

1 Do grandparents compete with or support their grandchildren? In Guatemala, paternal
2 grandmothers may compete, and maternal grandmothers may cooperate.

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28

29 Abstract

30 Previous research has found that the presence of grandparents, particularly grandmothers,
31 is often positively associated with child survival. Little research has explored the potential
32 mechanisms driving these associations. We use data from rural Guatemala to test whether
33 contact with, and direct investment (advice and financial) from grandparents is associated
34 with child health, proxied by height. Our results demonstrate the complexity of family
35 relationships and their influence on child health, suggesting that both cooperative and
36 competitive relationships exist within the family. The clearest evidence we find for
37 grandparental influence is that having a living paternal grandmother tends to be *negatively*
38 associated with child height. In contrast, contact with maternal kin appears broadly to be
39 beneficial for child height, although these relationships are weaker. These patterns are
40 mirrored in maternal BMI, suggesting grandparental influence acts partly through maternal
41 health. These findings support the hypotheses that, under conditions of limited resources,
42 family relationships may be competitive within the family lineage which shares the same
43 resource base, but cooperative when there are few costs to cooperation. Finally, financial
44 assistance from maternal grandfathers is positively correlated with infant length but
45 negatively with the height of older children, perhaps because the receipt of financial
46 support is an indication of need. The provision of advice shows no associations with child
47 height.

48

49 Introduction

50 Evolutionary anthropologists expect to see broadly positive effects of grandparents on the
51 health of their grandchildren. The cooperative breeding hypothesis (1) and the grandmother
52 hypothesis for the evolution of menopause (2,3), both of which draw on kin selection theory
53 (4), predict that post-reproductive individuals will direct investment towards existing kin,
54 such as adult children and grandchildren (see also (5)). There is empirical evidence which
55 supports this prediction, and which does suggest that the presence of grandparents is
56 beneficial for their grandchildren (6–8). However, some of this research suggests that
57 grandparental presence is not always beneficial to children, and a few studies even find that
58 grandchild mortality is higher in the presence of grandparents. This has been attributed to
59 the effects of resource competition within families(7,9,10) . Much of the previous research
60 on this topic, at least in low income settings, focuses on child survival as the outcome of
61 interest. While this is clearly the most important child outcome, it is a crude measure of
62 child health; the impact of grandparents may be underestimated if this is the only outcome
63 measure used, rather than more sensitive measures of child health.

64

65 A handful of studies have tested the influence of grandparents (mainly grandmothers) on
66 other measures of child health. These studies suggest that the presence of grandmothers is
67 often correlated with improved child health, but not always, and sometimes beneficial
68 effects are specific to certain children. In the Gambia, Sear et al (11) found that having a
69 living maternal grandmother, was associated with improved child height and weight. In
70 Ethiopia, Gibson and Mace (12) found that having a living maternal grandmother was
71 associated with taller girls, but not boys, and that having a living paternal grandmother was
72 associated with increased height in boys but not girls. In India, Leonetti et al (13) report that

73 Bengali paternal grandmothers resident in the household positively influenced child height
74 but co-residence of Khasi maternal grandmothers only impacted on the height of children
75 born to the youngest daughter of the grandmother. If the grandmother lived with an older
76 daughter, the direction of the association is reversed. Yet Khasi grandmothers exert a
77 positive effect on child height for the children of her older daughters if she is not living with
78 them (13). Also in India, rural Vadodara, Sharma and Kanani (14) found that children who
79 had grandmothers (of unspecified lineage) present in the household were a little less
80 undernourished than those whose were not.

81

82 Evidence for associations between the presence of grandfathers and child health are even
83 scarcer, and reported findings give mixed messages. For example, in the Gambia,
84 grandfathers had inconsistent effects on child height and weight, although there was some
85 evidence that having a living grandfather, either maternal or paternal, was associated with
86 shorter child height than if the grandfather was dead (15). In Ethiopia, Gibson and Mace (12)
87 found no correlations between grandfathers of either lineage and child height or weight,
88 and these null findings were replicated in Thailand (16).

89

90 One factor clouding the results of this previous research may be that measures of
91 grandparental investment were fairly simple indicators of availability, such as survival status
92 or coresidence. Studies which have correlated grandparental availability and child health or
93 survival tend to assume that any positive associations are driven by the provision of help
94 from grandparents to adult children and grandchildren (as is predicted by theory), but few
95 actually test this assumption (but see (12) for an exception).

96 In high income contexts more has been done to try and unearth what roles grandparents
97 play by looking at direct measures of investment, e.g. child care or financial support. This is
98 possible because contemporary, large-scale demographic datasets which have collected
99 detailed information on such variables are available (8,17,18). Such studies often report that
100 grandparents improve child health, usually measured as psychological and emotional
101 wellbeing. Again, there are a few studies where grandparents may be negatively associated
102 with child outcomes, but this may be because grandparents give the most help to children
103 most in need (8,19), although this cannot explain variation by lineage (20). Unfortunately
104 such detailed data from low income settings are limited, although data from hunter-
105 gatherers on time allocation of allocarers (21–23), and of downward intergenerational food
106 transfers (24), do support the prediction that grandparents invest in their grandchildren.

107

108 Here we use a detailed, large-scale demographic dataset from a low income country,
109 Guatemala, which contains information on the provision of three types of support from
110 grandparents to adult children and grandchildren, to test whether contact frequency with,
111 or the provision of financial support or advice from, each grandparent is associated with
112 improved child health. Contact frequency is a more sensitive measure of grandparental
113 investment than simple survival status, as grandparents need to be in contact with kin to
114 provide help. Financial support is a direct measure of material assistance, and indirect
115 evidence has shown that increased financial resources available to coresident grandmothers
116 improved grandchild nutritional status, when resident grandmothers, but not grandfathers,
117 had access to extra funding through the post-apartheid South African Old Age pension
118 programme (25). Advice may also be an important form of direct support which
119 grandparents can provide to their adult children, which may influence grandchild health. For

120 example, in an intervention study in Senegal, grandmothers were given information on
121 maternal health practices during and after pregnancy which they then transferred directly
122 to their daughters (in-law), who in turn were more likely to take up this advice compared to
123 a control group whose mothers (in-law) were not given the intervention (26). Other studies
124 have provided qualitative evidence that grandmothers are a common support of advice
125 around the perinatal period and for child feeding practices (Malawi: Bezner et al (27); Nepal:
126 Masvie (28); Gambia: Thompson and Rahman (29)), and recognising child illness (Ghana:
127 Douglass and McGadney-Douglass (30)), which may explain why caloric intake was found to
128 be higher in children with grandmothers in one Indian study by Sharma and Kanani (14).

129

130 As indicated above, previous work, albeit using grandparental survival status or coresidence,
131 has suggested that not all grandparents are equal when it comes to improving child health
132 or survival. Grandmothers, presumably because of their roles in caring for children and
133 providing advice to mothers and children, tend to be more frequently associated with child
134 outcomes, while grandfathers are typically less often associated with child health or survival
135 (with a few exceptions: (31)). In particular, the maternal grandmother has the strongest,
136 most frequent, and most often positive effect on child survival and health (6,7). Paternal
137 grandmothers tend to be less commonly beneficial than maternal grandmothers, although
138 they are sometimes associated with higher child survival. Two historical populations also
139 show evidence of higher grandchild mortality in the presence of paternal grandmothers:
140 Japan (32), and Germany, where mothers-in-law were apparently known as “the devil in the
141 house” (33). This lineage difference between maternal and paternal grandmothers is often
142 attributed to the indisputable genetic link between women, their daughters, and their

143 granddaughters (for all other grandparent-grandchild relationships there is at least one link
144 involving paternity uncertainty).

145

146 Paternity uncertainty may help explain why maternal grandmothers are more often
147 beneficial to children than paternal grandmothers, but it doesn't explain why grandmothers
148 are associated with *higher* child mortality in some societies. The answer here may be
149 resource competition within the family (10). Under conditions of resource stress, there may
150 be competition within the family for those limited resources, particularly among the lineage
151 within which resources are inherited. This was first suggested as the explanation for higher
152 mortality of female children in the presence of maternal grandmothers in a matrilineal
153 Malawian population (9), and subsequently suggested as the reason for less beneficial/more
154 harmful influences of paternal grandmothers in most of the existing literature, since the
155 majority of extant human societies are patrilineal (7,34). Resource competition has also
156 been suggested as the cause of some negative associations between the presence of
157 grandfathers and child survival, particularly in strongly patrilineal societies where older men
158 have the highest status, and therefore the best access to food, within households (35).

159

160 We contribute to the gap in research on grandparental influences on child health by
161 examining the impact of each different grandparent on child health (approximated by
162 height) in rural Guatemala, and examining *how* grandparents influence child health. We use
163 child height (standardised for age) as a proxy for health because stunted growth is a
164 common outcome of chronic malnutrition and poor health during childhood (36). Child
165 weight is likely to reflect short-term nutritional assaults to child health and so may be less
166 revealing when considering the long-term impact of grandparental investments. To

167 investigate the influence of grandparents, and the impact of direct measures of
168 grandparental support, we examined (a) how survival status and contact frequency of
169 individual maternal and paternal grandparents impact on child height, (b) whether direct
170 measures of grandparental support (advice or financial) are correlated with child height, and
171 (c) if the different types of grandparental contact and investment are more important for
172 infants' or older children's height.

173

174 Data

175 Data for the Guatemalan Survey of Family Health (Encuesta Guatemalteca de Salud Familiar
176 - EGSF) were collected from four regional departments in rural Guatemala (Chimaltenango,
177 Totonicapán, Suchitepéquez and Jalapa) between May and October 1995 (37). These data
178 were collected by the RAND Corporation and are available at
179 <http://www.rand.org/labor/FLS/EGSF.html>. Women aged 18 to 35, and up to four of their
180 youngest children, were measured for height and weight. Social network data were also
181 collected providing information on survival status and frequency of contact with
182 grandparents (i.e. the woman's parents and in-laws), as well as details on financial
183 assistance and personal support (advice) the mother received from each grandparent over
184 the past year. Further information was obtained about the child's father's absence from the
185 household as well as demographic information like maternal education, ethnicity, age, the
186 child's birth order and sex. Our models include married women only (i.e. those with in-laws)
187 although almost all sampled women were married (2.3% were not).

188

189 Guatemala during the 1990s, and still today, is one of the world's poorest countries and
190 children are severely stunted by World Health Organization (WHO) standards (38). The total

191 fertility rate in 1995 was 5.24 children per woman and child (under five) mortality rate was
192 61 deaths per 1000 live births. The Guatemalan population is divided approximately equally
193 by ethnic identity. Around half are of Mayan, and descendants of other pre-conquest
194 peoples, and the others originate from Spanish and mixed descent, known as Ladina (39).
195 The ethnic split of the EGSF sample is roughly one third Ladina, mainly because this is a rural
196 population which accommodates a higher proportion of indigenous people. For both groups
197 post-marital residence practices are flexible with newlyweds choosing patri-, matri-, or neo-
198 local dwellings, as is convenient (40). The Ladina group tend to own more land, attain
199 professional employment, and work in urban centres, while indigenous peoples mainly live
200 on subsistence agriculture and artisan industries, and they are socially and economically
201 marginalised. However, at the time of the EGSF survey, the majority of the inhabitants (i.e.
202 both ethnicities) of rural parts of Guatemala had limited access to clean water, electricity,
203 and public health facilities, and women are poorly educated. The combination of these
204 factors largely explain why Guatemalan children do poorly on world standards of growth
205 (39).

206

207 Methods

208 The EGSF sample comprises 2892 mothers with 3370 children aged from birth to five years.
209 Height for age z-scores (HAZ) were calculated based on NCHS/WHO international reference
210 population (41). To test which grandparents influence child height, we performed multiple
211 regression analyses on a split sample of infants aged 0-12 months and older children aged 1-
212 5 years. Around 17 percent of mothers had more than one child in the sample and so we
213 included a random effect for mother in the older child models. The infant sample did not
214 include siblings and so no random effect was included in those models. We removed twins

215 from all analyses (n=19). We first examined the relationship between grandparent survival
216 status and contact frequency with mothers, and child height, and then included variables
217 denoting the type of investment grandparents provided – financial and advice. All
218 grandparent variables were categorical. All models controlled for the child’s birth order, sex,
219 age and age squared, and the mother’s height, age, education, ethnicity, father absence,
220 and the department in which the family resides. Distributions of grandparent variables are
221 shown in Table 1 and descriptive statistics of all other variables are shown in Table 2.
222 Another strength of these data, is that there is considerable variation in contact frequency
223 with individual grandparents as well as the types of investment received from each. We
224 therefore model grandparental contact and investments individually for each grandparent.

225 **Table 1 here**

226 **Table 2 here**

227 Results

228 Figure 1 shows the distribution of HAZ scores for this sample of Guatemalan children. It is
229 evident that these children are severely stunted by WHO standards of growth. The mean
230 HAZ score is -2.37 standard deviations below the mean; between 2 and -2 is considered
231 healthy by WHO standards (36). Table 3 shows results from modelling grandparent survival,
232 contact frequency, financial aid, and advice received from grandparents, on infant and child
233 height, controlling for father absence, and all other demographics. The coefficients
234 represent the number of standard deviations of height for age, above or below the mean of
235 those in the reference category.

236 **Figure 1 here**

237 **Table 3 here**

238 *Contact frequency:* For babies, twelve months and younger, we find evidence for a
239 relationship between contact frequency with paternal grandmothers and infant length:
240 regular and daily contact are both associated with shorter babies. For children aged one to
241 five years, effect sizes are smaller suggesting grandparental influence may be weaker in
242 older children, but the relationship between paternal grandmother contact and child height
243 is still largely negative. In contrast, maternal grandmothers are broadly positively associated
244 with infant length and child height: coefficients are largely positive, and occasionally seeing
245 a maternal grandmother is significantly associated with taller stature in the 1-5 age group.
246 Figure 2 (a and b) illustrates the impact of each category of maternal and paternal
247 grandmother contact on (a) infant length and (b) child height, clearly demonstrating the
248 opposite effects of maternal and paternal grandmothers. There is weak evidence that
249 having a coresident maternal grandfather may also improve child height, as coresidence
250 with maternal grandfather is significantly associated with height in older children. Other
251 kinds of contact with maternal grandfathers is not consistently or significantly associated
252 with infant or child height. Paternal grandfathers too are not consistently or significantly
253 associated with child height in either age group.

254 **Figure 2 a & b here**

255 *Financial Assistance:* the relationship between financial assistance from grandparents and
256 child height is more complicated. When adding variables for financial assistance in the
257 models, only financial assistance from maternal grandfather is significantly associated with
258 child height in all models, however this relationship is positive for infants, but negative for
259 older children.

260 *Advice:* We found no evidence that the provision of advice from grandparents made any
261 difference to child height: point estimates are close to zero, none are significant, and the
262 signs of coefficients show no particular patterns.

263

264 In sum, the clearest evidence we have for grandparental influences suggests that contact
265 with paternal grandmothers is associated with shorter child height. We further find some
266 evidence that contact with maternal grandparents, particularly grandmothers, may be
267 beneficial for child height. It is possible that grandparental influences partly act through
268 maternal health, particularly since the effect sizes for these associations are larger for
269 babies than for older children. We performed multivariate linear regression analyses to test
270 if grandparental contact (and other forms of investment) was associated with maternal
271 body mass index (BMI). Patterns of associations between contact with grandmothers and
272 maternal BMI broadly show the same results as for child height. Contact, particularly
273 frequent contact, with paternal grandmothers is associated with significantly lower
274 maternal BMI. Contact with maternal grandmothers is not significantly associated with
275 maternal BMI, although the direction of associations is similar to those for child height
276 (Figure 3). We found little evidence for an effect of grandparent advice and financial
277 assistance on maternal BMI.

278

279 **Figure 3 here**

280 Discussion

281 Overall we see a positive impact of maternal grandmothers' contact with children on child
282 height. These results are particularly apparent for infants. By and large the impact of contact
283 with grandfathers on child health is limited. This population practices flexible post-marital

284 residence where some newlyweds live with the husband's family after marriage but if that is
285 inconvenient, they may live with the wife's family or they may live in a separate dwelling,
286 close to either the parents or in-laws (40). The patterns of contact frequency in our sample
287 reveal this pattern too: women tend to have slightly more contact with their in-laws
288 although many women see their own parents regularly and even daily. Previous research
289 suggests that maternal grandmothers might typically be more beneficial for child health and
290 survival (6,7,12,42), except in matrilineal populations where members of the matriline
291 compete for limited resources (9). Strassmann and Garrard (7) suggest that resource
292 competition is the explanation for the typically less beneficial effects of paternal
293 grandmothers compared to maternal grandmothers, given that most human populations
294 are patrilineal. Our findings lend support to this resource competition hypothesis. Not only
295 were children shorter in the presence of paternal grandmothers, but women had lower
296 BMIs if they were in frequent contact with their mothers-in-law. These findings also fit with
297 Beise and Volland's (33) suggestion that conflict between women and their mothers-in-law
298 may play a role, as the effects were particularly noticeable in infancy. The slightly better
299 child health seen with contact with maternal grandmothers, perhaps supported by higher
300 maternal BMI, suggests that contact with maternal grandmothers may involve helping
301 behaviour between mothers and daughters.

302

303 The more detailed data we have used on financial assistance and advice given to women by
304 their kin has not helped shed much light on how family support might influence child health.
305 There was no evidence that advice given to women made any difference to children's, or
306 women's, health. Previous research in other populations has suggested that older women
307 do have important roles in giving advice around childbirth and childcare to women, however

308 quite sizeable proportions of women claimed never to receive advice from grandparents in
309 this population, although this may reflect difficulties in interpreting the question. We also
310 have no information about the content or quality of advice given.

311

312 We find evidence for an association between maternal grandfather financial support and
313 child height but the estimates are in opposite directions for babies (positive) and older
314 children (negative). One problem with interpreting data on financial assistance from
315 relatives is that the provision of financial support may be based on the recipients' need.
316 Snopkowski and Sear (43), for example, found that poorer families received preferential
317 financial aid from grandparents (also see Schaffnit and Sear (44) for negative effects of
318 financial support on fertility). Receiving financial aid, therefore, may be an indication either
319 that a family is particularly in need of help (which may lead to a negative association
320 between the receipt of financial support and child health), or that a family is receiving extra
321 resources from relatives, which can be used to boost child health (leading to a positive
322 association between financial support and health). To test whether financial support might
323 be an indication of need in our sample, we examined what might predict financial support
324 from grandparents. We found that women with absent husbands were more likely to
325 receive financial support from their parents but not their in-laws, suggesting that financial
326 input from the woman's own family may be at least partly needs-based, although other
327 factors also accounted for some of the variation in financial support (such as education and
328 ethnicity). We unfortunately have little information about these absent husbands, and
329 absent husbands could result from labour migration, in which case, they may still be
330 contributing financially to a household even in their absence. Overall, then our results
331 suggest that there is considerable complexity within family relationships and their influence

332 on child health: both competition and cooperation within the family may explain
333 grandparental influences on child health, but results may also be confounded by differential
334 treatment of children and grandchildren by grandparents, if grandparents direct some kinds
335 of support preferentially to those children and grandchildren most in need.

336

337 Limitations

338 As with all cross-sectional studies we can only infer effects from correlations and not
339 assume that these relationships indicate a causal pathway. We also acknowledge that in
340 observational studies, there could be confounding factors that we cannot account for. We
341 have nevertheless controlled for as many potential confounders as possible. Also, it should
342 be noted that these data were not collected with our research question specifically in mind
343 so we are limited by the data available. We have tested a large number of variables, raising
344 the possibility that some significant results may be spurious (5% of the time seemingly
345 significant effects are random). However, we have based our interpretations on the pattern
346 of our results, shown by the direction of coefficients, as well as statistical significance.

347

348 Conclusion

349 We used a rich dataset from rural Guatemala to model the individual effects of
350 grandparental presence, contact frequency and direct investments (advice and financial) on
351 child height. Overall, our results support previous research finding that maternal
352 grandmothers tend to be beneficial for their grandchildren, although this relationship is
353 weak and many coefficients, although in the positive direction, are non-significant. We find
354 a negative relationship between contact with paternal grandmothers and child height,
355 supporting the hypothesis that paternal grandmothers and grandchildren compete for

356 resources within patriline. Previous work correlating the survival status of grandparents
357 with the survival of grandchildren has been criticised for not being able to exclude the
358 possibility that these relationships are driven by the influence of shared genes or
359 environments within families, i.e. families with long-lived grandparents might be healthy or
360 wealthy families who are also able to ensure the survival of young children. Our analysis
361 does not suffer from such problems. We should point out that there were no significant
362 findings for paternal grandfathers, nor for advice from any grandparent. The overall picture
363 gleaned from these data therefore may suggest that grandparents overall have a relatively
364 small impact on child height in this population. However, Guatemalan children fare very
365 poorly by world standards of nutrition meaning that even small amounts of support (or non-
366 support) from grandparents can have a meaningful impact on child health.

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368

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374

375 We have no competing interests.

376

377 Figure 1:
378 Distribution of HAZ scores in the EGSF sample.

379

380 Figure 2:
381 HAZ scores for each level of contact with grandmothers, adjusted for birth order, child age,
382 child age squared, sex, mother's education, age, height, ethnicity, father absence, and
383 department; (a) infants (b) 1-5 year olds.

384

385 Figure 3:
386 Maternal BMI scores for each level of contact with grandmothers, adjusted for age,
387 education, ethnicity, husband absence, and department.

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393 Table 1: Distribution of women's interactions with parents and in laws

	Mother	%	Father	%	Mother in law	%	Father in law	%
Contact frequency								
never	49	1.7	102	3.6	107	4.8	112	5.0
once a month or less	530	18.7	492	17.4	282	12.6	228	10.2
regularly: at least once a fortnight	746	26.4	629	22.3	369	16.5	328	14.7
daily	363	12.8	289	10.2	636	28.5	500	22.4
coresident	736	26.0	573	20.28	400	17.9	302	13.5
dead	405	14.3	740	26.19	441	19.73	765	34.23
Advice (alive GPs only)								
never	1,014	41.8	1,225	58.6	1,090	60.5	1,104	74.7
sometimes	920	37.9	595	28.5	467	25.9	271	18.3
often	493	20.3	269	12.9	246	13.6	103	7.0
Financial support (alive GPs only)								
none	1,970	68.8	1,459	69.8	1,454	80.6	1,235	83.6
gave/lent money	757	31.2	630	30.2	349	19.4	243	16.4

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397 Table 2: descriptive statistics for all other variables

	n	%		
Time husband spends away				
not resident in household	108	5.9		
often away	193	10.6		
sometimes away	249	13.7		
never away	1,268	69.8		
Ethnicity				
indigenous	1806	63.3		
ladina	998	35.0		
other	49	1.7		
Department				
Suchitepequez	736	25.9		
Jalapa	755	25.7		
Chimaltenango	737	24.5		
Totonacapan	664	24.0		
Mothers:	n	mean	s.d.	
height in cm	2668	147.3	5.8	
age	2873	25.8	5.19	
highest grades attained	2861	2.7	2.99	
Children:				
birth order	3370	3.4	1.99	
age in months	3359	33.4	19.08	

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Grandparents and child height

403 Table 3: Results of regression analyses for grandparental contact and support on HAZ scores for babies (0-12 months), and 1-5 year old children.

	Babies (0-12 Months)			Children (1-5 Years)		
	Model 1 n=523	Model 2 n=522	Model 3 n=522	Model 1 N=2448	Model 2 n=2443	Model 3 n=
Height for age z-score	Beta (s.e.)	Beta (s.e.)	Beta (s.e.)	Beta (s.e.)	Beta (s.e.)	Beta (s.e.)
Contact with matGM (ref: dead)						
never	-0.28 (0.32)	-0.27 (0.32)	-0.27 (0.32)	0.02 (0.19)	0.02 (0.19)	0.01 (0.19)
once a month or less	0.27 (0.18)	0.30 (0.18)	0.33 (0.19)	0.18 (0.08)*	0.19 (0.08)*	0.21 (0.09)*
regularly, at least once a fortnight	0.13 (0.17)	0.20 (0.17)	0.21 (0.18)	0.03 (0.08)	0.03 (0.08)	0.05 (0.09)
daily	0.03 (0.22)	0.14 (0.23)	0.19 (0.24)	0.11 (0.11)	0.12 (0.11)	0.14 (0.11)
coresident	-0.07 (0.30)	0.01 (0.31)	0.10 (0.33)	-0.11 (0.15)	-0.09 (0.15)	-0.07 (0.16)
Contact with patGM (ref: dead)						
never	-0.43 (0.38)	-0.52 (0.39)	-0.52 (0.39)	-0.40 (0.17)*	-0.40 (0.17)*	-0.40 (0.17)*
once a month or less	-0.27 (0.20)	-0.22 (0.20)	-0.16 (0.21)	0.06 (0.10)	0.05 (0.10)	0.03 (0.10)
regularly, at least once a fortnight	-0.38 (0.19)*	-0.37 (0.19)†	-0.36 (0.20)	0.03 (0.09)	0.00 (0.09)	-0.04 (0.09)
daily	-0.43 (0.16)**	-0.40 (0.16)*	-0.40 (0.17)*	-0.08 (0.08)	-0.11 (0.08)	-0.14 (0.08)
coresident	-0.29 (0.19)	-0.26 (0.20)	-0.27 (0.21)	-0.14 (0.10)	-0.17 (0.10)	-0.21 (0.11)
Contact with matGF (ref: dead)						
never	0.15 (0.26)	0.09 (0.26)	0.11 (0.26)	0.08 (0.15)	0.05 (0.16)	0.05 (0.16)
once a month or less	-0.07 (0.17)	-0.16 (0.17)	-0.17 (0.18)	-0.04 (0.08)	-0.01 (0.08)	-0.02 (0.08)
regularly, at least once a fortnight	0.05 (0.14)	-0.04 (0.15)	-0.03 (0.16)	0.09 (0.07)	0.13 (0.07)	0.12 (0.08)
daily	0.24 (0.22)	0.11 (0.23)	0.11 (0.23)	-0.08 (0.11)	-0.03 (0.11)	-0.04 (0.11)
coresident	-0.05 (0.35)	-0.17 (0.36)	-0.19 (0.37)	0.32 (0.18)	0.40 (0.18)*	0.39 (0.18)*
Contact with patGF (ref: dead)						
never	-0.34 (0.33)	-0.26 (0.35)	-0.30 (0.35)	-0.01 (0.16)	0.03 (0.16)	0.04 (0.16)
once a month or less	-0.16 (0.20)	-0.12 (0.20)	-0.18 (0.21)	0.12 (0.10)	0.12 (0.10)	0.15 (0.10)
regularly, at least once a fortnight	-0.10 (0.17)	-0.02 (0.18)	-0.03 (0.18)	-0.05 (0.08)	-0.01 (0.09)	0.02 (0.09)
daily	0.01 (0.15)	0.04 (0.16)	0.01 (0.16)	0.08 (0.07)	0.11 (0.08)	0.13 (0.08)
coresident	-0.28 (0.20)	-0.25 (0.20)	-0.31 (0.21)	0.06 (0.11)	0.08 (0.11)	0.11 (0.11)

Grandparents and child height

Money from matGM (ref: none)							
	gave and/or lent money	-0.24 (0.14)	-0.23 (0.15)		-0.02 (0.07)	-0.01 (0.08)	
Money from patGM (ref: none)							
	gave and/or lent money	-0.08 (0.16)	-0.05 (0.16)		0.16 (0.08)*	0.14 (0.08)	
Money from matGF (ref: none)							
	gave and/or lent money	0.34 (0.16)*	0.34 (0.16)*		-0.20 (0.08)*	-0.21 (0.09)*	
Money from patGF (ref: none)							
	gave and/or lent money	-0.18 (0.19)	-0.22 (0.19)		-0.13 (0.09)	-0.09 (0.09)	
Advice from matGM (ref: never)							
	Sometimes		0.01 (0.15)			-0.05 (0.07)	
	Often		-0.24 (0.20)			0.00 (0.10)	
Advice from patGM (ref: never)							
	Sometimes		-0.14 (0.14)			0.05 (0.07)	
	Often		0.10 (0.20)			0.13 (0.10)	
Advice from matGF (ref: never)							
	Sometimes		0.02 (0.16)			0.04 (0.08)	
	Often		-0.10 (0.26)			0.00 (0.13)	
Advice from patGF (ref: never)							
	Sometimes		0.04 (0.18)			-0.09 (0.09)	
	often		0.30 (0.29)			-0.18 (0.14)	
	Intercept	-7.99	-7.99	-8.08	-14.43	-14.43	-14.43

404 Key: matGM = maternal grandmother, patGM = paternal grandmother, matGF = maternal grandfather, patGF = paternal grandfather. All models control for
 405 father absence, child's birth order, age, age², sex, and mother's height, age, education, ethnicity, and regional department (full models can be found in ESM).

406 *= $p < 0.05$ **= $p < 0.01$ †= $p = 0.051$

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