Turku Center for Welfare Research

Working Papers on Social and Economic Issues 14/2016

Correlation between grandparental investment and child development in England

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Abstract

Evolutionary studies have shown that in many traditional populations the beneficial effects of grandparental presence for grandchildren may vary according to the sex and lineage of the grandparents, as well as by the sex of the grandchild. However, few studies have investigated the relevance of these factors in modern developed societies. The present study uses the Millennium Cohort Study (n = 5,033 children) to analyse the association between grandparental investment and child development in contemporary England. Grandparental investment is measured by contact frequencies reported by children's parents at the child's age of 3 and child development by "early learning goals" over the first year of primary school assessed with the Foundation Stage Profile (FSP). Children who have contacts with maternal grandparents receive higher FSP scores compared to children with no contact at all. In addition, children who have daily contacts with paternal grandfathers have lower FSP scores. The study provides evidence of the relevance of grandparental investment on grandchild development also in developed societies. The results are discussed with reference to the grandmother hypothesis, sex-specific reproductive strategies and sex chromosome hypothesis.

Introduction

Grandparents may increase their inclusive fitness by investing in their grandchildren, with whom they share on average 25% of their genes (Hamilton 1964). Previous research has shown that in pre-modern and traditional populations grandparents may have improved their fitness by keeping grandchildren alive and the beneficial effect of grandparents could vary by sex and lineage of the grandparents, as well as by the sex of the grandchild (Fox, Sear, Beise, Ragsdale, Voland & Knapp, 2010; Sear & Mace, 2008). However, in modern Western societies with low child mortality rates, grandparents are no longer needed to keep children alive (Coall & Hertwig, 2010; 2011). This means that in modern societies the effects of grandparental investment should not be measured by grandchild survival, but rather by studying "softer" types of outcomes, such as grandchild development (Sear & Coall, 2011).

A review of 19 studies by Sear and Coall (2011) shows that grandparental support generally correlates with better child outcomes in modern societies. In these studies child outcome is measured by the child's psychological adjustment, mental and physical development, lack of depression, and academic achievement. The effect on children often appears to be mediated by the parent-grandparent relation: some recent studies have found that in contemporary societies, especially the quality of the relation between parents and grandparents influenced both fertility (Waynforth, 2011) and child development (Scelza, 2011).

Previous studies have shown that all grandparents may not benefit grandchildren equally (Sear & Mace, 2008; Sear & Coall, 2011). In pre-modern and traditional populations the presence of grandmothers are found to improve child survival rates (e.g. Jamison, Cornell, Jamison & Nakazato, 2002; Ragsdale, 2004; Lahdenperä, Lummaa, Helle, Tremblay, & Russell, 2004; Sear, Mace, & McGregor, 2000; 2003; Voland & Beise, 2002), while grandfathers are found to have much less beneficial impact on child survival (e.g. Lahdenperä, Russell & Lummaa, 2007). In contrast, in modern societies maternal grandparents are found to increase child well-being measured by psychological adjustment and development (Lussier et al., 2002; Tanskanen & Danielsbacka, 2012; Tanskanen & Danielsbacka, 2016). In addition, some studies have evidenced that the presence of paternal grandmothers may benefit granddaughters, while the presence of paternal grandfathers may benefit grandsons (Fox et al. 2010;

Johow, Fox, Knapp & Voland, 2011). Evolutionary researchers have explained biased grandparental effect by the grandmother hypothesis, sex-specific reproductive strategies, and sex chromosome hypothesis (Table 1).

Table 1. Theoretical predictions for differential grandparental effect: Is the specific grandparent type expected to improve child development?

	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Grandmother hypothesis	Yes		Yes	
Sex-specific reproductive strategies	Yes	Yes		
Sex chromosome hypothesis			Granddaughter	Grandson

The grandmother hypothesis (Hawkes et al., 1997) states that the long postmenopausal lifespan of females might be an evolved adaptation allowing post-reproductive grandmothers to provide assistance to their offspring contributing to the fertility of daughters and daughters-in-law, and the survival of grandchildren. Combined with the costs of reproductive conflict, especially between an older woman and her daughter-in-law (Lahdenperä, Gillespie, Lummaa & Russell, 2012), the grandmother hypothesis may account for the evolution of the long postreproductive life span in humans although it remains debated (see e.g. Coall & Hertwig, 2010; Strassmann & Garrard, 2012 for discussion; see Kachel et al., 2011 for a mathematical simulation). The grandmother hypothesis states that the grandmaternal support has played a major role in child rearing in our evolutionary past (Lahdenperä et al., 2004), and it may do so also in modern societies (Coall & Hertwig, 2010). Based on the grandmother hypothesis grandmothers are expected to improve child development.

Evolutionary researchers have argued that humans exhibit sex-specific reproductive strategies (Euler, 2011). In mammals, where males can never be completely sure that they are the biological fathers of an offspring, and females tend to invest more in each offspring due to pregnancy and lactation (Trivers, 1972), females tend overall to provide higher parental investment than males. Because of their lower levels of parental investment, males can theoretically increase their reproductive success more than females by mating with many partners (but see Kokko & Jennions, 2003), so that other things being equal, men can be expected to invest more in offspring quantity and

women in quality. Sex-specific reproductive strategies lead to different reproductive interests between maternal and paternal grandparents (Euler, 2011). Since females tend to invest more in their children than males, the investment from maternal grandparents towards their daughter and her children are more likely to benefit grandchildren than paternal grandparents' investment towards their son and his children (Coall & Hertwig, 2010). Thus, the sex-specific reproductive strategies theory assumes that investment from maternal grandparents, in particular, may increase child development.

Also paternity uncertainty hypothesis predicts that all grandparents do not improve child development equally (Euler, 2011). In the case of grandparents, paternity uncertainty means that only the maternal grandmother can be sure that the grandchild is genetically related to her, while maternal grandfathers and paternal grandmothers have one link of paternity uncertainty, and paternal grandfathers have two uncertain links (Coall & Hertwig, 2010; Euler & Weitzel, 1996). In line with the expectations based on paternity uncertainty several studies from modern societies show that maternal grandparents tend to invest more in their grandchildren than paternal grandparents, and grandmothers tend to invest more than grandfathers (; but see; Pashos, 2000).

However, according to paternity uncertainty hypothesis maternal grandmothers should not only invest in their grandchildren the most of all grandparent types but they may also have most beneficial impact on child development. That is to say, it is not the grandparental investment per se that may make a difference, but rather what grandparents are doing when they are with the grandchild (Coall & Hertwig, 2010). Because maternal grandmothers can be sure that they are investing in their genetically related offspring, while interacting with the child they may commit to increase child development more than other grandparent types, for example, by teaching them basic skills and involving to their activities. Thus, based on paternity uncertainty hypothesis maternal grandmothers should most probably of all four grandparent types increase child development.

Predictions based on the grandmother hypothesis and sex-specific reproductive interests ignore the possibility that the sex of a grandchild may also bias grandparental investment patterns. Increasing number of recent studies have taken into account not only the parental and grandparental sex, but also that of the grandchild (Chrastil, Getz, Euler & Starks, 2006; Fox et al., 2010; Johow et al., 2011; Kaptijn, Thomese, van

Tilburg & Liefbroer, 2013; Kirchengast & Putz, 2016; Rice, Gavrilets, & Forsberg, 2010; Seki, 2012; Tanskanen, Rotkirch & Danielsbacka, 2011). These studies have suggested that grandparental investment may be affected by the different inheritance patterns of sex chromosomes.

With respect to autosome chromosomes, grandparents are equally related to their granddaughters and grandsons, but this is not the case with sex chromosomes (Euler, 2011). For Y chromosome relatedness, maternal grandfathers are 0% related to both granddaughters and grandsons, while paternal grandfathers are 100% related to grandsons and 0% related to granddaughters. With respect to X chromosomes, maternal grandmothers are 25% related to granddaughters and grandsons, while paternal grandmothers are 0% related to grandsons and 50% related to granddaughters. Thus maternal grandparents should benefit equally from having granddaughters and grandsons, whereas paternal grandmothers should benefit more from having granddaughters than grandsons, and paternal grandfathers should benefit more from grandsons than granddaughters. These expected genetic benefits may translate into favouritism (Chrastil et al., 2006; Fox et al., 2010). Thus, the sex chromosome hypothesis assumes that paternal grandmothers should increase the level of development of granddaughters, while paternal grandfathers should increase grandsons' development.

In the present study we analyse the relationship between grandparental investment and grandchild development in contemporary England. The most common limitations of previous studies concerning the association between grandparental investment and child outcomes is that they do not separate different types of grandparents from each other (but see e.g. Tanskanen & Danielsbacka, 2012). Since to date only few studies have explored the association between grandparental investment and child outcomes with respect to lineage, grandparental sex and grandchild sex (e.g., Scholl Perry, 1996). The present study takes all these factors into account.

Data and Methods

The study uses data from the Millennium Cohort Study (MCS), which is a large cohort survey. The aim of the MCS is to gather longitudinal information on children born at the beginning of the 21st century. Children are the subjects of the study, and parents or

parent figures are the informants, who answer questions concerning their children. In the MCS information is gathered from the main respondents (mostly the biological mothers of the children) and from the partner respondents (mostly the biological fathers of the children) separately (see Hansen, 2010 for a more detailed data description).

The article uses the second wave of the MCS data (collected in 2003–2005) and the children's development scores as reported by their teachers (concerning the school year 2005–2006). The study sample includes those cases where the main respondent is the biological mother, and partner respondent is the biological father of the target child, and they are interviewed in the second wave of the MCS. In addition only those cases where both parents live in the same household with the child are included because grandparental effects could vary between family types. In cases of twins or triplets, only one child of the set is included. The child development assessments are systematically collected only from schools in England, not from other MCS countries (Johnson, 2008), which is why only cases from England are included in the analyses. After these exclusions the study sample included 4,636 children aged approximately three (M = 37.3 months, SD = 2.13, min. = 33.9, max. = 54.3).

The dependent variable is the Foundation Stage Profile (FSP) assessment, which measures child development. The relevance to analyse the child development scores is evident from the perspective of previous findings. Studies have shown that early achievement correlates, for example, with better educational performance and a higher salary in later life (e.g., Currie & Thomas, 1999, 2001; Feinstein & Duckworth, 2006). In the state schools of England, teachers complete the FSP assessment concerning "early learning goals" at the end of the children's first school year (at the age of 5). These assessments are collected by the Department for Children, Schools and Families, and the FSP records are merged to the MCS data. The MCS data includes FSP records from 95% of the cohort member children (Johnson, 2008).

The FSP assessment consists of six subscales that include thirteen nine-point scale items (see QCA, 2003). These subscales are personal, social and emotional development (disposition and attitudes, social development, emotional development); communication, language and literacy (language for communicating and thinking, linking sounds and letters, reading, writing); mathematical development (numbers as labels and for counting, calculating, shape, space and measures); knowledge and

understanding of the world; creative development; and physical development (Cronbach's α = 0.86). The FSP assessment score ranges from 0 to 117, and the higher the number the better the assessment (M = 86.8, SD = 18.6). To correct for the skewness of the FSP variable, it was transformed using square transformation and dividing this by 1000.

Grandparental investment is measured by contact frequencies as reported by the children's parents in the second wave when the child was about 3 years old. In the second wave of the MCS the children's mothers were asked to report the frequency of contact with her parents (maternal grandmothers and grandfathers) and the fathers of contact with his parents (paternal grandmothers and grandfathers) with an 8-point scale ranging from "never" to "every day". The scale was classified into 5 categories: 0 = Never (including not alive), 1 = 1–3 times a month or less often, 2 = Once or twice a week, 3 = 3–6 times a week, 4 = Every day. Those children who live in the same household with their grandparents are classified to category "every day" (Pollet, Nelissen & Nettle, 2009). For the analyses the grandparental contact frequency variable is transformed into a dummy variable (see Table 2).

Table 2. Cross-tabulation of grandparental investment variable (%)

Contact frequencies	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Never	2.0	5.8	2.4	6.4
1-3 times a month or less often	36.8	44.6	47.5	48.9
Once or twice a week	24.5	24.9	32.0	28.3
3-6 times a week	20.8	15.3	10.4	8.4
Every day	16.0	9.3	7.7	7.9
n	4,636	4,028	4,423	3,777

Associations between grandparental investment and child development are studied using linear regression analysis. We control for several potential confounding factors: child's sex, age, ethnicity, number of siblings, mother's age, father's age, the financial situation of the family, and combined educational attainment of parents. Previous studies show that these factors often correlate with child development scores (Hansen & Jones, 2008; Kiernan & Mensah, 2011). Parental education is measured by the National Vocational Qualification (NVQ), and we have classified it in two categories (higher educated group = NVQ level 4 or 5; lower educated group = other). Combined

education level of the main and partner respondent have four categories (1 = both parents have reached level 4 or 5; 2 = mother have reached level 4 or 5, father have not; 3 = father have reached level 4 or 5, mother have not, 4 = neither of the parents have reached level 4 or 5) (Table 3). With the exception of the child's age, number of siblings and parents' age all of the control variables are categorical and for the analyses they are transformed as dummy variable.

Table 3. Descriptive statistics (%/mean)

	%/mean	SD
Child's sex (%)		
Boy	50.0	
Girl	50.0	
Child's age in months (mean)	37.3	2.15
Child's ethnicity (%)		
White	83.2	
Mixed	2.7	
Indian	3.8	
Pakistani or Bangladeshi	6.6	
Black	1.9	
Other	1.8	
Child's number of siblings (mean)	1.2	0.98
Mother's age (mean)	32.6	5.23
Father's age (mean)	35.4	6.02
Parents' education (%)		
Both parents reached level 4 or 5	22.2	
Mother reached level 4 or 5, father not	14.7	
Father reached level 4 or 5, mother not	13.5	
Neither of the parents reached level 4 or 5	49.6	
Perceived financial situation of the family (%)		
Living comfortably	28.6	
Doing alright	39.3	
Just about getting by	25.0	
Finding it quite or very difficult	7.2	
n	4,636	

Results

Results are presented in Table 4 and first we included all children in analyses. The category "never" was chosen as the reference category. In the case of maternal grandmothers, those who have weekly contacts earn significantly higher development test scores and those who have daily contacts marginally significantly higher scores compared to reference category "never". For maternal grandfathers the differences are

statistically significant in categories “once or twice a week”, “3–6 times a week” and “every day”. In addition, those who have monthly contacts with maternal grandfathers receive marginally significantly higher test scores than group “never”. For paternal grandfmothers the differences are not statistically significant in any category. In the case of paternal grandfathers “never” being the reference category daily contact with the paternal grandfathers correlates with the decreased test scores.

Table 4. Associations between grandparental investment and child FSP scores (β-coefficients)

	All children	Granddaughters	Grandsons
Maternal grandmother			
Never	ref	ref	ref
1-3 times a month or less often	0.43	0.24	0.64
Once or twice a week	0.58*	0.50	0.68
3-6 times a week	0.61*	0.42	0.83†
Every day	0.54†	0.37	0.76†
n	4,636	2,319	2,317
Adj. R2	0.13	0.11	0.12
Maternal grandfather			
Never	ref	ref	ref
1-3 times a month or less often	0.32†	0.16	0.44†
Once or twice a week	0.40*	0.22	0.57*
3-6 times a week	0.44*	0.18	0.70*
Every day	0.50*	0.33	0.65*
n	4,028	1,993	2,035
Adj. R2	0.13	0.11	0.12
Paternal grandmother			
Never	ref	ref	ref
1-3 times a month or less often	0.18	0.23	0.16
Once or twice a week	0.12	0.26	0.02
3-6 times a week	0.22	0.18	0.30
Every day	-0.11	-0.18	-0.04
n	4,423	2,201	2,222
Adj. R2	0.12	0.11	0.11
Paternal grandfather			
Never	ref	ref	ref
1-3 times a month or less often	-0.15	-0.39	0.12
Once or twice a week	-0.17	-0.35	0.03
3-6 times a week	-0.22	-0.71*	0.34
Every day	-0.51*	-0.52	-0.45
n	3,777	1,889	1,888
Adj. R2	0.13	0.11	0.12

* $p < .05$, †$p < 0.1$

Next, we study whether grandparental investment correlates with the development scores of granddaughters (Table 4). In the case of maternal grandmothers and grandfathers and paternal grandmothers no significant associations were detected. For the paternal grandfathers, there is a mostly non-significant trend to associate with decreased test scores among granddaughters. Those granddaughters having weekly contacts with paternal grandfathers earn significantly lower test scores.

Then, the correlation between grandparental investment and grandsons' development is studied (Table 4). The results show that those grandsons who receive maternal grandmothers' investment "3–6 times a week" and "every day" receive marginally significantly higher scores compared to reference group "never". Moreover, "never" being the reference group maternal grandfathers' investment weekly and daily basis are associated with significantly and daily basis marginally significantly with increased test scores among grandsons. In the case of paternal grandmothers and grandfathers there were no significant associations.

Finally, we included interaction term between grandparental investment and grandchild sex (Table 5). We investigated the potential associations of four grandparent types, respectively. However, we did not find significant interactions in any of these models.

Table 5. Associations between grandparental investment and child FSP scores by child's sex (β-coefficients)

	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Grandparental investment	0.07	0.12*	-0.03	-0.09
Child's sex				
Boy	ref	ref	ref	ref
Girl	0.88*	0.93*	0.86*	0.79*
Grandparental investment × child's sex				
Grandparental investment ×boy	ref	ref	ref	ref
Grandparental investment ×girl	-0.02	-0.08	-0.03	-0.01
n	4,636	4,028	4,423	3,777
Adj. R2	0.13	0.13	0.12	0.13

* $p < .05$, †p < 0.1

Conclusions

This study analysed the effects of biased grandparental investment in the present-day

England. We found that children who have contacts with maternal grandparents receive higher FSP assessment compared to children with no contact at all. These results are consistent with the prediction derived from the sex-specific reproductive strategies.

In line with our results previous studies of pre-modern and traditional populations have found that grandmothers (maternal grandmothers in particular) often increase grandchild survival (see Sear & Mace, 2008 for review). In addition, a recent study that used the MCS data found an association between maternal and paternal grandmothers' investment and grandchildren's nutritional status (Tanskanen, 2013). However, our results are not in line with the two studies from modern societies, which showed that the investment of maternal, but not paternal grandparents correlates with grandchild well-being (Lussier et al., 2002; Tanskanen & Danielsbacka, 2012). That is to say, maternal grandmothers tend to have the highest impact on grandchildren, while other grandparents may show more variation in their influences.

We also found that children who have daily contacts with paternal grandfathers earn lower FSP scores compared to children with no contact at all. Interestingly, some studies from pre-modern and traditional populations have found that the presence of paternal grandfathers correlate with decreased child survival rates (see Sear & Mace, 2008 for review). Even though, many studies from modern nations have found beneficial effects of close ties to grandparents (e.g., Lussier et al., 2002; Tanskanen & Danielsbacka, 2012; Tanskanen & Danielsbacka, 2016), some studies also found negative effects of very high grandparental investment (e.g. Pittman, 2007), probably because this is usually related to poverty and family instability in developed countries (Sear & Coall, 2011). In this study only families with both biological parents in the household were included in the analyses. In addition, the financial condition of the family, and parents' education, among other factors, were controlled for. However, even after these adjustments, daily contact only from paternal grandfathers (but not with other grandparent types) was associated with lower developmental indicators.

It is not clear why children who see paternal grandfathers daily basis receive lower developmental test scores compared to children with no contact at all. It could be that while interacting with their grandchildren, paternal grandfathers do not always involve themselves intensively in their grandchildren's lives, maybe as a result of paternity uncertainty. If others are more involved in their interactions with the child, that child

may benefit more by spending time with them compared to spending time with paternal grandfathers. Also another potential explanation can be put forward for the result concerning paternal grandfathers. Paternal grandfathers are usually the oldest of all grandparent types, and advanced age may correlate with poor health. Perhaps daily contact with paternal grandfathers is a result of their poor health (i.e., paternal grandfathers need support from their children). That is to say, paternal grandfathers would not so much take care of their grandchildren, but receive support from their adult children and in-laws. Because the subjects of the MCS study were small children, grandparental contact frequencies are measured via the parents, and it is not clear do the grandparents invest in their children and grandchildren or do they receive support from their children (see Coall & Hertwig, 2010 and responses for the discussion of the measurement of grandparental investment).

The present study does not support the sex chromosome hypothesis, which assumes that paternal grandmothers increase their granddaughters' development more than their grandsons' development. In addition, the study does not support the sex chromosome prediction that paternal grandfathers increase the development of grandsons more than that of granddaughters. Thus, the study did not find convincing evidence for the predictions that some types of grandparents increase granddaughters' development more than that of grandsons or vice versa. However, studies from pre-modern populations have found at least some support for discrimination by grandparents in terms of the grandchild's sex (see Fox et al., 2010; Johow et al., 2011). It is not clear why sex discrimination seems to exist in pre-modern populations but not in modern societies. Future research is needed to reply to the question of sex discrimination in pre-modern versus modern societies.

To conclude, the present study shows that maternal grandparents tend to improve child development in contemporary England. Thus, the study shows that grandparental investment that may have increased child survival in our evolutionary past may still have beneficial effects on grandchildren in modern societies.

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