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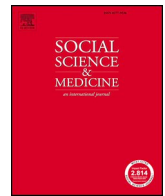
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Grandparental childcare, health and well-being in Europe: A within-individual investigation of longitudinal data

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ABSTRACT

Previous studies suggest grandparental childcare is associated with improved health and well-being of grandparents but limited information on the causal nature of this association exists. Here, we use the longitudinal Survey of Health, Ageing and Retirement in Europe (SHARE) of people aged 50 and above across 11 countries including follow-up waves between 2004 and 2015 ($n = 41,713$ person-observations from 24,787 unique persons of whom 11,102 had two or more measurement times). Between-person and within-person (or fixed-effect) regressions were applied, where between-person models show associations across participants and within-person models focus on each participant's variation over time. Health and well-being were measured according to self-rated health, difficulties with activities of daily living (ADLs), depressive symptoms, life satisfaction and meaning of life scores. Across all analyses, childcare assistance provided by older adults to their adult children, was associated with increased health and well-being of grandparents. However, these associations were almost completely due to between-person differences and did not hold in within-person analyses that compared the same participants over time. Fewer ADL limitations for grandparents who provided childcare assistance was the only association that remained in the within-individual analyses. These findings suggest that there might be only limited causal association between grandchild care and grandparental well-being and that it may be specific to physical rather than cognitive factors. The results are discussed with regard to evolutionary psychology assumptions of altruistic behavior and positive health outcomes for the helper.

1. Introduction

Grandparental care may provide many benefits for grandchildren (Sear and Coall, 2011; Sear and Mace, 2008; but see Tanskanen and Danielsbacka, 2017), but does it also produce health and well-being benefits for grandparents, and if it does, is this association causal? In contemporary aging societies, this question is salient (Coall and Hertwig, 2010; Mare, 2011). An obvious reason for the growing interest in grandparental well-being is the fact that life expectancy and the number of elderly people are increasing in Western populations (Bengtson, 2001; Glaser et al., 2010). The relevance of exploring grandparental outcomes is derived from the potential health benefits to the helpers, which provides a new perspective on older people who are simultaneously providers of assistance to others and recipients of the

health benefits they may gain from these helping behaviors (Coall and Hertwig, 2010; Tanskanen and Danielsbacka, 2019).

Previous studies have used either subjective (e.g., self-rated health; Di Gessa et al., 2016a) or objective (e.g., cognitive tests; Arpino and Bordone, 2014) measurements of grandparental health and well-being. In this article, we measure grandparental health and well-being with self-rated health, life satisfaction, meaning of life scores, depressive symptoms and activities of daily living (ADL) limitations. All these measurements are based on respondents' own perceptions, and thus, they may be defined as subjective measures of grandparental health and well-being. However, depressive symptoms and ADL limitations are both measured through a series of questions that have been validated in previous studies (Katz et al., 1963; Prince et al., 1999) and they may be considered also more "objective" measures than self-rated health, life

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satisfaction and meaning of life. In addition, self-reported ADL limitations in the Survey of Health, Ageing and Retirement in Europe (SHARE) correlate with objective measures of grip strength and walking speed (Seidel et al., 2011).

According to evolutionary theory, grandparents' investments in grandchildren may ultimately increase the number of offspring who survive to reproductive age (Euler, 2011; Hawkes et al., 1997; Sear and Coall, 2011). Inclusive fitness theory (Hamilton, 1964) suggests that a selection pressure exists for altruism toward one's own kin, especially toward close kin in descending order. Previous studies have produced evidence for grandparental fitness benefits in historical populations (Lahdenperä et al., 2004) and in contemporary societies, suggesting that grandparental care might still be beneficial for grandchild well-being (Sear and Coall, 2011; Tanskanen and Danielsbacka, 2012; but see Tanskanen and Danielsbacka, 2017) and parental fertility (Kaptijn et al., 2010; Tanskanen et al., 2014; Waynforth, 2011).

Evidence also suggests that grandparenthood and grandparental childcare are associated with direct survival benefits for grandparents themselves as measured by mortality (Christiansen, 2014; Hilbrand et al., 2017a). One mechanism linking grandparental investment and decreased mortality is that grandparental investment (e.g., looking after one's grandchildren), potentially through increased activity levels or cognitive stimulation, may improve a grandparent's health and well-being, which in turn reduces mortality (Hilbrand et al., 2017b). Thus, from this viewpoint, the evolutionary function of health benefits received from helping is enhanced survival and longevity of the ego (Kim et al., 2014).

Another potential explanation for positive grandparental health outcomes is that positive emotions such as improved life satisfaction and lower depressive symptoms function as proximate mechanisms (or motives) that facilitate investments toward children and grandchildren. Hence, the evolutionary function of positive emotions is that they encourage grandparents to act in an evolutionary beneficial way (i.e., to invest in grandchildren). This function is not necessarily targeted at the grandparent's own direct health and survival; however, the possible well-being benefits may be a by-product (Buss, 2000; De Waal, 2008; Euler, 2011). Thus, according to evolutionary theory, we may predict that grandparental childcare is associated with improved subjective and objective measures of grandparental health and well-being.

Importantly, the association between grandparental childcare and the health of grandparents may not always be positive (Coall and Hertwig, 2011; Glaser et al., 2010). Indeed, a negative effect may arise when no grandparental investment exists at all (Drew and Silverstein, 2007) or when grandparental investment reaches its highest level (e.g., in the form of custodial care; Baker and Silverstein, 2008; Chen and Liu, 2012; Grinstead et al., 2003; Hughes et al., 2007; Taylor et al., 2016). Therefore, the familial context of grandparental childcare is central to understanding the health implications of helping. The context of grandparenting (e.g., whether they are custodial or non-coresiding) may cause possible selection effects (i.e., regarding health and well-being custodial grandparents could have initially different characteristics than non-coresiding grandparents), which in turn can explain grandparental outcomes. If grandparental outcomes are due to selection effects, the association between caregiving and health and well-being should not be causal.

Previous evidence suggest, however, that providing moderate help may have health benefits for the grandparents. Positive associations have been found between active grandparenting (measured as contact frequencies, emotional closeness or childcare), especially among grandparents who do not live with their grandchildren, and grandparent's subjective well-being (Di Gessa et al., 2016a, 2016b; Mahne and Huxhold, 2015), increased life satisfaction, improved mental health and lower risk of depression (Arpino and Bordone, 2014; Grundy et al., 2012; Tsai et al., 2013; but see Brunello and Rocco, 2016) that may ultimately increase survival (Hilbrand et al., 2017a).

These studies provide a valuable body of evidence that

grandparental childcare and health are associated among non-custodial grandparents when compared to noncaregiving grandparents. Many of the studies mentioned above (e.g. Di Gessa et al., 2016a, 2016b; Tsai et al., 2013) have utilized longitudinal data, meaning that they have measurements for more than one time point and can thus investigate whether different groups of grandparents (e.g., those who provide childcare and those who do not) differ in their health outcomes at a subsequent time point. These analyses, however, remain between-individuals which does not enable conclusions about the causal nature of this association to be made (i.e., whether an increase or decrease in childcare is influencing a particular grandparent's health over time). These studies provide a between-person approach by comparing the health and well-being of non-caring grandparents with that of caregiving grandparents. Longitudinal, within-individual analyses are needed to better understand potential causality in this association.

Attempts to understand the causal and longitudinal nature of the association between grandparental childcare and grandparental outcomes have just begun. Using SHARE data, Arpino and Bordone (2014) provide important evidence suggesting a causal association between grandparental childcare and improved verbal fluency in grandparents by utilizing an instrumental variable (IV) approach. To date, however, only a handful within-individual analysis have investigated within-person effects between childcare and grandparental health outcomes (Ates, 2017; Ku et al., 2012, 2013; Reinkowski, 2013; Sheppard and Monden, 2018). Within-person effects show how an increase or decrease in grandchild care is associated with the health of a particular grandparent over time. Only longitudinal analyses, such as within-person regression, or other methods addressing the problem of endogeneity, such as IV regression, can provide evidence of a possible causal association between caregiving and grandparental outcome.

A preliminary study by Reinkowski (2013) used three waves of SHARE data and utilizing different methods including within-person models to detect causal associations did not found any within-person associations between grandparental childcare and grandparental health outcomes (measured with an index of physical health, cognitive functioning and mental health) among grandmothers. To build upon Reinkowski (2013) work, our analysis utilizes additional SHARE data waves, we were able to extend the analysis to include grandfathers, and to incorporate additional outcome measures that reflect grandparent's life satisfaction and meaning of life. We have also tested different interactions according to grandparent's gender, age and country group. Thus, our analyses bring several additional results compared to Reinkowski (2013) preliminary study. Sheppard and Monden (2018) also tested with three waves of SHARE data whether looking after grandchildren is associated with depressive symptoms, subjective life expectancy and life satisfaction and found no within-person associations.

Using longitudinal Taiwanese data, Ku et al. (2012) found a small within-individual effect between the provision of childcare and grandparent's health. However, they did not distinguish the effect of caregiving by grandparents' co-residence status. In their subsequent study, when they separated the sample by co-residence status, the within-person effect among non-coresiding grandparents attenuated and was no longer statistically significant (Ku et al., 2013). Using German longitudinal data, Ates (2017) found no within-person effects supporting the association between supplementary childcare and grandparent's self-rated health. These findings point to the possibility that the associations found in the first mentioned set of studies may reflect between-person effects and potential selection bias – healthier grandparents with greater well-being provide more childcare than those in poorer health conditions – or that an unobservable third factor associated with both childcare and health is producing the association (Hilbrand et al., 2017b).

Here, we investigate whether the childcare-grandparental health/well-being association reported previously can be found in a within-person design (i.e., whether changes in grandchild care influences

grandparent health and well-being over time) with a large and multinational database. Our study is a valuable addition to the previous investigations that have tried to detect causal associations between grandparental childcare and grandparental health and well-being because we are able to use multinational data, over longer follow-up periods, incorporating several outcome measures and include interactions according to grandparent's gender, age and country group.

We will examine within-person (or fixed-effect) associations in longitudinal models that concentrate on within-person variation in exposure and exclude between-person effects (Curran and Bauer, 2011). This design will enable us to test a social causation hypothesis (i.e., whether changes in grandchild care frequencies are associated with subsequent changes in grandparent health and well-being) and also an alternative hypothesis that the association is due to social selection (i.e., changes in grandparental health and well-being are associated with subsequent changes in the amount of grandchild care). To establish the correct temporal ordering, grandparental childcare and other covariates are measured one study wave before the outcome variables of grandparental health and well-being (for the social selection hypothesis, childcare is the outcome variable and it is measured one study wave after the independent variables i.e., grandparental health and well-being, and covariates).

In addition, the association between grandparental childcare and grandparental health may vary due to different demographic factors, therefore we investigate several interactions. Based on previous results examining grandparental childcare and grandparental health, in this analysis we have included interactions between childcare and grandparent's gender, age and country group. The reason for including interactions between grandparental childcare and gender is that it is well known that grandmothers provide more childcare than grandfathers (e.g., Coall and Hertwig, 2010) and for this reason they might also have different outcomes associated with childcare provided. Grandmothers may also experience active grandparenting more rewarding than grandfathers, which may also produce different well-being outcomes for grandmothers compared to grandfathers (e.g., Danielsbacka and Tanskanen, 2016). Grandparental age can be an important determinant of health and that is why it is relevant to see whether childcare is differentially related to grandparental health outcomes among different age groups. Previous results show (Di Gessa et al., 2016c; Hank and Buber, 2009) that in Europe the need for grandparental childcare as well as intensive childcare is associated with country of residence and that is why we include also interaction between grandparental childcare and country groups in our analyses. We have grouped the countries into four categories (Southern Europe: Italy and Spain; Central Europe: Switzerland, France, Germany, Austria and Belgium; Northern Europe: Netherlands, Sweden and Denmark; Eastern Europe: the Czech Republic) based on family policy regimes (Leitner, 2003; Reinkowski, 2013). In addition to interaction results, we further examine the differences in gender, age and country groups by running separate analyses for each group.

We examine these questions across five waves of the longitudinal SHARE data that examined respondents aged 50 and above from 11 European countries between 2004 and 2015. The fixed-effect procedure used here provides a test of the causality in the associations between grandparental childcare and health and well-being.

2. Material and methods

2.1. Data

We used data from the SHARE, which was designed to collect longitudinal data on the aging process of Europeans (see www.share-project.org). The target population consists of people aged 50 and above who speak the official language of their country and did not live abroad or in an institution during the fieldwork period. The SHARE data collection procedure was based on a computer-assisted personal

interview. Here, we use the first (data collection in 2004 and 2005 (Börsch-Supan, 2018a; Börsch-Supan and Jürges, 2005)), second (2006 and 2007 (Börsch-Supan, 2018b; Börsch-Supan et al., 2008)), fourth (2011 and 2012 (Börsch-Supan, 2018c; Malter and Börsch-Supan, 2013)), fifth (2013 (Börsch-Supan, 2018d; Malter and Börsch-Supan, 2015)) and sixth (2015 (Börsch-Supan, 2018e; Malter and Börsch-Supan, 2017)) wave data collected from 11 European countries: Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Switzerland, Belgium and Czech Republic. The third wave of SHARE was a retrospective life history data collection round (SHARELIFE) with different questionnaires and was thus excluded from this study. In the total and between-individual analyses, we included respondents who had at least one grandchild, and answered all of the variables used in this study. Our final sample included 41,713 person-observations from 24,787 unique people (aged 50–89 years) over the 11-year follow-up period. In within-person analyses only those respondents who participated in at least two waves, who had at least one grandchild, and answered all of the variables used in this study are included. This resulted in within-person models with 28,028 person-observations from 11,102 unique people.

2.2. Outcome variables

SHARE contains several measures of grandparental health and well-being including self-rated health, life satisfaction, meaning of life scores, depressive symptoms and limitations with activities of daily living (ADL limitations) that we explored in this study (see Table 1 for descriptive statistics). Respondents reported *self-rated health* in all study waves on a scale ranging from 1 = *excellent* to 5 = *poor*. We inverted the scale so that a higher score reflected improved health and treated the variable as continuous. *Life satisfaction* and *meaning of life* questions were asked only in waves 2, 4, 5 and 6. *Life satisfaction* was measured via self-report on a scale ranging from 0 (*completely dissatisfied*) to 10 (*completely satisfied*). For the *meaning of life* measure, respondents were asked to answer five questions on a 4-point scale (ranging from 1 = *never* to 4 = *often*). These questions were “How often do you look forward to each day?” “How often do you feel that your life has meaning?” “How often do you feel full of energy these days?” “How often do you feel that life is full of opportunities?” and “How often do you feel that the future looks good for you?” A mean sum score was created from these items (Cronbach's alpha = 0.80). The standardized sum scale ranged between 1 and 4, where higher numbers denoted greater feelings of meaning of life.

Depressive symptoms were measured in the SHARE questionnaire (waves 1, 2, 4, 5 and 6), using the EURO-D 12-item scale with established validity and reliability (see Prince et al., 1999). Respondents were asked whether, in the last month prior to the interview, they had experienced any depressive symptoms such as feeling depressed or sad, feeling that they would rather be dead, and whether they had lost interest in things, had trouble sleeping recently. The response options were either yes/no or whether or not the respondent had experienced any of these feelings. Approximately 78% of all person-observations reported having depressive symptoms.

In waves 1, 2, 4, 5 and 6, respondents were also asked whether they had experienced any difficulties with basic activities of daily living (ADL limitations) that they expected to last at least three months. In the questionnaire, such difficulties included walking 100 m, getting up from a chair after sitting for long periods, dressing (including putting on shoes and socks), shopping for groceries up to a total of 23 different difficulties. Approximately 54% of all person observations included at least one difficulty. The reason that such a high proportion of people experienced a limitation (c.f., Di Gessa et al., 2016a) was that we included all possible limitations mentioned (including, for example, problems with instrumental activities, mobility, fine motor skills), not only the most noticeable limitations such as bathing, showering, or walking across the room. By including all possible limitations, we are

Table 1

Descriptive statistics of the 41,713 person observations from 24,787 people across waves 1, 2, 4, 5 and 6 of the SHARE.

	Total no.	No. of persons	%	Mean (SD)	Within person SD
Self-rated health					
Poor	3391	2748	8.1		
Fair	10983	8396	26.3		
Good	16087	12124	38.5		
Very good	7660	6136	18.3		
Excellent	3648	2916	8.7		
Life satisfaction ^a	34,696	22,099		7.7 (1.74)	0.74
Meaning of life ^a	34,805	22,146		3.3 (0.62)	0.24
Depressive symptoms	41,775	24,827		2.3 (2.18)	0.96
ADL limitations	41,775	24,827		2.1 (3.29)	1.27
Sex					
Men	16,658	10,243	39.9		
Women	25,111	14,580	60.1		
Age at interview	41,769	24,823		67.9 (9.01)	2.0
Partnership status					
Living with spouse/partner	26,655	16,874	63.8		
Living without spouse/partner	15,114	8496	36.2		
Employment status					
Working	7350	5360	17.6		
Not working	34,419	20,748	82.4		
Years of education	41,769	24,823		10.4 (4.35)	0
Smoking					
Never smoke	23,005	13,531	55.1		
Ever smoke	11,749	7123	28.1		
Currently smoking	7015	4227	16.8		
Heart attack					
Never had heart attack	36,411	22,346	87.2		
Ever had heart attack	5358	4053	12.8		
Cancer					
Never had cancer	39,517	23,673	94.6		
Ever had cancer	2252	1935	5.4		
Number of children	41,763	24,819		2.6 (1.28)	0.2
Number of grandchildren	41,769	24,823		3.9 (2.91)	0.6
Child care					
No care	19,896	13,687	47.7		
Less often than almost every month	6217	5042	14.9		
Almost every month	5578	4692	13.4		
Almost every week	7104	5647	17.0		
Almost daily	2924	2347	7.0		
Country					
Austria	3388	2059	8.1		
Germany	3081	2143	7.4		
Sweden	4029	2391	9.7		
Netherlands	2243	1378	5.4		
Spain	3979	2566	9.5		
Italy	3553	1993	8.5		
France	4699	2691	11.3		
Denmark	3528	1986	8.5		
Switzerland	2426	1312	5.8		
Belgium	5582	3020	13.4		
Czech Republic	5261	3284	12.6		

Notes. Total no. = Number of total person-observations; No. of persons = Number of unique person.

SD = Overall standard deviation; Within-person SD = Within-person standard deviation.

Notes. Total no. = Number of total person-observations; No. of people = Number of unique people; SD = Overall standard deviation; Within-person SD = Within-person standard deviation.

^a questions were asked only in waves 2, 4, 5 and 6.

able to gain more accurate information regarding the possible changes in ADL functioning over time.

2.3. Independent variable

Grandchild care was the main independent variable in this study.

The SHARE includes questions whether respondents provided childcare without the presence of the parents during the 12 months prior to the interview and, if so, how often (ranging from 1 = *almost daily* to 4 = *less than almost every month*). Only those respondents who had grandchildren were asked this question regarding up to 20 children, separately (in all waves). We calculated the mean grandchild care variable by summing and averaging the answers for all children, producing a scale where 0 = *no care* (48% of all person observations), 1 = *less than almost every month* (15%), 2 = *almost every month* (13%), 3 = *almost every week* (17%), 4 = *almost daily* (7%). For instance, if a grandparent has grandchildren via three children and he/she looks after one child's children less often than every month and second and third child's children almost every month the mean childcare is thus almost every month $((1 + 2 + 2)/3 = 1.7)$. We have treated the childcare variable as continuous. For sensitivity purposes we also formulated a variable that accounted for approximate total care days (which might be higher than mean care because a grandparent might provide care less frequently but more in total for several children's children; thus, the total care days might be higher than the mean care score indicates). Sensitivity analyses with this variable did not change the results.

2.4. Control variables

Several potential confounds, which were assessed at baseline (i.e., one study wave before the outcome measure), were adjusted for. These covariates included respondent gender, age at interview, partnership status, employment status, years of education, smoking status, heart attack status, cancer status, and number of children and grandchildren. We also included the fixed-effect of country in the analyses. These confounders were included because in previous studies they have been shown to associate with grandparental health, well-being and/or childcare provided (Tanskanen and Danielsbacka, 2019). In within-person models, those covariates whose values do not change between the waves (i.e., time-invariant factors) were omitted from the analyses (i.e., respondents gender, years of education, country). In addition to other covariates, we controlled for the time period (in months) between the baseline and outcome measure interview. Covariates, whose values might change between waves, were modeled as time-varying variables (e.g., age at interview, partnership status, employment status). To avoid a drop in the number of observations, the age of the youngest grandchildren was not controlled for in the basic analyses because the SHARE only collected this information systematically with regard to the respondents' four oldest children. However, we conducted sensitivity analyses in which this variable was accounted for with similar results to those found in the main analyses. Descriptive statistics are presented in Table 1.

2.5. Methods

We analyzed the SHARE data using random-intercept multilevel regression and, in the case of *depressive symptoms* and *ADL limitations*, multilevel Poisson regression analyses where the repeated measures (i.e., person-observations) are nested within responding persons. We conducted both between- and within-person (or fixed-effect) models, where the between-person effects represented the results across individuals, and the within-person effects represented individual variation over time. In practice, the between-person models provide mean scores for respondents whereas for the within-person models, the observed grandparents served as their own controls (other studies using this approach see e.g., Jokela et al., 2018). Therefore, within-person models eliminate all time-invariant components (Allison, 2009) such as ethnic background, numerous genetic factors, and other selection effects. In all analyses the outcome variable was measured as time-lagged, i.e., one study wave after the independent and control variables.

Within-person regression models have several strengths, but they

also have some limitations. One is that these models cannot account for the time-variant unobserved characteristics. Fixed-effect models may also exacerbate measurement errors which means that it is important to avoid over-interpretation (Angrist and Pischke, 2008). In addition, the sample size may be reduced in within-person models because of a small number of participants who experience a change in the case of both outcome and main independent factors. However, in the present study this is not an issue because we have enough observations in the within-person models, as mentioned above. Despite the limitations, within-person regressions may provide a test for causality in the association between active grandparenting and grandparental well-being (see also Ates, 2017).

3. Results

3.1. Descriptive results

The descriptive results of the childcare transitions of respondents who provided within-person data and were thus included in the fixed-effect models are shown in Table 2. The majority of grandparents maintained the same childcare level between waves. The childcare transition frequencies indicated that more transition existed between categories close to each other than those further from each other, and more transition to less frequent rather than more frequent care was found during the study period which may reflect ageing of grandparents and grandchildren. Stability and change as measured by the intraclass correlation coefficient reporting the correlation of the person-observations within a person over time for childcare was 0.67. The patterns were fairly similar for both women (0.67) and men (0.66). The intraclass correlations for ADL limitations, self-rated health, meaning of life, life satisfaction, and depressive symptoms were 0.73 (women = 0.73, men = 0.77), 0.70 (women = 0.70, men = 0.70), 0.69 (women = 0.70, men = 0.68), 0.66 (women = 0.65, men = 0.66), and 0.66 (women = 0.65, men = 0.67), respectively. These correlations indicate high stability over time especially with regard to ADL limitations and self-rated health.

3.2. Analytical results from the multilevel models

We investigate the associations between childcare provision and ADL limitations, self-rated health, life satisfaction, meaning of life and depressive symptoms. The magnitudes of the total, between-person, and within-person regression coefficients of the multilevel models are illustrated in Fig. 1. Total regression coefficients consist of both between-person and within-person effects. Between-person coefficients illustrate variation across individuals (i.e., between those grandparents who provide more childcare and those who provide less). We are here mainly interested in within-person coefficients, which represent an individual's variation over time (i.e., whether changes in the amount of childcare are associated with subsequent changes in grandparent's health and well-being).

The total regression coefficients show that across all health

outcomes, grandchild care was associated with more positive outcomes (Fig. 1). The majority of these effects, however, were found in the between-person analyses and thus they represent mainly variation between individuals. In the between-person analysis, childcare frequencies were associated with increased self-rated health, life satisfaction and higher meaning of life scores (Fig. 1; self-rated health $\beta = 0.06$, $p < .001$; life satisfaction $\beta = 0.08$, $p < .001$; meaning of life $\beta = 0.04$, $p < .001$). Similarly, grandchild care was associated with fewer depressive symptoms and fewer ADL limitations (Fig. 1; depressive symptoms $\beta = -0.03$, $p < .001$; ADL limitations $\beta = -0.14$, $p < .001$).

In the within-person analyses, however, the majority of these associations did not remain. This means that those grandparents who experienced a change in their childcare frequencies did not experience any corresponding change in the subsequent wave of their self-rated health, life satisfaction, meaning of life or depressive symptoms that would be associated with the childcare provided (Fig. 1; self-rated health $\beta = 0.004$, $p = .532$; life satisfaction $\beta = 0.01$, $p = .222$; meaning of life $\beta = -0.01$, $p = .131$; depressive symptoms $\beta = -0.002$, $p = .635$). The ADL limitations outcome variable was the only exception. ADL limitations decreased when childcare provision increased according to both between-person and within-person models (Fig. 1; ADL limitations $\beta = -0.01$, $p = .039$). Although within-person association was small and the between-person effect was much stronger, these results nevertheless suggest that grandparents may gain specific health benefits from active grandparenting over time.

3.3. Interactions

Because grandparental childcare might have different effects on grandmothers and grandfathers as well as grandparents of different ages, we re-conducted all within-person models with interaction terms between grandparent age (categorized and centred at 60 years old) and childcare and grandparent gender and childcare. To examine potential cultural differences, we grouped the countries into four categories (Southern Europe: Italy and Spain; Central Europe: Switzerland, France, Germany, Austria and Belgium; Northern Europe: Netherlands, Sweden and Denmark; Eastern Europe: the Czech Republic) and included the interaction term between country group and childcare in within-person models. Country groups were classified based on type of family policy regimes (Danielsbacka et al., 2011; Haavio-Mannila and Rotkirch, 2009; Leitner, 2003; Reinkowski, 2013), and were used instead of specific countries to achieve sufficient statistical power. In addition, we split the data according to gender, age and country groups to examine further the possible differences between groups.

We found an interaction effect in within-person models between childcare and the grandparents' age at interview for life satisfaction and meaning of life (Table 3). Analyses with split data confirmed that for both of these outcomes, the results were similar: Increases in childcare decreased life satisfaction and meaning of life among the youngest grandparents and conversely, improved these outcomes among the oldest grandparents, although in the split models the associations were

Table 2

Transitions in childcare between consecutive study waves (5 study waves in total). All respondents who experienced change.

Childcare	Childcare					Total n
	No care	Less often than almost every month	Almost every month	Almost every week	Almost daily	
No care	5711	605	363	421	177	7277
Less often than almost every month	956	1012	424	240	40	2672
Almost every month	470	447	725	442	83	2167
Almost every week	497	240	515	1282	253	2787
Almost daily	261	58	80	276	505	11,780
Total n	7895	2362	2107	2661	1058	16,083
Total %	49.1	14.7	13.1	16.6	6.6	

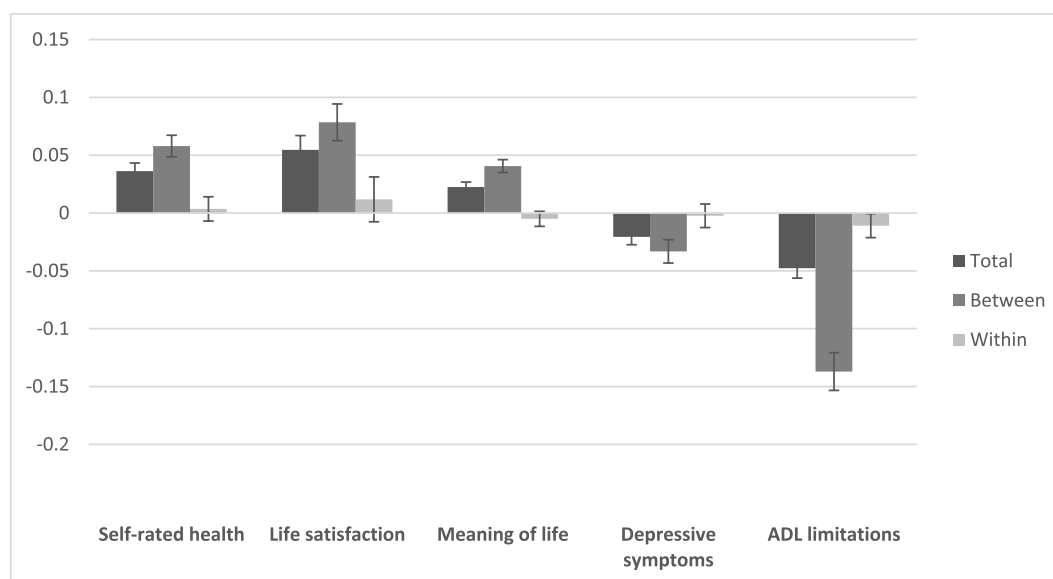


Fig. 1. Associations between childcare and outcome variables based on total (blue bars), between-person (red bars), and within-person (grey bars) regressions using four repeated measurements of childcare and outcomes (41,713 person observations from 24,787 people, of whom 11,102 had two or more measurement times) from the Survey of Health, Ageing and Retirement in Europe, 2004–2015. The bars illustrate the magnitude of the linear regression coefficients (self-rated health, life satisfaction, and life meaning) and Poisson regression coefficients (depressive symptoms and ADL limitations). Bars = 95% CIs. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

significant in the case of life satisfaction only among oldest age group women (over 80 years-old) ($\beta = 0.20$, $p = .042$, $n = 1949$ person observations from 1124 persons) and in the case of meaning of life only among youngest age group women (under 60 years-old) ($\beta = -0.02$, $p = .043$, $n = 3396$ person observations from 1939 persons). Other interactions were non-significant except in the case of ADL limitations: Childcare reduced the ADL limitations of Northern Europeans (Table 3; split analyses for Northern Europeans: $\beta = -0.07$, $p < .001$, $n = 4136$ person observations from 1468 persons). Therefore, the effect of childcare on grandparent health does appear to vary by age and childcare regime. Interestingly, we did not find any differences by gender either in interaction models or separate models for grandmothers and grandfathers (results from split models not shown in the tables).

3.4. Sensitivity analyses

Because all outcome variables are not available in all waves, we have conducted robustness checks with the data waves 2, 4, 5 and 6 for outcomes self-rated health, depressive symptoms and ADL limitations. These sensitivity analyses did not change the main results except in the case of within-person analysis for association between childcare and ADL limitations which cease to be significant when first wave respondents are excluded ($\beta = -0.01$, $p = .260$, $n = 8774$ person observations from 4020 persons). This highlights the need for long follow-up period and sufficient amount of data to detect possible within-person associations.

In addition, we considered that the health outcomes associated with grandparental childcare might require long exposure periods as reflected in more than two measurements within a person. As such, we reanalyzed the basic models mentioned previously by including only the person-observations of participants who took part in all five waves (in the case of life satisfaction and meaning of life, four waves; total and between models $n = 12,420$ person-observations from 4481 people; within-person models 6752 person observations from 1688 people). These sensitivity analyses did not considerably change the main results.

Due to the data structure, age of a grandchild as well as co-residence of a grandparent and grandchild could not be included in the basic

analyses without a large decrease in number of observations. To determine whether these limitations make a difference, we performed sensitivity analyses in which we restricted the sample first only to those participants who provided systematic information regarding whether they had at least one 14-year-old or younger grandchild (total and between models 27,168 person observations from 16,680 people; within-person models 17,411 person observations from 7010 people) and second only to those grandparents whose living arrangements were known and excluded those grandparents who lived with their 14-year-old or younger grandchildren in the same household ($n = 671$). Either of these sensitivity analyses did not change the main results substantially. Only when taking into account grandchild age, meaning of life scores decreased slightly in the within-person models when childcare increased ($\beta = -0.01$, $p = .006$). In addition, within-person models taking into account grandchild age for the association between childcare and ADL limitations cease to be significant which again highlights the need for sufficient statistical power for within-person analyses ($\beta = -0.006$, $p = .348$; within-person models 12,196 person observations from 4844 people).

3.5. Social selection

Finally, we studied whether these results may be due to social selection. Specifically, whether the association was reversed and it is actually grandparental health and well-being at baseline that predicts subsequent childcare. In most cases, no within-person effects were found in these models. Thus, these results indicate that the association between grandparental childcare and grandparent health is not explained completely through social selection (Appendix Table A1). Only in the case of depressive symptoms were significant negative within-person effects observed, which indicates that increase in depressive symptoms in baseline predicted less childcare in the subsequent wave (Appendix Table A1). Based on these results, and consistent with the findings of Hilbrand et al. (2017b), the between-person associations found for childcare and health may be due to an unobserved third variable that affects both health and childcare.

Table 3

Within-person associations between child care and self-rated health, life satisfaction, meaning of life, depressive symptoms and ADL limitations including interaction terms between child care and age, child care and gender, and child care and county of origin of the respondent.

		Model 1		Model 2				Model 3					
		β	SE	95%CI		β	SE	95%CI		β	SE	95%CI	
				lower	upper			lower	upper			lower	upper
Self-rated health	Child care	0.001	0.007	−0.01	0.02								
	Age at interview (centred to 60 years)	−0.02	0.002	−0.03	−0.02								
	Child care x Age at interview	0.0003	0.001	−0.001	0.002								
	Child care					−0.002	0.018	−0.04	0.03				
	Child care x Gender					0.003	0.011	−0.02	0.02				
	Child care									0.01	0.008	−0.01	0.02
	Child care x Country group									−0.005	0.005	−0.02	0.01
Life satisfaction	Child care	−0.01	0.01	−0.04	0.01								
	Age at interview (centred to 60 years)	−0.02	0.004	−0.03	−0.01								
	Child care x Age at interview	0.003**	0.001	0.001	0.01								
	Child care					−0.03	0.03	−0.10	0.03				
	Child care x Gender					0.03	0.02	−0.01	0.07				
	Child care									0.03	0.01	−0.003	0.05
	Child care x Country group									−0.01	0.01	−0.03	0.01
Meaning of life	Child care	−0.01	0.004	−0.02	−0.01								
	Age at interview (centred to 60 years)	−0.01	0.001	−0.01	−0.01								
	Child care x Age at interview	0.001***	0.0004	0.001	0.002								
	Child care					−0.01	0.01	−0.03	0.01				
	Child care x Gender					0.004	0.01	−0.01	0.02				
	Child care									−0.005	0.005	−0.01	0.005
	Child care x Country group									−0.0001	0.003	−0.01	0.01
Depressive symptoms	Child care	−0.004	0.01	−0.02	0.01								
	Age at interview (centred to 60 years)	0.02	0.002	0.01	0.02								
	Child care x Age at interview	0.0002	0.001	−0.001	0.001								
	Child care					0.01	0.02	−0.03	0.05				
	Child care x Gender					−0.01	0.01	−0.03	0.01				
	Child care									−0.004	0.01	−0.02	0.010
	Child care x Country group									0.001	0.005	−0.01	0.01
ADL limitations	Child care	−0.0005	0.008	−0.02	0.01								
	Age at interview (centred to 60 years)	0.07	0.002	0.06	0.07								
	Child care x Age at interview	−0.001	0.001	−0.002	0.00004								
	Child care					−0.04	0.02	−0.08	0.002				
	Child care x Gender					0.02	0.01	−0.01	0.04				
	Child care									0.002	0.007	−0.01	0.02
	Child care x Country group									−0.01**	0.005	−0.02	−0.004

* $p < .05$, ** $p < .01$, *** $p < .001$.

Note: All models control for respondent's partnership status, employment status, years of education, smoking, ever had a heart attack, ever had a cancer, number of children and grandchildren and time period between waves.

Note: self-rated health $n = 28,032$ person observations from 11,104 persons; life satisfaction $n = 27,404$ person observations from 10,861 persons; meaning of life $n = 27,557$ person observations from 10,917 persons; depressive symptoms $n = 26,153$ person observations from 10,283 persons; ADL limitations $n = 20,751$ person observations from 8066 persons.

4. Discussion

Here, we investigated whether grandparental childcare produces direct benefits for grandparents over time. Overall, we found that grandparental childcare was associated with better health and well-being, decreased depressive symptoms and fewer ADL limitations among European grandparents. However, these associations were largely due to between-person effects and, except for ADL limitations, were absent when comparing the same individuals over time. That is, grandparents who looked after their grandchildren more were healthier but within-individual changes in childcare, in the majority, were not associated with corresponding changes in health and well-being of the grandparents over time.

The analyses where within-person effects were detected suggests

that childcare by grandparents may be causally associated specifically with health benefits identified through physical health measures. The only significant within-person effect in the main analyses showed that the number of ADL limitations decreased over time among grandparents whose childcare frequencies increased over the previous wave. No such within-person associations were found in the case of other health and well-being measurements. Thus, changes in childcare frequencies are associated with corresponding changes in grandparent ADL limitations. Moreover, this was independent of the associations that exist when comparing across different grandparents. It is important to note that if grandparents have severe ADL limitations they are unlikely to look after their grandchildren at all, meaning that in our analyses the changes in ADL limitations most likely occur between those older people who have only few or none limitations in the first

place. It could be also that panel attrition might influence the results related to ADL limitations. Selective panel attrition is possible in the SHARE data, because people with initial better health could be more likely to participate in the follow-up waves than their worse-off counterparts (Bergmann et al., 2017; Börsch-Supan et al., 2013). Finally, it must be noted that the between-person effect of ADL limitations remained stronger than the within-person effect, indicating that most of the total variance in association between childcare and ADL limitations is due to between-person variation.

To examine the possibility that for different subgroups of grandparents childcare effects may be positive or negative, interactions between childcare and grandparent age, gender, and country group were conducted. Previous research has shown that grandparental childcare may differ according to these variables and thus its association with grandparental health and well-being may also differ according to different gender, age and country categories (Tanskanen and Danielsbacka, 2019). Interestingly, these analyses revealed that an increase in childcare was associated with decreased life satisfaction and meaning of life scores among the youngest grandparents but on the contrary it was associated with an increase in both these outcomes among the oldest grandparents. This finding is consistent with the idea that not solely the childcare, but also the grandparents' life stage may impact their health outcomes.

Additional interaction results added further support to the association between childcare and a decrease in ADL limitations. Specifically, it was found that providing more frequent childcare significantly reduced ADL limitations especially among Northern European grandparents. In Northern European countries with generous public benefits for families and the availability of formal child care services, grandparents look after their grandchildren at lower intensities compared to grandparents from other parts of Europe and grandparental child care could be rather complementary than the main source of support for adult children (Hank and Buber, 2009). Moreover, the pension systems as well as health care and social services for older people are most generous in Northern European countries. In these circumstances grandparents are not so often "forced" to look after their grandchildren but they can provide child care when their own condition is favourable. Thus, in Northern European countries it may not be too burdensome for older people to look after grandchildren, which can explain why providing child care support can have health benefits for them. Previous studies that have also used an outcome variable similar to our functional limitations measure, have either not looked at interactions (Di Gessa et al., 2016a; Hughes et al., 2007) or have not found differences between subgroups such as between different European regions (Reinkowski, 2013). Therefore, to our knowledge this may be a unique finding that makes sense in terms of levels of care but needs replication.

The current analysis provides a more nuanced picture of the associations between childcare and grandparental health benefits than has been available previously. Specifically, we have statistically separated the between- and within-person effects to continue the process of establishing the causal nature, if any, of this association. Our main findings show that the positive associations between active grandparenting and grandparent subjective well-being (Di Gessa et al., 2016a, 2016b; Mahne and Huxhold, 2015), better life satisfaction, better mental health and lower risk of depression (Grundy et al., 2012) that may ultimately increase survival (Hilbrand et al., 2017a) may not be as general an effect as previously thought. For most health outcomes it is likely the positive associations reflect between-person variation (but see Arpino and Bordone, 2014). According to our analyses, only in the case of ADL limitations can we observe a within-person effect. The effect was small and is possible it is a chance finding. However, it will benefit from further investigation. Our results are in most part consistent with those of the preliminary study by Reinkowski (2013) and Sheppard and Monden (2018) who found hardly any within-person associations using three waves of SHARE data and Ates (2017) who found no causal association in Germany between supplementary grandchild care and

grandparents' self-rated health. In comparison with previous studies we were able to utilize more SHARE data waves and outcome variables than Sheppard and Monden (2018), extend the analysis to include grandfathers and incorporate additional outcome measures that reflect grandparent life satisfaction and meaning of life than Reinkowski (2013) and compared to Ates (2017) study of 1875 person-observations from 625 people from Germany, we were able to use a multinational sample and a broader range of outcome variables.

The risk of potential reverse causation, the possibility that there is social selection and healthier grandparents increased their childcare over time was directly examined and excluded. Social selection with regard to the association between health and childcare arises when a grandparent whose health or well-being status changes providing a different amount of childcare over subsequent study waves. However, only one small but significant within-person effect was found with regard to these analyses, and it concerned the association between depressive symptoms and childcare. This finding indicated that when depressive symptoms increase, childcare frequencies decrease over time, which makes sense as depression may reduce social activities more generally.

Overall, neither social causation nor social selection appear to be likely explanations for most of the associations between grandparental childcare and grandparental health and well-being. Based on our results, we conclude that simultaneous variation in health and childcare are most likely predominantly due to a third, unobserved, factor that covaries with health and childcare. We call for future studies to investigate likely mediating factors in more detail.

In addition to these methodological considerations, our results also yielded some theoretical implications. According to evolutionary theory, we have predicted that grandparental childcare may be associated with better grandparental health and well-being. This could be caused through either the helping behavior itself, a general effect that might improve individual's own direct survival. Alternatively, improved grandparental well-being may be a by-product of acting in a fitness enhancing way (i.e., helping one's own descendants to survive and reproduce). Whether the association between caregiving and grandparental health is or should be causal is another question.

Although it could be assumed that caregiving offered a selective advantage in our evolutionary past (Hawkes and Coxworth, 2013), and contemporary humans may have a genetic propensity towards helping behavior (Brown et al., 2011), this does not necessarily mean that changes in caregiving behavior should have within-person effects in an individual's health over time. If selective advantages exist in higher caregiving tendencies, then the differences should in fact exist between people, not within-individuals. Natural selection operates through selective survival and reproduction and requires variation in a population. This means that in the case of genetic propensity towards helping behavior and its association with health and longevity, there should be variation between individuals. Whether caregiving contributes proximately to grandparental health and well-being in within-individual observations in contemporary society or, for that matter, previous societies over time might not be the point of interest from an evolutionary point of view. The strong between-person associations found in this study support this view.

Conversely, if we consider health and well-being as benefits that serve as proximate mechanisms to facilitate and encourage grandparents to invest in their offspring (or did in our past), then this motivating effect should be especially visible in the case of measurements that are likely to increase with increases in childcare over time (e.g., life satisfaction or meaning of life). Such a within-individual effect was only found in reduction of ADL limitations (improved physical health). Investing in theoretical explanations on the nature of the association between caregiving and caregivers' health will help to define more precisely in which questions we actually are predicting causal associations and in which we are not.

Our results may also offer new insights into the wider conversation

concerning altruistic behavior and positive health outcomes for the helper. In light of previous studies that have found associations between altruistic behavior and positive health outcomes (e.g., Brown et al., 2005; Brown et al., 2003; Morrow-Howell et al., 2003; Post, 2005), some researchers have interpreted the results as causal: Doing good makes you feel good (e.g., Post, 2005). The same applies, however, to these associations in the case of potential health benefits of active grandparenting (Hilbrand et al., 2017a, 2017b): We do not know whether these associations are causal (i.e., within-person effects) or whether they reflect between-person differences.

The present study has several methodological strengths. Using repeated-measure data, we were able to separate between-person and within-person associations from one another. The use of representative and cross-national data makes our results more generalizable compared with single-country studies and those with non-representative samples. However, it should be noted that to more formally address the issue of causality, one would ideally carry out an experimental study. In the absence of such experiments, a quasi-experimental study design such as detecting within-person variation over time with longitudinal survey data can be used to gather hints of causality. The limitations of the present study include that the SHARE does not have any measurement of grandparental investment other than childcare. Positive within-person effects might be found using other grandparental investment measurements such as financial help that may not require the local investment of time and effort associated with childcare. Future studies are needed to explore the within-person effects of, for example, contact frequencies and relationship quality with grandchildren on grandparental health and well-being.

To conclude, the present study found that active grandparenting is associated with improved health and subjective well-being among

grandparents in between-person models (those that present the results across individuals). In most cases, however, these associations did not hold for the within-person models that analyzed an individual grandparent's variation over time. These results also have implications for policy because it is important to know how the health and well-being of older adults in ageing societies may be improved. It is also valuable to know that the childcare assistance provided by grandparents is not associated with decreased health and well-being of grandparents over time.

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Appendix

Table A1

Total, between and within effects between self-rated health, life satisfaction, meaning of life, depressive symptoms and ADL limitations and child care according to five multilevel linear regression models.

	Total effect				Between effect				Within effect			
	β	SE	95%CI		β	SE	95%CI		β	SE	95%CI	
			lower	upper			lower	upper			lower	upper
Self-rated health	0.05***	0.01	0.04	0.07	0.10***	0.01	0.08	0.11	−0.01	0.01	−0.04	0.01
Life satisfaction	0.03***	0.004	0.02	0.04	0.05***	0.01	0.04	0.07	−0.01	0.01	−0.02	0.003
Life meaning	0.14***	0.01	0.12	0.17	0.21***	0.02	0.18	0.24	0.03	0.02	−0.01	0.07
Depressive symptoms	−0.02***	0.003	−0.03	−0.02	−0.03***	0.004	−0.04	−0.03	−0.01*	0.006	−0.02	−0.001
ADL limitations	−0.02***	0.002	−0.03	−0.02	−0.03***	0.003	−0.04	−0.03	0.01	0.005	−0.02	0.0003

Note: All models control for respondent's partnership status, employment status, years of education, smoking, ever had a heart attack, ever had a cancer, number of children and grandchildren and time period between waves.

Note: within-person models: self-rated health n = 23,606 person observations from 9292 persons; life satisfaction n = 18,765 person observations from 8065 persons; meaning of life n = 18,857 person observations from 8100 persons; depressive symptoms n = 14,863 person observations from 5724 persons; ADL limitations n = 14,863 person observations from 5724 persons.

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