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Higher Parity Is Associated With Lower Mortality in a European Population of Women With High Fertility: Results From Ireland

Joanna Orr, PhD,[1,*] Rose Anne Kenny, MD, PhD,[1,2] and Christine A. McGarrigle, PhD[1]

[1]The Irish Longitudinal Study on Ageing (TILDA), Lincoln Gate, Trinity College Dublin, Ireland. [2]Mercer's Institute for Successful Ageing, St James's Hospital, Dublin, Ireland.

*Address correspondence to: Joanna Orr, PhD, The Irish Longitudinal Study on Ageing (TILDA), Lincoln Gate, Trinity College Dublin, Dublin, Ireland. E-mail: orrjo@tcd.ie

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Abstract

Research has often found a U- or J-shaped association between parity and mortality. Many researchers have suggested repeated pregnancy, childbirth, and lactation taxes the body beyond a certain parity level. Available research has concentrated on populations with controlled fertility or historic populations. Ireland presents an opportunity to explore these associations in a modern sample with high fertility. We use data from the Irish Longitudinal Study on Ageing (TILDA) to test whether parity is associated with mortality in women aged 50 years or over (n = 4177). We use Cox proportional hazards models to model survival and adjust for demographics and early life circumstances. We test whether a number of health characteristics mediate these effects. Models were also stratified by birth cohort to test possible cohort effects. Higher parity was associated with lower risk of mortality, even after adjustment for early life and socioeconomic circumstances. This effect was not mediated by current health characteristics. The effects were largely driven by those born between 1931 and 1950. Increasing parity is associated with decreasing mortality risk in this sample. The effects of parity could not be explained through any of the observed health characteristics. These findings are in contrast to much of the literature on this question in similar populations. Lack of fertility control in Ireland may have "selected" healthier women into high parity. Social explanations for these associations should be further explored.

Keywords: Ireland, Mortality, Parity, Women

Ireland had the highest fertility rate in Europe in the mid to late twentieth century, with the average total births per woman fluctuating between 3.2 and 4.1 between 1960 and 1980 (1). In contrast, the average fertility rate in the rest of the European Union area ranged between 1.5 and 2.6. After 1980, the fertility rate declined and approximated the European average, although it remains one of the highest in the region. Access to contraception in Ireland was illegal or tightly regulated until 1992 (2). Research into the link between parity and mortality has not often had the opportunity to explore whether parity is related to mortality in areas with high parity; the research has tended to look at modern European and North American populations (3). Research into the association between parity and mortality has on the most part found a nonlinear relationship, with null or low parity and high parity both being associated with higher risk of mortality in modern developed nations (3,4). The literature suggests a number of competing hypotheses (5). The "disposable soma" theory suggests that pregnancy, childbirth, and lactation tax the body's resources, and that there is a trade-off between increased parity and longevity (3,5). Other theories suggest that social and health factors "select" women into childbearing and into high parity (a "healthy woman" effect). In modern populations women with more resources have more access to fertility control, and therefore this relationship is confounded (6).

Biologically, reproduction has been found to be inversely related to longevity in multiple non-human species (7). While the resulting "cost of reproduction" theory has broadly suggested that competing resource allocation is the principal mechanism behind the trade-off between longevity and parity, the pathways behind the relationship are not fully clear (7). In some cases, for example, in particular insect models, the cost of reproduction

functions through species-specific mechanisms (8), which minimizes the generalizability of the cost of reproduction theory to all organisms. The cost of reproduction theory also is slightly at odds with most research in humans, where, as has been discussed, nulliparous women also have increased mortality risk. The link between reproduction and longevity in humans may therefore be driven by different biological mechanisms or may be moderated by social factors.

In human females, nulliparity has been found to be associated with higher risk of breast cancer (9) and ovarian cancer (10) while a parity of one to three has been associated with higher risk of thyroid cancer compared to nulliparity (11). High parity has been found to be a risk factor for cervical cancer (12) and any childbirth increases the risk of high grade cervical cancer in women with persistent human papilloma virus infection (13). Nulliparity has also been linked to a general faster accumulation of health limitations (14), while a high number of births have been associated with higher prevalence of heart disease, diabetes, and obesity (15–17). Pathways such as competing resource allocation, as well as higher oxidative stress related to increased parity have been suggested (18). Higher parity is also associated with later menopause (19,20). Later age at menopause is in turn associated with later mortality (21). These effects point to a possible complex hormonal link between reproductive health and longevity; however, the mechanism remains unclear. Similar difficulties have been encountered when disentangling the link between use of oral contraceptives (OC) and later life health, as OC has been found to be positively associated with some cancer and cardiovascular disease risks but negatively associated with other cancer risks (22).

Social pathways for a link between parity and mortality have also been suggested. Becoming a parent can imply economic trade-offs, whereby there is loss of income due to increased caring responsibilities. Artificial contraception was difficult or impossible to access for women in this cohort in Ireland, and knowledge of fertility awareness methods was inconsistent (23,24). Lower socioeconomic status, as well as early first childbirth, which is associated with lower socioeconomic status, are both associated with higher parity (25–27). This could confound the relationship between high parity and higher mortality, with social deprivation plausibly being the driver for both. The current study exploits the opportunity to investigate this question in a sample with fewer socioeconomic differences between those with null, low and high parity. We aimed to investigate if high parity is associated with mortality within this population. We also aimed to test potential mediators between parity and mortality to better understand how parity may interact with health.

Method

Sample

The Irish Longitudinal Study on Ageing (TILDA) is a nationally representative prospective cohort study of community-dwelling adults aged 50 years and older living in Ireland (28,29). The first wave of data collection was completed between October 2009 and February 2011. Respondents were recruited through stratified random sampling and completed at-home computer-assisted personal interviews. We use data from women participating at Wave 1 of TILDA, and follow-up data on mortality. A total of 4429 female respondents aged 50 and older with valid parity data were interviewed at Wave 1. From these, 4177 had complete data for all variables of interest.

Measures and Analysis

Mortality data were obtained from follow-up interviews with informants nominated by the respondent at their previous interview, and from public records of death from the General Register Office (GRO), where no end-of-life interview was obtained. Follow-up within the study is ongoing but was censored for respondents without a death at final interview date (January–December 2018). Respondents lost to follow up were censored at the end of the follow-up period for publicly available data through the GRO (February 28, 2017). Date of death was missing for some respondents (n = 168). The period of death was known in these cases, and the date of death was therefore set at the mid-point between waves in which the death occurred (Supplementary Table A).

Parity was defined as the number of reported children from each respondent. There was no direct measure for number of live births in the TILDA data set; therefore, a composite measure was derived. Respondents were asked the total number of living children they had (including step, foster, and adoptive children). There was no way to distinguish between biological, step, foster, or adoptive children. However, respondents were asked if any of their children lived with them, and any respondent who described any of their live-in children as step, foster, or adoptive children had the total number of children adjusted accordingly (n = 2). Respondents who completed a Self-Completion Questionnaire (SCQ) at Wave 1 were also asked if they had ever experienced the death of a child. Respondents who reported the death of a child were given +1 on the total number of children (n = 397).

Initial univariate associations between parity and covariates were carried out using Chi 2 and univariate linear regression. Associations between parity of 0, 1, 2, 3, 4, and 5 or more children and covariates were explored. We tested univariate associations between parity and sociodemographic and health characteristics measured at baseline. Health characteristics found to be univariately associated with parity were included as potential mediators.

To assess the relationship between parity and mortality, 2 exposure variables were tested; we first fit models with continuous parity and continuous parity squared to assess whether there was a linear or quadratic relationship between parity and mortality (3,4). Cox models were then adjusted for sociodemographic covariates, and those that temporally precede, or become established, during the child-bearing years. These included self-reported childhood health at age 14 (excellent, very good, good, fair, and poor) and wealth (well-off, about average, and poor), education (primary/none, secondary, and third/higher), father's social class (professional/managerial, nonmanual, skilled/semiskilled manual, unskilled, farmer, and parents never worked), religion (Catholic, other religion, and no religion), smoking (never, past, and current), and marital status (married or cohabiting, divorced or separated, and widowed). To account for the complex nature of the survey data used, we use Stata's svy command to specify population weights, clustering, and sampling design.

Formal mediation of cox survival models is not available using svy weighted data. The next stage of analysis was therefore conducted on a nonweighted sample. We used the Stata command med4way (30) to test mediation pathways for all possible current health mediators of the relationship between parity and mortality. These were included individually, and finally all included together in a full model. Potential mediators were included on theoretical grounds derived from the literature, and included current number of medications used and self-rated health (excellent or very good vs good, fair or poor) as measures of general health, any cardiovascular

disease (includes high blood pressure, angina, heart attack, heart failure, heart murmur, abnormal heart rhythm, stroke, transient ischemic attack, and any other heart disease) (31), diabetes (17), breast cancer (9), thyroid cancer (11), ovarian cancer (10), and cervical cancer (12,13).

These models were stratified by birth cohort (decades) to account for differences in Irish women's access to contraception, as well as social norms regarding family size, extra-marital childbearing and single parenthood. We used left-truncation of the time scale to account for the time unobserved before entry into the study (32). This is specified by including the date of entry into the study, in this case date of first interview. We defined the beginning of the period "at risk" as date of birth. All analysis was carried out using Stata 15.1 (33).

Sensitivity Analysis

A sensitivity analysis was carried out using the number of children as a categorical variable with 8 categories (0, 1, 2, 3, 4, 5, 6, and 7 or more children). Three models are presented, unadjusted, adjusted for sociodemographic characteristics, and fully adjusted for sociodemographic and health characteristics. We include Wald tests of linearity to test for linear trends of increasing number of children.

Results

The follow-up period for respondents lost to follow up was 7 years. Respondents with Wave 5 data were followed for an average of 8 years. A total of 557 deaths were recorded in the sample (13.3%), and the median survival time was 87.1 years [86.1; 87.9]. Parity in the sample is described in Supplementary Table B. Mean parity was 3.21 (SD = 2.13) and was positively associated with age. An informal comparison with data from Eurostat suggests this is slightly below the average in Ireland for the period 1960–2005 (during which time much of our sample would have been of childbearing age, 15–45 years). Further comparison with Eurostat data suggests the trends in fertility are similar in both samples (Supplementary Material C).

Missingness is given in Supplementary Table D. A total of 4.5% of participants had missing data on father's social class, and lower numbers had missing data on other variables of interest. These observations were excluded from analysis. Associations between parity and sociodemographic covariates are given in Table 1. Women with 3 children had the lowest unadjusted mortality, while nulliparous women had the highest. Demographic factors such as age, education, and religion were all related to parity; nulliparous as well as high parity women were more likely to be older. Women with fathers in professional or managerial classes were more likely to have no children or only one child, while women with fathers who were farmers were most likely to have five or more children. Those who had ever been married were more likely to have children and have a higher quantity of children. Catholic women were more likely to have 5 or more children than women of other religions or the nonreligious. The nonreligious were more likely to be nulliparous. Women with higher education had fewer children and were more likely to be nulliparous. Women with high parity were more likely to have never smoked, and both nulliparous women and women with high parity were less likely to be current smokers. Childhood health and wealth were not associated with parity.

Health conditions and their association with parity are given in Table 2. Those with one child were the least likely to report their health as excellent or very good. Cardiovascular conditions were most likely in women with high parity. High parity was also related to diabetes risk, and those with 2–4 children had the lowest risk. Although parity was not significantly associated with ovarian cancer incidence (p = .07), those with one child appeared to have a highest risk but this could not be confirmed due to low ovarian cancer incidence. Women with high parity had the highest number of physical limitations, while women with 2–4 children had the lowest.

Cox Proportional Hazard Models

A linear model using continuous parity was selected as the best fitting model. Table 3 shows hazard ratio (HR) estimates for unadjusted, adjusted, and mediation models using survey weights. The initial model, adjusted only for age (as timescale), showed that parity was associated with a 5% reduction in the risk of death for each additional child. The inclusion of sociodemographic characteristics had no impact on the parity HR. There was a small increase in the effect size of parity once health characteristics were also included in the model.

Table 3 also presents models stratified by birth cohort. When sociodemographic-adjusted models were stratified by birth cohorts, significant effects of parity on mortality were only observed for those born between 1941 and 1950 (aged 60–69 years) (a 13% reduction of risk) and those born between 1931 and 1940 (aged 70–79 years) (a 5% reduction of risk). Again, the inclusion of sociodemographic and health characteristics in the models had minimal impacts on the parity HRs.

Although initial results showed an unexpected direction and linearity in the relationship between parity and mortality, mediation models were included to assess whether associations between these and parity and mortality could help explain results. Results for mediation analyses direct effects are given in Table 4. None of the health conditions tested was shown to mediate the effect of parity, although many had independent effects on mortality. Interactions between parity and the putative mediator are also shown. Only self-rated health had a significant interaction with parity, although this effect was small and was not found to significantly affect the total effect. Detailed results for mediation models are given in Supplementary Material E.

Sensitivity Analysis

An analysis using the number of children as a categorical variable had consistent results and showed that the effects were linear (Supplementary Figure F). Apart from women with one child, women with higher numbers of children all had smaller HRs than nulliparous women. These HRs showed a declining linear trend with increasing numbers of children, confirmed in all models using Wald tests. Full HRs are given in Supplementary Table F.

Discussion

We have shown that in this population, mortality risk decreased with increasing number of children. This result remained consistent after adjustment for socioeconomic and childhood circumstances, and after testing possible mediation pathways. We did not find any mediation effects. Birth cohort analyses showed that the 1931–1940 and 1941–1950 birth cohorts were the main drivers of this association. It is possible that too few deaths were observed in the youngest age cohort for an association to be present, while the oldest age cohort may be representing an exceptional, healthy "survivor" cohort.

Table 1. Sociodemographic Characteristics by Number of Children (n = 4177)

Characteristic % or Mean (*SD*)	Total Children	0 (n = 515)	1 (n = 259)	2 (n = 786)	3 (n = 936)	4 (n = 749)	5+ (n = 932)	p Value
Mortality	13.3	18.8	16.2	11.3	9.3	11.5	16.7	<.001
Age	63.7 (9.9)	65.2 (10.7)	62.9 (10.1)	61.1 (9.0)	61.8 (8.9)	63.1 (9.3)	67.7 (10.0)	<.001
Father's social class								
Profes/Manag	13.7	20.6	18.2	14.9	14.3	11.5	8.6	<.001
Nonmanual	7.6	9.1	7.0	9.4	7.4	6.9	6.2	
Skilled/Semi-skilled	30.4	26.6	33.2	30.7	35.0	29.5	27.6	
Unskilled	15.1	9.3	14.3	16.3	14.6	15.4	17.8	
Farmers	26.3	27.6	22.4	22.3	22.2	29.9	31.2	
Never worked	6.9	6.8	5.0	6.5	6.4	6.8	8.6	
Wealth age 14								
Well off	11.7	13.6	11.6	13.7	10.8	11.6	10.1	.483
Average	71.1	68.9	71.4	70.2	72.4	71.2	71.4	
Poor	17.2	17.5	17.0	16.0	16.8	17.2	18.6	
Self-rated health age 14								
Excellent	55.7	56.5	47.9	57.6	55.8	53.5	57.3	.380
Very good	25.0	23.3	28.6	23.4	24.7	27.6	24.7	
Good	12.5	11.3	15.4	12.7	13.0	12.4	11.7	
Fair	4.8	6.6	6.6	4.2	4.3	4.1	4.7	
Poor	2.0	2.3	1.5	2.0	2.2	2.3	1.6	
Religion								
Catholic	89.9	87.4	83.0	84.1	91.4	91.3	95.3	<.001
Other religion	6.3	7.4	9.7	9.3	5.6	6.3	3.0	
Not religious	3.9	5.2	7.3	6.6	3.1	2.4	1.7	
Education								
Primary or none	27.8	20.8	25.9	23.2	23.9	26.3	41.3	<.001
Secondary	40.9	36.5	43.6	41.9	42.4	42.3	39.0	
Third level	31.3	42.7	30.5	35.0	33.7	31.4	19.7	
Smoking								
Never	50.5	51.7	43.6	47.2	51.3	50.2	54.2	.031
Past	31.4	33.4	36.3	33.1	29.7	30.4	29.7	
Current	18.1	15.0	20.1	19.7	19.0	19.4	16.1	
Marital status								
Married	64.7	30.1	59.1	72.7	72.3	74.9	62.8	<.001
Single	8.0	56.5	7.3	1.8	0.8	0.1	0.3	
Separated/Divorced	7.5	2.7	12.4	9.7	9.5	6.3	6.0	
Widowed	19.8	10.7	21.2	15.9	17.4	18.7	30.9	

Note: p values represent probability for chi-square tests for categorical variables, and for poisson regression for continuous variables (age).

Our findings contradict findings from comparable populations in England and the United States (34). The majority of studies exploring parity and mortality in modern developed populations have found that the effects of parity are U or J shaped (3,4). The U-shaped relationship has substantial support, including a sibling study from Sweden, which found that family and early-life socioeconomic circumstances where not behind the association (35). However, a review of a number of studies using historic and contemporary populations found that, although there was substantial variation, historic populations showed a trend of higher parity being associated with lower mortality (6). Mortality has been found to be lower in high parity women in other comparable populations, such as Norway (34,36). In Norway, this effect has been hypothesized to be related to high-quality social protections, which could remove some of the social, financial, and health care burdens associated with high parity (34).

While Ireland's social protection system has not been more comprehensive than, for example, neighboring countries such as Great Britain, the timing of improvements in public health in Ireland may have a role to play in explaining the effects we have observed in this analysis. In a similar way to other processes of modernization, public health in Ireland lagged behind comparable European countries. Gains in life expectancy occurred later in Ireland than in England and the United States, where public health was drastically improving during the early 20th Century. The equivalent process began in Ireland in 1947 with the introduction of the Health Act, which aimed to improve the health of the population through various pathways, including health care, combating infectious disease and improvement of sanitation (37). Delaney and colleagues demonstrated that infant mortality was greatly reduced following the 1947 Act, and that this improvement in infant health in the late 1940s and 1950s had an impact on the adult health of these birth cohorts in 2006 (37). Kaptijn and colleagues showed that a U-shaped association between parity and mortality disappeared following the epidemiological transition to lower mortality in the Netherlands at the turn of the twentieth century (38). While this doesn't explain why we observe that women with higher parity had higher survival in Ireland, it does provide evidence that the interaction between parity and mortality is flexible, and in part dependent of temporal societal characteristics, such as mortality rate.

In Ireland, the lower use of OC and other forms of fertility management up until the late twentieth century resulted in high fertility. Some studies have found evidence of higher parity being protective of mortality in populations where fertility was not controlled

Table 2. Health Characteristics by Parity Categories (n = 4177)

Characteristic% or Mean (*SD*)	Total	0 (n = 515)	1 (n = 259)	2 (n = 786)	3 (n = 936)	4 (n = 749)	5+ (n = 932)	p value
Self-rated health	44.8	42.6	37.5	50.1	46.1	46.2	41.7	.001
Medications	2.7 (2.7)	2.8 (2.7)	2.8 (2.8)	2.5 (2.6)	2.6 (2.6)	2.5 (2.5)	3.1 (2.8)	<.001
CVD	45.4	46.4	46.3	41.7	42.5	41.1	53.9	<.001
Diabetes	6.0	6.4	7.0	4.3	4.8	5.6	8.3	.008
Physical impairments	2.3 (2.4)	2.5 (2.5)	2.4 (2.4)	2.1 (2.4)	2.2 (2.3)	2.3 (2.3)	2.7 (2.5)	<.001
Breast cancer	3.9	4.1	4.6	2.8	3.6	4.1	4.5	.524
Ovarian cancer	0.3	0.6	1.2	0.1	0.2	0.1	0.2	.073
Cervical cancer	0.2	0.0	0.0	0.3	0.3	0.4	0.2	.706
Thyroid cancer	0.1	0.0	0.0	0.0	0.1	0.0	0.1	.780

Note: p values represent probability for chi-square tests for categorical variables, and for poisson regression for continuous variables with a poisson distribution (number of medications, number of physical limitations). CVD = Cardiovascular disease.

Table 3. Cox Survival Models for Number of Children as Continuous Variable (hazard ratios), Using Survey Weights (n = 4177)

	Unadjusted[a]	Sociodemographics[b]	Health and Sociodemographics[c]
Parity	**0.95 [0.92; 0.98]**	**0.95 [0.91; 0.98]**	**0.94 [0.91; 0.98]**
Age groups			
Age 50–59	1.01 [0.87; 1.18]	1.00 [0.84; 1.19]	1.00 [0.83; 1.20]
Age 60–69	**0.87 [0.78; 0.98]**	**0.86 [0.76; 0.97]**	**0.85 [0.76; 0.96]**
Age 70–79	**0.95 [0.90; 1.00]**	**0.92 [0.87; 0.98]**	**0.92 [0.87; 0.98]**
Age 80+	0.96 [0.92; 1.01]	0.98 [0.92; 1.04]	0.99 [0.93; 1.05]

Note: Estimates presented are hazard ratios and their corresponding 95% confidence intervals. CVD = Cardiovascular disease. Statistically significant results are $p < .05$ and are presented in bold.

[a]Adjusted for age (timescale variable). [b]Adjusted for socioeconomic characteristics: education, childhood health and wealth, father social class, religion, marital status, and smoking. [c]Adjusted for socioeconomic and health characteristics: excellent/very good self-rated health, number of medications, any cardiovascular condition, diabetes, and number of physical impairment.

(6,39). The impact of mass use of OC on mortality and health has not yet fully been assessed, although a net benefit has been suggested (40–43). Research into the association between specific health outcomes and OC use has shown that OC is both negatively and positively associated with a number of health outcomes (22). In Ireland, OC use is only likely in the younger age group in the over 50s population (in our sample, those who were turning 50 to 59 in 2010, and would have had wider access to OC starting from the 1990s). If OCs have a net protective effect against mortality, it is plausible that lower mortality effects amongst women with two to four children who controlled their fertility in comparable populations would not be observed in Ireland. Our analyses provide some evidence for this; there were essentially no effects in those aged 50–59 years who would have had wider access to contraceptive methods, although this may also be due to the lower number of deaths in this age group. The possible long-term effects of both endogenous and exogenous sex hormone exposure are complex, but future research could shed further insight into how these are associated with factors which are both biological and social, such as parity.

Another idiosyncrasy of the Irish population in this time period is that marriages happened relatively late in life (44). Beginning a childbearing trajectory at a younger age has been hypothesized to tax physical resources before full maturity, leading to earlier deterioration of health (45). Age at first birth is also related to parity itself, as those who have their first child at a young age tend to have longer fertility histories and a higher total number of births (27). As Irish women have tended to begin their childbearing trajectories at relatively older ages, early childbirth as a risk factor associated with high parity is attenuated in this population. This may help explain the differences between the Irish sample, and English and U.S. samples.

Finally, our study could contradict the results of other European studies due to an unobserved social mechanism. High parity was highly valued in Irish society, with the ideal number of children for Irish women being consistently higher than comparable countries (46). In 1981, nearly half of Irish mothers with completed fertility stated that their actual number of children was less than desired, even though the mean number of children in these women was close to three and was high compared to similar populations at the time such as other European countries and the United States (46). The social desirability of big families could reasonably be expected to impact on the well-being of those with both low and high numbers of children. Stavrova has demonstrated that single parenting is associated with lower well-being only in countries with strong social norms around parenting and marriage (47). While this relationship has only been demonstrated regarding marriage norms and well-being, exploring how this may affect social expectations around parity would help to further clarify our findings in Ireland. Social support has also been posited as a mechanism between parity and later life health in other studies, whereby larger families serve as a form of social, financial and care support for older adults. However, the evidence for this mechanism is not strong (48).

Our results do not provide evidence for the "disposable soma" theory of pregnancy and childbirth, whereby the body is taxed by the "wear and tear" of having children. They may be showing a protective effect of higher parity on longevity in the specific Irish sample, however, if this were the case, we would expect to see Irish women living for longer than their European counterparts. Data

Table 4. Mediation Models for Parity and Health Characteristics Including Parity#Mediator Interactions (n = 4177)

Characteristics	Un-adjusted	Sociodemographic	Self-rated Health	Medications	CVD	Diabetes	Physical Impairments	All
Total parity	**0.94 [0.91; 0.98]**	**0.94 [0.90; 0.98]**	**0.94 [0.90; 0.99]**	**0.94 [0.88; 1.00]**	**0.90 [0.84; 0.96]**	**0.94 [0.90; 0.98]**	**0.92 [0.86; 0.98]**	**0.94 [0.90; 0.97]**
Self-rated health	*	*	**0.58 [0.41; 0.81]**	*	*	*	*	**0.65 [0.52; 0.81]**
Parity#self-rated health			**0.99 [0.92; 1.07]**					
Medications	*	*	*	**1.06 [1.01; 1.11]**	*	*	*	1.02 [0.98; 1.05]
Parity#medications				1.00 [0.99; 1.01]				
CVD	*	*	*	*	0.89 [0.66; 1.21]	*	*	0.95 [0.79; 1.15]
Parity#CVD					1.07 [0.99; 1.15]			
Diabetes	*	*	*	*	*	**1.91 [1.20; 3.04]**	*	**1.41 [1.07; 1.86]**
Parity#diabetes						0.95 [0.86; 1.06]		
Physical impairments	*	*	*	*	*	*	**1.07 [1.02; 1.13]**	**1.05 [1.01; 1.09]**
Parity#physical impairments							1.00 [0.99; 1.02]	

Notes. Estimates presented are hazard ratios and their corresponding 95% confidence intervals. Statistically significant results are $p < .05$ and are presented in bold. The unadjusted model is adjusted for age (timescale variable) only. The sociodemographic adjusted model is adjusted for sociodemographic covariates. Models 3 to 7 are adjusted for covariates and corresponding mediator. Model 8 is fully adjusted for all covariates. CVD = Cardiovascular disease.

from Eurostat show that life expectancy in Ireland has largely followed the same patterns as European life expectancy, although Irish life expectancy was lower than the European average up until the mid-2000s (49), though this is also confounded by the late epidemiological transition to lower mortality in Ireland (37). This suggests that higher parity is not protective. A selection effect is more likely, where, because of the social desirability and high mean parity in the population, women who were healthier at baseline had a higher number of births. Although, as discussed, the U-shaped relationship observed in other studies does not appear to be due to selection (35). It is also possible that the associations observed here result from a complex interplay between biological, social and even historic factors, including a selection effect, the increased longevity gains in this Irish cohort, age at first birth, complex hormonal pathways, as well as social desirability and social support gained through having a large family within the Irish context.

There are some limitations to our study. The measure of parity used counts living children, not live births, with adjustments made for having lost a child and having counted foster or adopted children as biological children. It is likely that there is some degree of error in this measure. However, such measures of parity are relatively common in the parity-mortality literature (34,50). Even with these considerations, data on fertility in Ireland has notoriously been poor (46). An additional concern is that we could not estimate the effect of parity on mortality for those who died before being observed. We have statistically adjusted for this by using left truncation. Our use of birth-cohort stratified analyses also somewhat controls for these biases. The use of population weights to conduct a supplementary analysis also serves to approximate the sample characteristics more closely to the wider population. We were unable to include menopause as a potential mediator in our models, although it is potentially associated with both parity and mortality. A number of measures for menopause were available in TILDA, including gone through menopause, age at menopause, and use of hormone replacement therapy. Age at menopause was considered as a potential mediator for these analyses, however, inspection of the data showed a large number of missing observations (18.0%) and also a significant number of implausible values.

This study represents an opportunity to use high quality data with 8 years of follow-up to assess the impact of parity on mortality, in a population which has not been previously studied in this context. We find that, contrary to expectations, higher parity does not appear to be associated with higher mortality. We did not find any health mechanisms which could explain this association. We suggest there may be a selection effect behind our observations, as well as a possible social effect. Further work on social mechanisms would be beneficial.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None declared.

Ethical Approval

Ethical approval for each Wave of TILDA was obtained from the Trinity College Dublin Research Ethics Committee. Signed informed consent was obtained from all participants.

Data Availability

For information and to apply to access data from TILDA, please visit the Irish Social Science Data Archive (ISSDA) on www.ucd.ie/issda/data/tilda.

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