mothers' educational level 4 (level 1 being the reference category) (PGM's model: HR = 1.37; PGF's model HR = 1.43; both models: p

< .05) and weaker than the effect of educational level 5 (PGM's model: HR = 1.59; PGF's model HR = 1.72; both models: p < .05). Contact with paternal grandparents has a stronger effect than the perceived financial situation, if we compare financially comfortable families with those who found it quite or very difficult to cope (PGM's model: HR = 1.17; PGF's model HR = 1.20; both models: p < .05). The effect of paternal grandparents is also stronger than the effect of parents' working status in case of male breadwinner families, who were more likely to have a family addition, compared to dual breadwinner families (PGM's model: HR = 1.19; PGF's model HR = 1.20; both models: p < .05).

TABLE 4

Finally, we studied the association between grandparental contact frequency and parents having above average fertility, i.e. three or more children. Results shown in Table 5 indicate that across all grandparental types, contact frequencies are now associated with a lower likelihood of having more children. However, the associations are significant only among maternal grandmothers and, to a lesser degree, maternal grandfathers. "Never" being the reference category, contact "1–3 times a month or less often" (for maternal grandmothers and grandfathers) and "every day" (for maternal grandmothers) significantly decreased the probability of having a child. Thus contact with maternal grandparents, maternal grandmothers in particular, appears to decrease the parents' likelihood of having a large family. During the total follow-up period, the predicted probability of having a third or subsequent child was 29% among those with no contact with maternal grandmothers compared to 22% among those with daily contact. There was no significant correlation between the investment of paternal grandparents and the probability of parents having a third or subsequent child.

TABLE 5

Discussion

While the evolutionary significance of grandparents has been demonstrated in many studies of traditional and historical human populations, we know much less about the role of grandparents in the reproductive behaviour of their children in contemporary industrialized societies. There is a particular lack of studies that analyse the effect of grandparental lineage and sex on fertility (Sear &

Coall, 2011). We have provided the first evidence for a positive influence by some types of grandparent but a negative influence by other types on childbearing in a modern, low fertility society. Previous studies have found that the effects of grandparental presence vary by lineage in pre-modern and traditional societies, possibly reflecting different solutions to sex-specific reproductive investment and quantity-quality trade-offs (see Euler, 2011; Sear & Coall, 2011; Sear & Mace, 2008 for reviews). We show a similar differential impact in a developed society, with the influences also going in similar directions.

Results suggest that paternal grandparents' investment correlates with parents' increased probability of having more children, especially the probability of having a second child. In contrast, investment from maternal grandmothers correlates with the decreased likelihood of families having a third or subsequent child. These results are in line with the sex-specific reproductive strategies theory (Euler, 2011; Sear & Coall, 2011), which assumes that paternal grandparents should improve parents' probability to have another child, while maternal grandparents may even decrease it in some circumstances. They are also in concordance with the results from pre-modern and traditional populations, which show that the presence of paternal grandparents may increase parental fertility more often than the presence of maternal grandparents (see Sear & Coall, 2011 for review).

Obviously, several other factors influence childbearing. Younger mothers were more likely to have another child, as were families with better financial condition and more highly educated mothers. These results are in line with the study by Jokela (2009) who analysed parents' probability to have another child with the MCS data. Also dual worker families and families where either one or both parents belonged to an ethnic minority group were more likely to have a new child, while the existing number of children decreased probability to experience a child birth.

Our results are partly in line and partly divergent with the studies by Kaptijn and colleagues (2010a), Thomese and Liefbroer (2013) and Waynforth (2011). In line with these studies we found that grandparental investment correlates with parental fertility in modern societies. Our findings underline the fact that grandparental effects on fertility are not equal, but may even go in opposite directions, and can also be parity-specific. This diverging impact may explain why some studies have found no clear effect for grandparental investment on contemporary fertility (e.g. Aassve et al., 2012).

It is unclear why paternal grandparents' investment correlates with the increased risk of progression to a second child, but not to a third or subsequent child. In modern societies, where fertility rates are low and a minority has three or more children, maternal grandparents are the closest and most heavily investing. Nevertheless, they do not appear to promote larger families. Paternal grandparents can "boost" female fertility, but not beyond a second child. That is to say, paternal grandparents support the family size to reaches the social median, while maternal grandmothers appear to ensure that their daughters do not have above-average numbers of children.

Combining the present results with some recent findings, we can detect support for the quality-quantity trade-offs in the case of grandparental investment in the contemporary UK. An analysis by Tanskanen and Danielsbacka (2012) using data from England and Wales showed that the involvement of maternal grandparents correlated with fewer emotional and behavioural problems among their adolescent grandchildren. There was no similar association between paternal grandparent involvement and fewer emotional and behavioural problems in grandchildren. However, we do not yet have direct evidence that grandparents are involved in actual trade-offs, and further studies should try to assess their investments from this perspective. A recent study by Aasve and colleagues (2012) found grandparental investment to affect fertility differently depending on the existence and age of grandchildren to other adult children (i.e the parents' siblings), indicating the existence of such trade-offs at least in the allocation of grandparental resources.

It is important to note that the outcome of grandparental investment may not necessarily be adaptive with regards to long term fitness. Investment from grandparents that may previously have improved grandchild quality in the sense of child survival, and thus increased the fitness of the grandparents themselves, may no longer increase grandparental fitness in contemporary societies. A study from modern Sweden showed that a lower number of grandchildren correlated with their higher quality, as measured by socioeconomic status and school performance; however, it did not lead to higher grandparental fitness in the long term (Goodman, Koupil & Lawson, 2012). Low fertility in modern western societies may be the outcome of parental and grandparental investment in offspring quality (Kaptijn, Thomese, van Tilburg, Liefbroer & Deeg, 2010b), even though parents and grandparents

in modern nations could more effectively achieve fitness benefits by favoring quantity over quality (Goodman et al., 2012).

Our results stress the importance of separating grandparental types and further show that these grandparental lineage effects may be different as the numbers of children in a family increases. It would be worthwhile to analyse the effects for other life history variables, including age at first birth and length of birth intervals.

The difference in outcomes was observed between grandparents who never met their adult children and those who met them at least sometimes. The threshold for influencing the child bearing of an adult offspring may be to provide at least some investment. Here, we measured investment by face to face contacts between parents and grandparents. Kin with at least some physical contact probably have higher amounts of other kinds of contacts, for example, via phone or by internet. Future studies should look in more detail into the effects of contact frequencies and types on investment patterns and their effects on family behavior.

Last but not least, we recommend further studies into the proximate mechanisms behind these quite perplexing results. It may be that contact with maternal and paternal kin provides different kinds of support and resources for the family. It could also be that frequent contact with the father's kin indicates stronger paternal investment from the father, while a higher reliance on maternal kin indicates the opposite. Thus grandparental investments may also reflect couple dynamics and paternal investment.

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Table 1. Sample descriptive statistics (%/mean)

Sex of the first child (%)	
Boy	51.1
Girl	48.9
Number of children in household (mean)	1.9
Mother's age (mean)	30.0
Mother's educational attainment (%)	
NVQ level 1	6.5
NVQ level 2	28.2
NVQ level 3	15.0
NVQ level 4	32.5
NVQ level 5	4.3
Other	13.5
Parents' ethnicity (%)	
Neither parent belongs to an ethnic minority group	86.4
One or both parents belong to an ethnic minority group	13.6
Combined labour market status of parents (%)	
Both wage working	53.7
Mother wage working, father not	2.6
Father wage working, mother not	35.9
None in wage work	7.8
Perceived financial situation of the family (%)	
Finding it quite or very difficult	8.3
Just about getting by	24.3
Doing alright	39.7
Living comfortably	27.6
Maternal grandmother alive (%)	93.2
Maternal grandfather alive (%)	84.0
Paternal grandmother alive (%)	90.1
Paternal grandfather alive (%)	79.1

n = 10,295

Table 2. Descriptive statistics of grandparental contact frequencies (%)

Contact frequencies	MGM	MGF	PGM	PGF
Never	2.8	7.8	2.8	6.7
1-3 times a month or less often	30.4	37.5	39.1	41.4
Once or twice a week	22.2	24.3	32.9	28.5
3-6 times a week	21.0	16.5	14.7	13.3
Every day	23.6	14.0	10.4	10.2

Notes: MGM = Maternal grandmother, MGF = Maternal grandfather, PGM = Paternal grandmother, PGF = Paternal grandfather.
MGM n = 9,437; MGF n = 8,544; PGM n = 9,038; PGF n = 7,982.

Table 3. Predicting the birth of another child by grandparental investment

Contact frequencies	Model 1: MGM	Model 2: MGF	Model 3: PGM	Model 4: PGF
Never	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
1-3 times a month or less often	0.95	1.03	1.29*	1.24*
Once or twice a week	0.88	0.95	1.12	1.13
3-6 times a week	0.87	0.98	1.08	1.05
Every day	0.84	0.96	1.19	1.19*
Goodness of fit				
–2 Log Likelihood	31179.186	28648.648	30021.283	26637.054
Nagelkerke R^2	0.075	0.074	0.073	0.075

Notes: MGM = Maternal grandmother, MGF = Maternal grandfather, PGM = Paternal grandmother, PGF = paternal grandfather.
Values are hazard ratios of discrete-time survival analysis.
The independent variable is grandparental contact frequencies and every model controls for the following variables: the sex of the first child, number of children in household, mother's age, and mother's educational attainment, parent's ethnicity, and parent's combined labour force participation, the financial situation of the family, are other grandparents alive, time, and time².
Model 1: n = 9,437; Model 2: n = 8,544; Model 3: n = 9,038; Model 4: n = 7,982.
* $p < .05$.

Table 4. Predicting the birth of the second child by grandparental investment

Contact frequencies	Model 1: MGM	Model 2: MGF	Model 3: PGM	Model 4: PGF
Never	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
1-3 times a month or less often	1.06	1.12	1.43*	1.44*
Once or twice a week	1.09	1.11	1.31*	1.30*
3-6 times a week	1.03	1.13	1.30	1.26*
Every day	1.01	1.05	1.34*	1.41*
Goodness of fit				
–2 Log Likelihood	19298.0	18076.188	18662.173	16931.315
Nagelkerke R^2	0.054	0.052	0.053	0.055

Notes: MGM = Maternal grandmother, MGF = Maternal grandfather, PGM = Paternal grandmother, PGF = Paternal grandfather.
Values are hazard ratios of discrete-time survival analysis.
The independent variable is grandparental contact frequencies and every model controls for the following variables: the sex of the first child, number of children in household, mother's age, and mother's educational attainment, parent's ethnicity, and parent's combined labour force participation, the financial situation of the family, are other grandparents alive, time, and time^2.
Model 1: n = 4,513; Model 2: n = 4,196; Model 3: n = 4,374; Model 4: n = 3,953.
* $p < .05$.

Table 5. Predicting the birth of third or subsequent child by grandparental investment

Contact frequencies	Model 1: MGM	Model 2: MGF	Model 3: PGM	Model 4: PGF
Never	1.00	1.00	1.00	1.00
1-3 times a month or less often	0.90	0.95	1.07	0.92
Once or twice a week	0.69*	0.78*	0.87	0.86
3-6 times a week	0.77	0.80	0.76	0.77
Every day	0.73*	0.86	0.96	0.88
Goodness of fit				
–2 Log Likelihood	11322.593	10066.96	10829.559	9239.204
Nagelkerke R^2	0.049	0.046	0.045	0.043

Notes: MGM = Maternal grandmother, MGF = Maternal grandfather, PGM = Paternal grandmother, PGF = Paternal grandfather.
Values are hazard ratios of discrete-time survival analysis.
The independent variable is grandparental contact frequencies and every model controls for the following variables: the sex of the first child, number of children in household, mother's age, and mother's educational attainment, parent's ethnicity, and parent's combined labour force participation, the financial situation of the family, are other grandparents alive, time, and time^2.
Model 1: n = 4,924; Model 2: n = 4,348; Model 3: n = 4,664; Model 4: n = 4,029.
* $p < .05$.

Table S1. Predicting the birth of another child by children's, parents' and grandparents' charasteristics

	Model 1: Another child	Model 2: Second child	Model 3: Third or subsequent child
Sex of the first child			
Boy	1.00 (ref)	1.00 (ref)	1.00 (ref)
Girl	0.97	0.97	0.94
Number of children in household	0.55*	0.59*	0.98
Mother's age	0.96*	0.99*	0.92*
Mother's educational attainment			
NVQ level 1	1.00 (ref)	1.00 (ref)	1.00 (ref)
NVQ level 2	0.95	0.92	1.04
NVQ level 3	1.12	1.04	1.36*
NVQ level 4	1.42*	1.40*	1.58*
NVQ level 5	1.72*	1.70*	1.73*
Other	1.34*	1.09	1.54*
Parents' ethnicity (%)			
Neither parent belongs to an ethnic minority group	1.00 (ref)	1.00 (ref)	1.00 (ref)
One or both parents belong to an ethnic minority group	1.29*	1.14*	1.41*
Combined labour market status of parents			
Both wage working	1.00 (ref)	1.00 (ref)	1.00 (ref)
Mother wage working, father not	0.94	0.86	1.18
Father wage working, mother not	1.15*	1.19*	1.23*
None in wage work	1.31*	1.09	1.56*
Perceived financial situation of the family			
Finding it quite or very difficult	1.00 (ref)	1.00 (ref)	1.00 (ref)
Just about getting by	1.02	1.00	1.08
Doing alright	1.04	1.07	1.06
Living comfortably	1.18*	1.16	1.25*
MGM alive			

No	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	0.91	1.04	0.79*
MGF alive			
No	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	1.01	1.08	0.91
PGM alive			
No	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	1.05	1.04	1.07
PGF alive			
No	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	1.01	1.06	0.94
Time	1.53*	1.63*	1.36*
Time²	0.97*	0.97*	0.98*
Goodness of fit			
–2 Log Likelihood	34155.906	20982.694	12573.579
Nagelkerke R^2	0.072	0.052	0.046

Values are hazard ratios of discrete-time survival analysis.

Model 1: n = 10,295; Model 2: n = 4,912; Model 3: n = 5,383.

* $p < .05$.