Extended abstract

Fertility history and cognition in later life

Sanna Read, London School of Hygiene and Tropical Medicine, London, United Kingdom
Emily Grundy, London School of Economics, London, United Kingdom

Introduction

Cognitive functioning declines in old age. Repeated and prolonged stress can result in a lower level and faster rate of change in cognitive functioning (Goldman, Turra, Glei, Lin, & Weinstein, 2006; Seeman, Singer, Rowe, Horwitz, & McEwen, 1997). Accumulation of stress could be associated with certain life events, such as events related to fertility history (Hurt, Ronsmans, & Thomas, 2006; Spence, 2008). Previous studies have mainly focused on the association between number of children and cognitive decline in old age and the role of estrogen and other hormones in this association. The longer lifetime exposure to estrogen among nulliparous women is thought to be the mechanism facilitating their better cognitive functioning compared to their parous counterparts (Behl, 2002). However, there is also evidence from animal models that the fluctuations in hormones and neuropeptides during pregnancies and motherhood may result in permanent changes in the brain that can actually facilitate learning and memory later in life (Li et al., 2013). As the accumulation of stress and hence cognitive decline could also result from factors other than hormonal changes, it is important to look at both genders and a wider range of potential psychosocial mechanisms. In the present study we investigate the association between fertility history and later life cognitive functioning, including both men and women and in addition to parity we also investigate the role of timing of births. We assess the role of socioeconomic position, heath, social isolation and control as potential mechanisms in the association between fertility history and later life cognition.

Method

Sample. We used a sample of men and women from the English Longitudinal Study of Ageing, a nationally representative longitudinal study of the older population of England. The first wave of ELSA conducted in 2002-2003 included men and women then aged 50 years or more from private households which had participated in any one of the 1998, 1999 or 2001 rounds of the cross sectional Health Survey for England (HSE; an annual government health survey based on a stratified random sample of all households in England). A total of 11,392 core members were interviewed in the first wave of the ELSA study (response rate 67%). In the present study we use five waves to measure the level and rate of change in cognition over a 10 year period.

Measures. Cognitive functioning was measured using three measures: immediate recall, delayed recall and verbal fluency. Z-scores for the three cognitive measures were calculated and a mean of the z-scores was used as a combined cognitive index. Number of children was measured using five binary variables indicating whether the respondents had had 0, 1, 2, 3, or 4+ natural living children. For parents dichotomous variables were derived indicating whether or not respondents had had a biological child before the age of 20 (women) or 23 (men) or after age 35 (women) or 39 (men). Age in years and whether the respondent had a no qualification were used from Wave 1. Time-varying variables for net wealth quintiles, limiting long-term illness, current smoking, level of physical activity, depressive symptoms (CESD-8), social isolation and sense of control (4 items from the CASP-19 scale) were used.

Analysis. We used latent growth curve modeling (Mplus) to examine the level and rate of change in cognitive functioning and whether fertility history was the association with the level or rate of change in cognitive functioning. The fit of the models was assessed by chi square, the Comparative Fit Index (CFI) and Root Mean Square Error of approximation (RMSEA). A value at or below 0.08 for the RMSEA, and at or above 0.95 for the CFI was considered to be an acceptable fit for the model. Full maximum likelihood estimation with robust standard errors (MLR) was used to take into account any non-normality in the sample and adjust for missingness.

Results

Descriptive results. The descriptive results for wave 1 are shown in Table 1. Over the follow-up, there was a slight shift towards higher net wealth quintiles and more physical activity. The proportion of those having a limiting long-tem illness increased over time. The proportion of smokers declined over the follow-up. There was also a slight decline in depressive symptoms among women. There was no group level change in social isolation or sense of control. Cognitive functioning slightly declined over the follow-up period.

Table 1. Distribution of covariates, cognitive functioning and fertility history in wave 1 (% or mean and SD).

Variables	Men	n	Women	n
Age in years	64.8 (10.00)	5110	65.5 (10.62)	6123
No qualification	36.6	5099	47.6	6115
Net wealth quintile	3.1 (1.43)	4661	3.0 (1.40)	6058
Limiting long-term illness	34.7	5107	35.3	6117
Currently smoking	17.4	5104	18.1	6115
Physical activity	2.0 (0.88)	5104	1.9 (0.88)	6114
Depressive symptoms, CES-D8 > 2	19.2	5015	28.4	6025
Social isolation	1.1 (1.04)	4658	1.0 (0.96)	5567
Control (CASP-19)	3.1 (0.66)	4652	3.1 (0.67)	5550
Immediate word list recall	5.3 (1.76)	5015	5.5 (1.78)	6020
Delayed word list recall	3.8 (2.08)	5009	4.1 (2.12)	6013
Verbal fluency	19.7 (6.50)	5011	18.8 (6.27)	6022
Number of natural children		5110		6123
0	16.7		14.8	
1	15.4		15.9	
2	38.8		37.9	
3	17.5		19.5	
4+	11.6		11.9	
Early childbirth [a]	15.2	4013	11.1	5004
Late childbirth [b]	12.2	4012	14.0	5004

[a] first birth at age <20 for mothers and <23 for fathers. [b] last birth at age >34 for mothers and >39 for fathers.

As expected, higher parity was associated with higher age, no qualification, lower net wealth, limiting long-term illness, lower physical activity, current smoking, and lower social isolation. Higher parity in women was associated with higher depression score in women, whereas in men the association was quadratic so that both nulliparity and high parity was associated were depressive

symptoms. Sense of control was lowest in both the childless and high parity in men and women. Early childbirth was associated with younger age, no qualification, lower net wealth, limiting long-term illness, lower physical activity, current smoking, depressive symptoms, social isolation and lower sense of control. Late child birth was associated with older age, lower net wealth, limiting long-term illness, lower physical activity, not currently smoking (only among women), depressive symptoms (only in men) and lower sense of control. Better scores on all three cognitive measures were associated with younger age, having a qualification, higher net wealth, no limiting long-term illness, higher physical activity, less depressive symptoms, lower social isolation and higher sense of control.

The association between fertility history and level and rate of change in cognitive functioning
Because the change over time included both linear and quadratic patterns, these growth terms were included in all models. The first model included number of children and age as a covariate for all men (Model 1 for all men, Table 2: χ^2 =16.51, *df*=16, CFI=1.00, RMSEA=0.005) and for all women (Model 1 for all women, Table 3: χ^2 =23.89, *df*=16, CFI=0.99, RMSEA=0.009). The first model for parents (excluding the nulliparous) included early and late birth and age and number of children as covariates for fathers (Model 1 for fathers, Table 2: χ^2 =16.51, *df*=16, CFI=1.00, RMSEA=0.005) and mothers (Model 1for mothers, Table 3: χ^2 =23.89, *df*=16, CFI=0.99, RMSEA=0.009). All subsequent models fitted well to the data: they had CFI value > 0.95 and RMSEA <0.08.

Table 2. Associations between fertility history and the initial level of cognitive functioning in the men in ELSA waves 1-5.

	Model 1	Model 2	Model 3	Model 4	Model 5
Number of children (ref =2)					
0	-0.12*	-0.07	-0.07	-0.06	-0.06
1	-0.19**	-0.14*	-0.14*	-0.14*	-0.14*
3	-0.11	-0.06	-0.06	-0.07	-0.07
4	-0.30***	-0.15*	-0.14*	-0.14*	-0.14*
Early child birth[a]	-0.23**	-0.15	-0.14	-0.14	-0.14
Late childbirth[a]	0.18*	0.18*	0.18*	0.18*	0.18*

Model 1: adjusted for age; Model 2: +education, wealth; Model 3: + liming long-term illness, physical activity, current smoking, depressive symptoms; Model 4: +social isolation; Model 5: +control. [a] Parents only. * *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001

Having 4 or more children compared to 2 children was associated with poorer cognitive functioning in both men and women. The decline in cognitive functioning was also faster in women with a high number of children. After adjusting for education and wealth, the association between high parity and level of cognitive functioning became considerably weaker, but it still remained significant. Adjusting for health, social isolation and sense of control did not change the association.

Nulliparity in women and having 1 child in men compared to 2 children were associated with poorer level of cognitive functioning. The association became somewhat weaker when socioeconomic position was adjusted. Nulliparity in men was also associated with poorer cognitive functioning, but after adjusting for education and wealth the association was non-significant.

Early childbirth was associated with poorer cognitive level in women and men, but after adjusting for education and wealth the association became considerably weaker remaining significant in

Table 3. Associations between fertility history and the initial level of cognitive functioning in the women in ELSA waves 1-5.

	Model 1	Model 2	Model 3	Model 4	Model 5
Number of children (ref =2)					
0	-0.22***	-0.17***	-0.17**	-0.17**	-0.17**
1	-0.19***	-0.11*	-0.11*	-0.11*	-0.11*
3	-0.13**	-0.08	-0.08	-0.08	-0.08
4[a]	-0.31***	-0.19**	-0.19**	-0.19**	-0.19**
Early child birth[b]	-0.37***	-0.21**	-0.20**	-0.20**	-0.21**
Late childbirth[b]	0.10	0.11	0.11	0.11	0.12

Model 1: adjusted for age; Model 2: +education, wealth; Model 3: + liming long-term illness, physical activity, current smoking, depressive symptoms; Model 4: +social isolation; Model 5: +control. [a] In all models linear slope (0.14*) and quadratic slope (-0.03*) were also significant [b] Parents only. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

women but becaming non-significant in men. In men, late fatherhood (having a child at age 39 or older) was associated with a higher level of cognitive functioning, and this association remained robust after adjusting for the covariates. In women the association was positive as well but weaker and remained at the borderline of significance (p=0.053).

Conclusion

The association between parity and level of cognitive functioning is non-linear so that both high and low parity compared to average parity are associated with poorer cognitive functioning in older age. In mothers, early child birth was also a risk factor for poorer later cognitive functioning, whereas late child childbirth in both genders was associated with better cognitive functioning. Although socioeconomic factors play an important role in the association, a considerable amount of variation was unexplained. The future studies need to investigate other potential factors. The pattern of the associations suggests that the underlying mechanisms could be related to earlier life events and to unmeasured selective influences..

References

Behl, C. (2002). Oestrogen as a neuroprotective hormone. *Nature Reviews Neuroscience, 3*(6), 433-442.

Goldman, N., Turra, C. M., Glei, D. A., Lin, Y. H., & Weinstein, M. (2006). Physiological dysregulation and changes in health in an older population. *Exp Gerontol, 41*(9), 862-870.

Hurt, L. S., Ronsmans, C., & Thomas, S. L. (2006). The effect of number of births on women's mortality: Systematic review of the evidence for women who have completed their childbearing. *Population Studies-a Journal of Demography, 60*(1), 55-71.

Li, R. N., Cui, J., Jothishankar, B., Shen, J., He, P., & Shen, Y. (2013). Early Reproductive Experiences in Females Make Differences in Cognitive Function Later in Life. *Journal of Alzheimers Disease, 34*(3), 589-594.

Seeman, T. E., Singer, B. H., Rowe, J. W., Horwitz, R. I., & McEwen, B. S. (1997). Price of adaptation - Allostatic load and its health consequences - MacArthur studies of successful aging. *Archives of Internal Medicine, 157*(19), 2259-2268.

Spence, N. J. (2008). The Long-Term Consequences of Childbearing Physical and Psychological Well-Being of Mothers in Later Life. *Research on Aging, 30*(6), 722-751.