The Pathways programme and:
Pathways from fertility history to later life health: Results from analyses of the English Longitudinal Study of Ageing

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PATHWAYS: Biosocial Influences on Health

Aims:

a) Identify the pathways that link socio-demographic circumstances and biological disadvantage to health

b) Develop and disseminate methods for the investigation of pathways between social and health related processes

c) Offer training for social scientists in the use of biomedical data to maximize returns on new data investments

Substantive applications

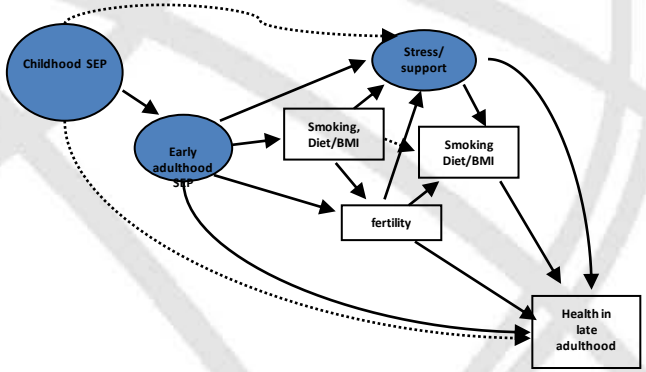
I. To what extent does stress, social support and health related behaviour mediate the effect of fertility history and childhood circumstances on later life health?

II. To what extent does marital history mediate the association between childhood and early life circumstances and health in mid life?

III. Social disadvantage and infant mortality: effect modification by birthweight or selection bias?

IV. Is alcohol use causally related to fibrinogen level?

V. Ethnic differences in health and use of healthcare (PhD project).



Methodological challenges

a) Complex structures
b) Measurement error
c) Missing data
d) Unmeasured confounding

Methods to be explored

- **Structural Equation Models** (SEMs) can deal with a)-c), but impose strong modelling assumptions which should be explored through sensitivity analyses
- Alternative models such as **Marginal Structural Models** and **Structural Nested Models** can be fitted semi-parametrically, relaxing some of these assumptions
- They can also relax some of the unmeasured confounding assumptions implicit in SEMs
- **Instrumental variables based methods** can deal with d) but require appropriate instruments

Data sources

- National Child Development Study (NCDS)
- English Longitudinal Study of Ageing (ELSA)
- ONS Longitudinal Study
- British Household Panel Survey (BHPS)
- General Practice Research Database
- Pooled data sets including genetic information
- Uppsala Birth Cohort Multigenerational Study

Project team

- **Emily Grundy**
- Bianca De Stavola
- Mike Kenward
- George B Ploubidis
- Sanna Read
- Richard Silverwood
- Rohini Mahur (PhD student)

Collaborators

- Juan-Pablo Casas
- Rhian Daniel
- Frank Dudbridge
- Shah Ebrahim
- Dave Leon
- Liam Smeeth

Training for social scientists

1. Genetics and biomarkers (12-13 April 2012)
2. Measures of physical function
3. Causal inference: Introductory (September 2012)
4. Causal inference: Intermediate (early 2013)
5. Causal inference: Advanced (3 days)
6. Genetic epidemiology Masterclass (1 day)

Associations between fertility histories and mortality in later life

- Several, but not all, studies show worse health/higher mortality for nulliparous and high parity women (and men).
- Early parenthood is associated with poorer later health/mortality (women) and poorer later mental health (women and men)
- Late fertility associated better health/lower mortality in both women and men (but some studies the reverse)

These associations may reflect:

- **Selection** and reverse causation
- **Direct effects** e.g. physiological consequences of pregnancy and childbirth.
- **Indirect effects** e.g. costs/benefits of child rearing

NCRM National Centre for Research Methods

Childrearing and health:

Health promoting:

- Incentives towards healthy behaviours and risk avoidance
- More social participation and activity
- Role enhancement
- Social support - in childrearing phases and in later life

Health challenging:

- Physiological demands of pregnancy, childbirth and lactation (although reduced risk breast & some other hormonally related cancers)
- Potential role conflict/role overload
- Stress (and depression)
- Economic strain
- Increased exposure infections
- Disruption of careers/education – especially for young parents

Effects, and balance between positive and negative, likely to vary by gender, fertility pattern, and socio-economic & socio-demographic factors, including cultural and policy context.

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

NCRM is funded by the Economic and Social Research Council

Associations between number of children and at least weekly contact with relatives; friends; & children, relatives or friends. ELSA wave 1.

No. of children (ref=0)	Relatives	Friends	Children/relatives or friends
Men			
1	1.3	1.0	1.7***
2	1.3	0.9	1.7***
3	1.7*	0.9	2.1***
4+	1.4	0.9	2.6***
N			3176
Women			
1	1.2	1.0	1.7**
2	1.2	0.9	1.7***
3	1.3*	0.8*	1.9***
4+	1.5*	0.9	1.9***
N			3835

Controls for age, education, wealth, housing tenure, marital status, health, ADL & IADL limitation. *p<0.05; **p,0.01, ***p<0.005. Grundy & Read JGSS 2012.

Receipt of help from a child at Wave 2 among parents with ADL/IADL limitation, by number of children, availability of daughter and contact with child at Wave 1.

	Help from child at Wave 2			
	Fathers (N=646)		Mothers (N=991)	
N of children (ref = 1)				
2	1.37	1.36	0.98	0.96
3	1.55	1.52	1.39	1.33
4+	1.70	1.69	2.15**	2.12**
Daughter	0.83	0.74	1.56*	1.43
Married	0.40***	0.40***	0.45***	0.44***
Weekly contact with child Wave 1	-	1.74**	-	1.73***

Controlling for age, wealth, education , housing tenure, and baseline general health and long term illness.

Source. Analysis of ELSA, Grundy & Read JGSS in2012.

Outline :Fertility history and later life mortality: outcomes investigated and data used:

:

- *All cause mortality*: Norwegian population registers; ONS Longitudinal Study (E&W): USA Health and Retirement Survey linked to mortality
- *Cause specific mortality*: Norwegian population registers
- *Health, health trajectories*, **mental health**: USA HRS; UK British Household Panel Study; English Longitudinal Study of Ageing (allows consideration of mediating variables such as smoking and emotional support), 1946 birth cohort.
- **Quality of life, loneliness, social contacts, receipt of help from children**: ELSA
- ***Allostatic load and health and limitation and mediation* through lifestyle, wealth and social support variables**: ELSA

Fertility history and mortality ages ~45-69 comparing England & Wales, Norway & USA (controlling for age, marital & socio-economic status &, in USA, race/ethnicity).

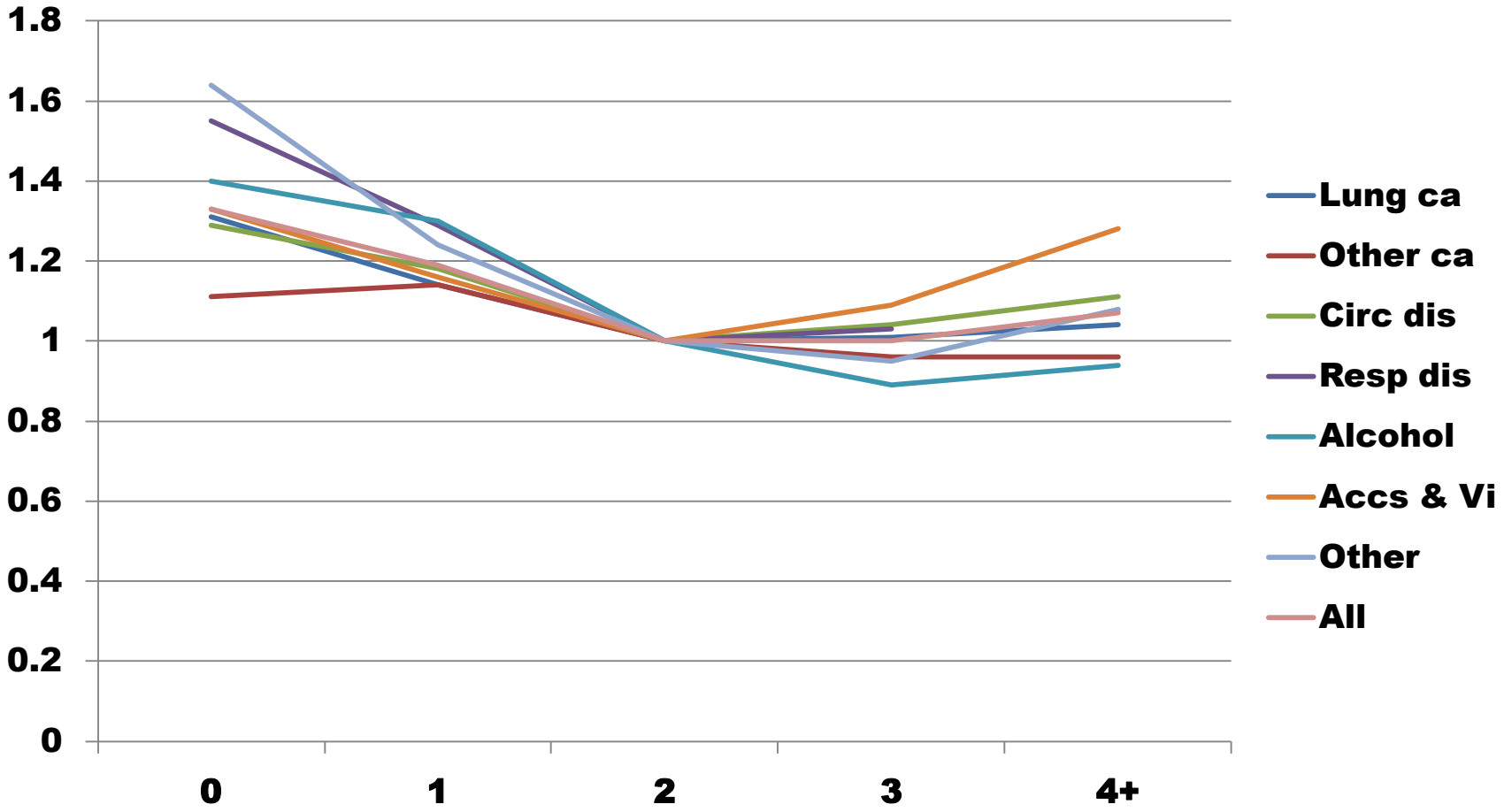
	E&W deaths 1980 2000 at ages 50-69	**Norway deaths 1980 2003 at ages 45-68**	**USA deaths 1994 2000 at ages 53-69**
ALL Women/Men:	*OR*	*OR*	*OR*
0	**1.28**	**1.50**	**1.47**
1	**1.10**	**1.31**	**1.34**
2 (ref)	**1.00**	**1.00**	**1.00**
3	**1.01**	**0.95**	**1.21**
4	**1.11**	**0.95**	**1.41**
5+	**1.25**	**0.94**	**1.66**
PAROUS			
Birth before 20 (F)/23 (M)	**1.30**	**1.21**	**1.55**
Birth after 39	**0.94**	**0.86**	**0.74**
Number of deaths	***2,212***	***23,241***	***329***

Analysis of ONS LS data ; Norwegian register data & US HRS, Grundy 2009. P<0.05; P<0.10

Fertility history and cause specific mortality: hypotheses:

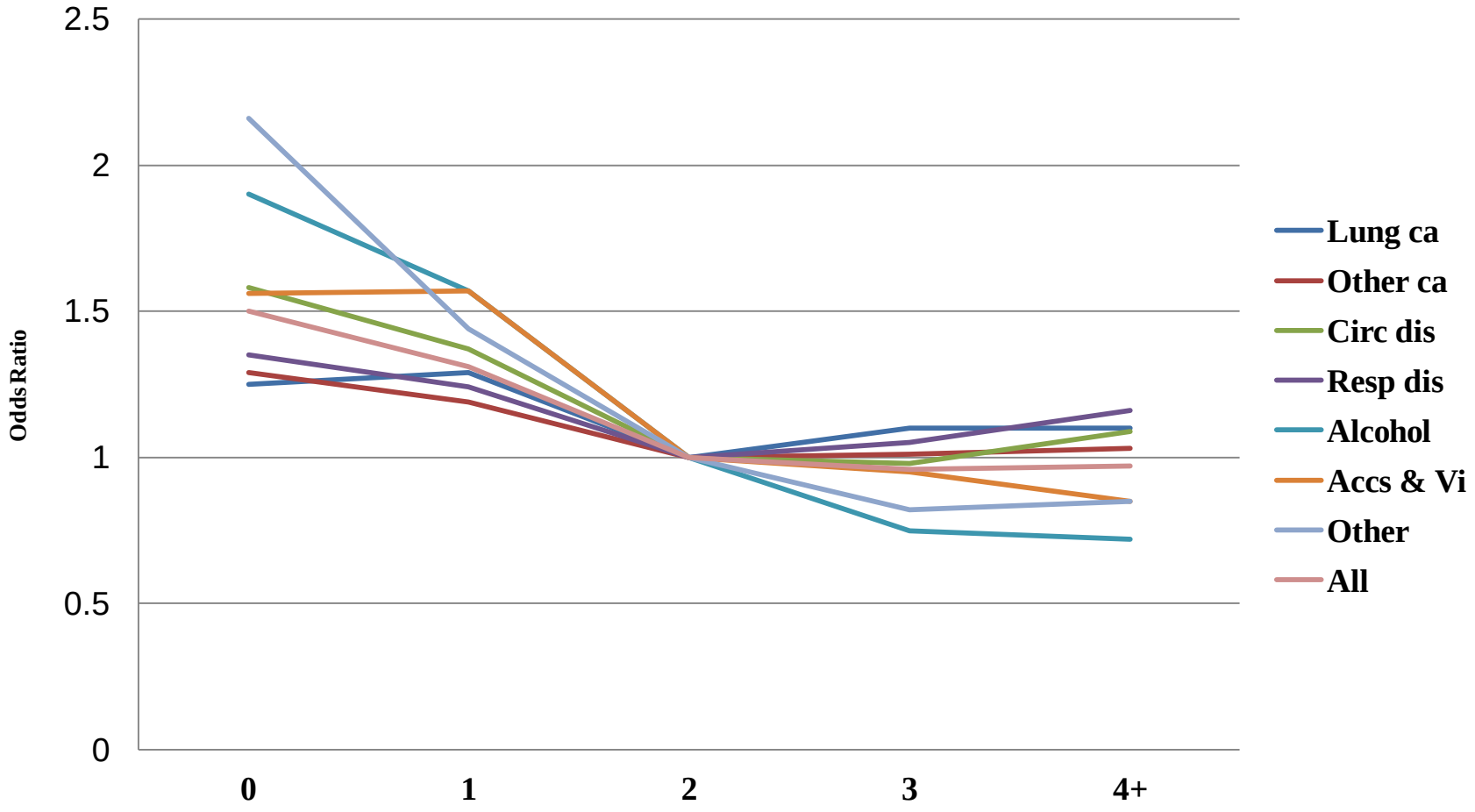
- Expect nulliparity and low parity (one child) to be positively associated with causes of death associated with early poor health and related behaviours (selection), causes related to lack of social control of health behaviours and lack of social support. i.e.all cause groups but particularly alcohol related diseases; lung cancer; accidents and violence; and circulatory and respiratory diseases.
- Additionally for physiological reasons expect nulliparity and low parity to be positively associated with female mortality from cancers of the breast, ovary and uterus.
- High parity (4+) – possible adverse effects arising from stress, socio-economic disadvantage and lifestyles offsetting or outweighing benefits of parenthood. If so would expect raised mortality from circulatory diseases and accidents and violence, especially among those of lower education.

Associations between parity and mortality by cause group, Norwegian men aged 45-68



Controlling for age, year, education, marital status, region, log population size of municipality (Model 3), Source: Grundy and Kravdal *Soc Sci Med* 2010

Associations between parity and mortality by cause group, Norwegian women aged 45-68



Controlling for age, year, education, marital status, region, log population size of municipality (Model 3): Source Grundy and Kravdal, *Soc Sci Med* 2010.

Conclusions from cause specific analysis

- Results support hypothesis that nulliparity and low parity associated with lack of social control of health related behaviours, lack of social support and adverse selection
- Results for female cancers also as expected, consistent with physiological causes – but also social support
- Limited support for hypothesis that stress of high parity might outweigh beneficial effects (once age at 1st birth and education controlled) **but** in stratified analyses high parity increased risks of circulatory disease mortality for low SES men; results may differ in countries offering less support for parents
- Gender difference in associations between high parity and mortality from accidents and violence – possibly due partly to gender differences in co-residence with children (not measured here)
- Need analyses including data on support exchanges, perceived and measured stress and health related behaviours.

Fertility history, health status and health trajectories: Analysis of the BHPS. Data and Methods

- We investigate associations between fertility histories of women and men with both level and change in two indicators of health
- Sample drawn from British Household Panel Study; 3,450 women and men born 1923-1950 who responded to the 1992 wave, were followed up to 2003 and were then aged 53-80 (6% excluded due to missing data).
- Methods: Multiprocess modelling of retention in sample and health outcomes conditional on retention.

Measures

- *Fertility history*: Number of natural children (0, 1, 2, 3, 4+); for parous:young age at first birth (<20/23); any birth at age >35/39; for parents with 2+ births: any birth interval < 18 months.
- *Co-variates*: Education; marital status; housing tenure; smoking; emotional support; co-residence with children (parents only)- all time varying except emotional support.
- Variables hypothesised to be associated with sample retention- interviewers' reports of problems with interview; recent mover; foreign born.

Outcomes:

- **Self rated health**: Excellent, Good, Fair, Poor, Very poor. Ordinal variable, higher=worse.
- **Health limitation:** "Does your health in any way limit your activities compared to most people of your age?"

Results: Joint logistic regression model of sample retention and health limitation conditional on retention

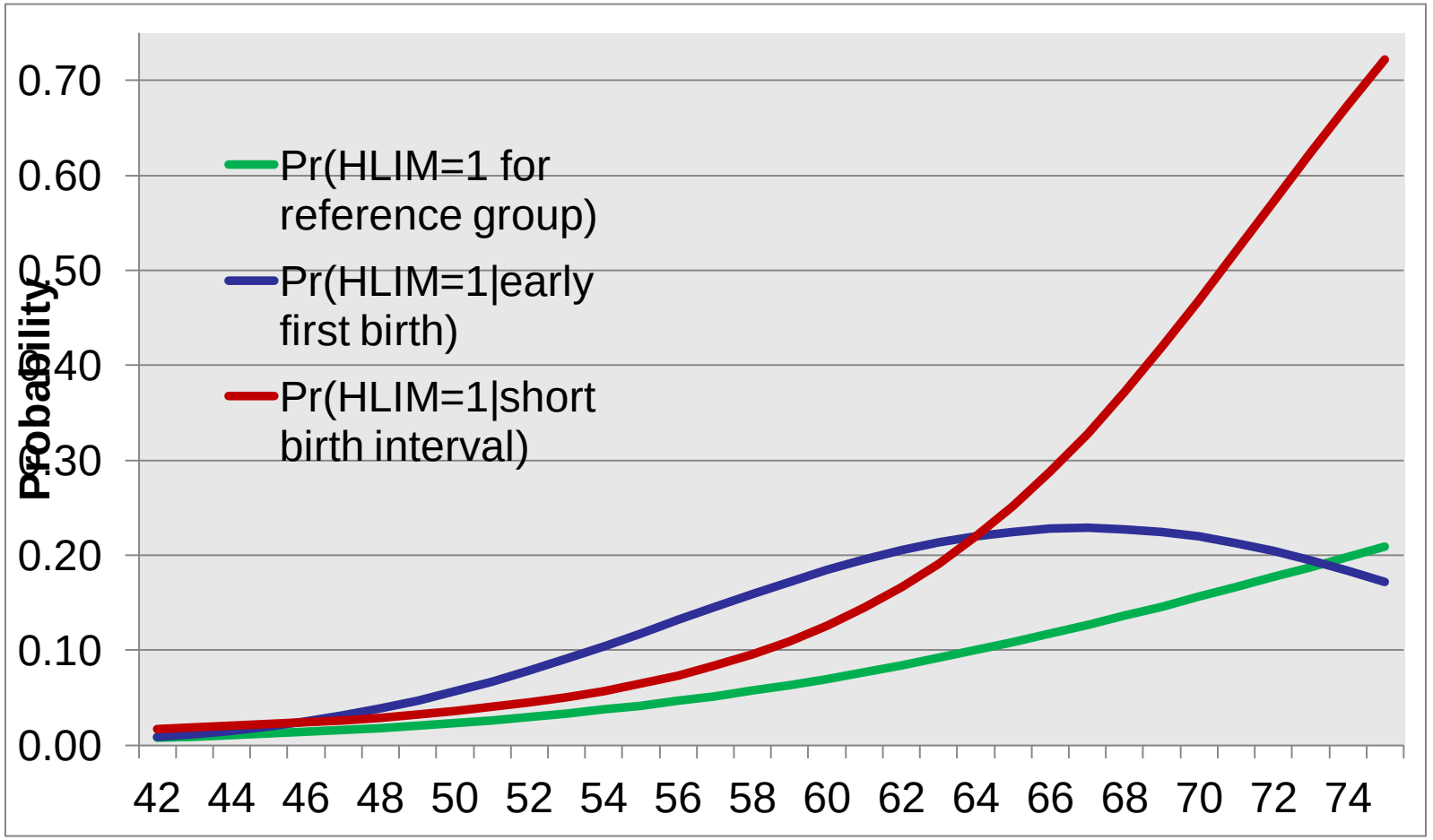
	Men		Women	
		Health		Health
	Average	Limitation	Average	Limitation
Age[b]	54.7	+++ **	55.0	+
Age squared[b]		- ***		+++ *
Number of children: 0	0.17	*	0.14	+ ***
1	0.14		0.16	
3	0.20	++	0.34	***
4+	0.14	+++	0.22	+++ ***
No Qualifications[b]	0.39	***	0.47	***
Not Married[b]	0.15		0.27	***
Nonowner[b]	0.21	+++ ***	0.24	+++ ***
Smoker[b]	0.28	***	0.29	***
Emotional Support	0.76	--- ***	0.81	-- ***

+/- p<0.05; ++/-- p<0.01; +++/--- p<0.001. ** indicates also associated with retention (interview quality also predicted retention).

Source: Read, Grundy, Wolf, Pop Studies 2011.

Rate-of-change in health over 11 years: Predicted probability of health limitation by fertility history characteristics, British women born 1923-49

(reference group = women with 2 children born when mother 20-34)



Source: Analysis of BHPS data in Read, Grundy & Wolf, Population Studies 2011

New directions:

Limitations of previous work

- Outcome measures – mortality and ADL limitation- may be too far 'upstream' – need indicators of sub clinical morbidity observable earlier in life course
- Failure to identify PATHWAYs through which fertility histories influence later life health
- Limited consideration of early life influences on both fertility histories and later health

Addressing these limitations

- Measures of allostatic load in mid and later life
- SEM and path analysis to identify pathways
- Modelling including early life indicators

Aims

- Derive a measure of allostatic load using biomarker data from the English Longitudinal Study of Ageing (ELSA)
- Identify *pathways* from fertility histories to later life health (and mediation via allostatic load) and examine the extent to which associations operate through (i.e. are mediated by) wealth, health related behaviours, and social support and strain.

Data and Methods

- English Longitudinal Study of Ageing (ELSA) waves 1 -3 (2002-2006)- nationally representative survey
- Socio-demographic information and self reported health collected in all waves
- Detailed health data including biomarkers collected in alternate waves –biomarker data used to derive an index of allostatic load
- Retrospective life course data collected in wave 3.
- Path models within structural equation modelling framweork using Mplus version 5.21. Maximum likelihood estimation with robust standard errors. Mplus deals with missing data using all available data under MAR assumptions.

Measures

Demographic & life course:

Age, education, childhood health problem (retrospective), married/not married, and co-residence/contact with children (time varying); ever divorced, ever widowed (wave 3).

Fertility measures:

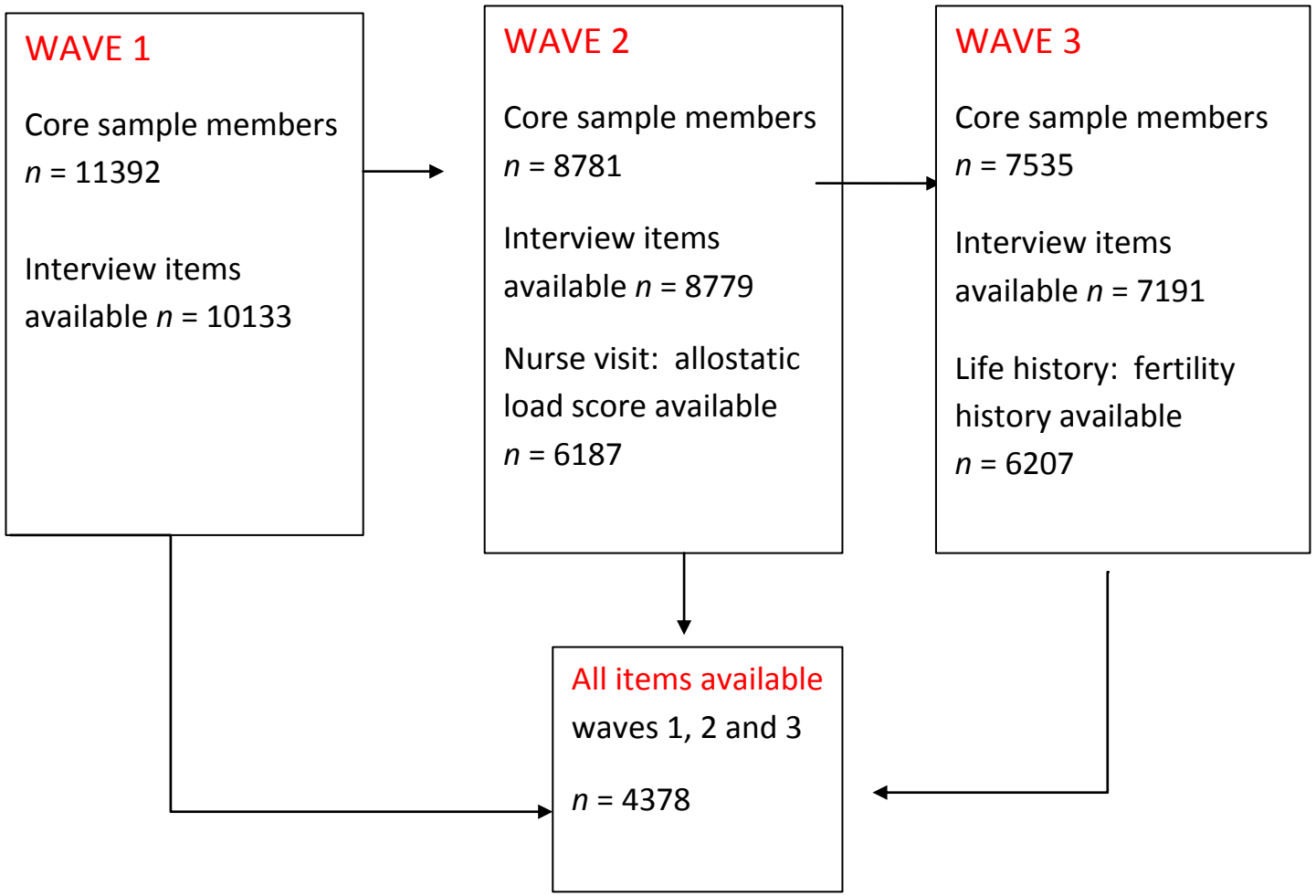
Number of natural children (0, 1,2,3,4+); any step child; any adopted child; deceased child; for parents: young (<20/23) age first birth; late age last birth (>34/39).

Intermediate

Wealth; smoking; physical activity; social support and strain (Wave 1)

Outcomes: Allostatic load (wave 2); self reported health limitation (wave 3).

Sample derivation and data availability



Allostatic load scores in ELSA

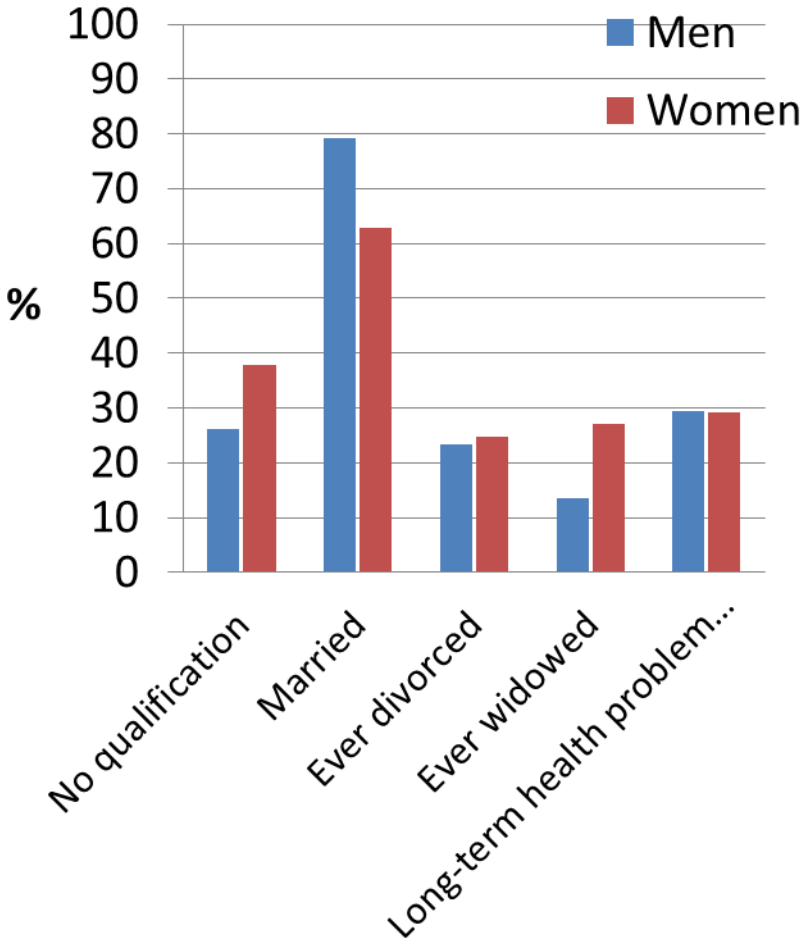
- Allostatic load: multisystem physical dysregulation resullting from long-term exposure to stress
- Grouped allostatic load index: number of biomakers indicating high risk (25th percentile) calculated separately for men and women(and age group), range 0 - 9

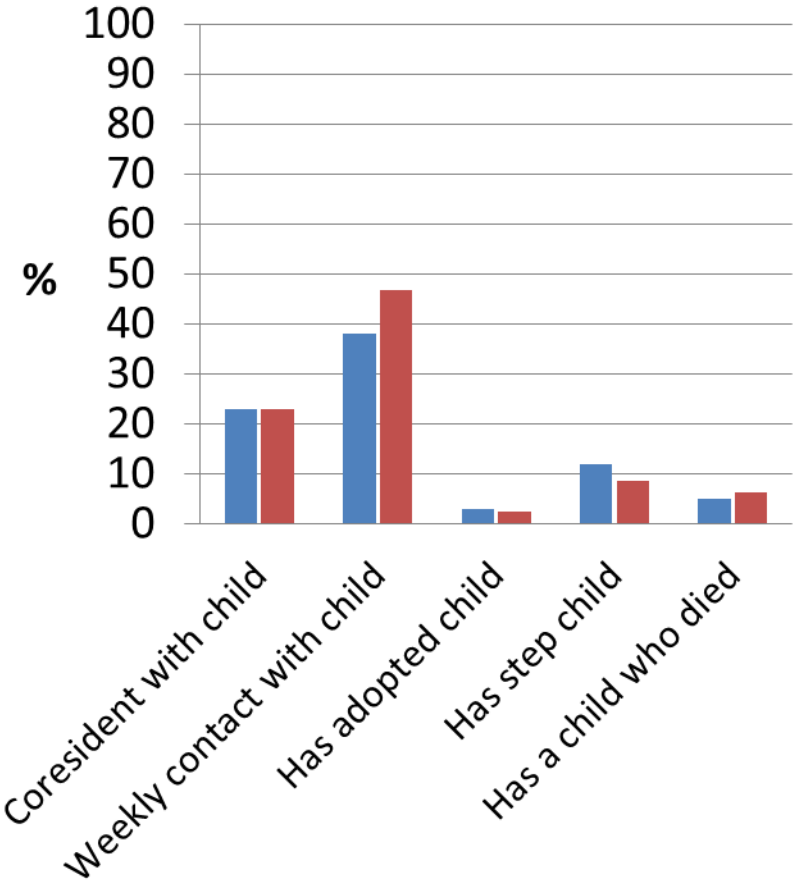
Upper 25th percentile	Lower 25th percentile
Systolic blood pressure	Diastolic blood pressure
Fibrinogen	Peak expiratory flow
Triglycerides	
C-reactive protein	
Glycated HgB	
Waist-hip ratio	
Total/HDL cholesterol ratio	

Allostatic load: 25th percentile high risk cut-off points, ELSA in wave 2 (2002).

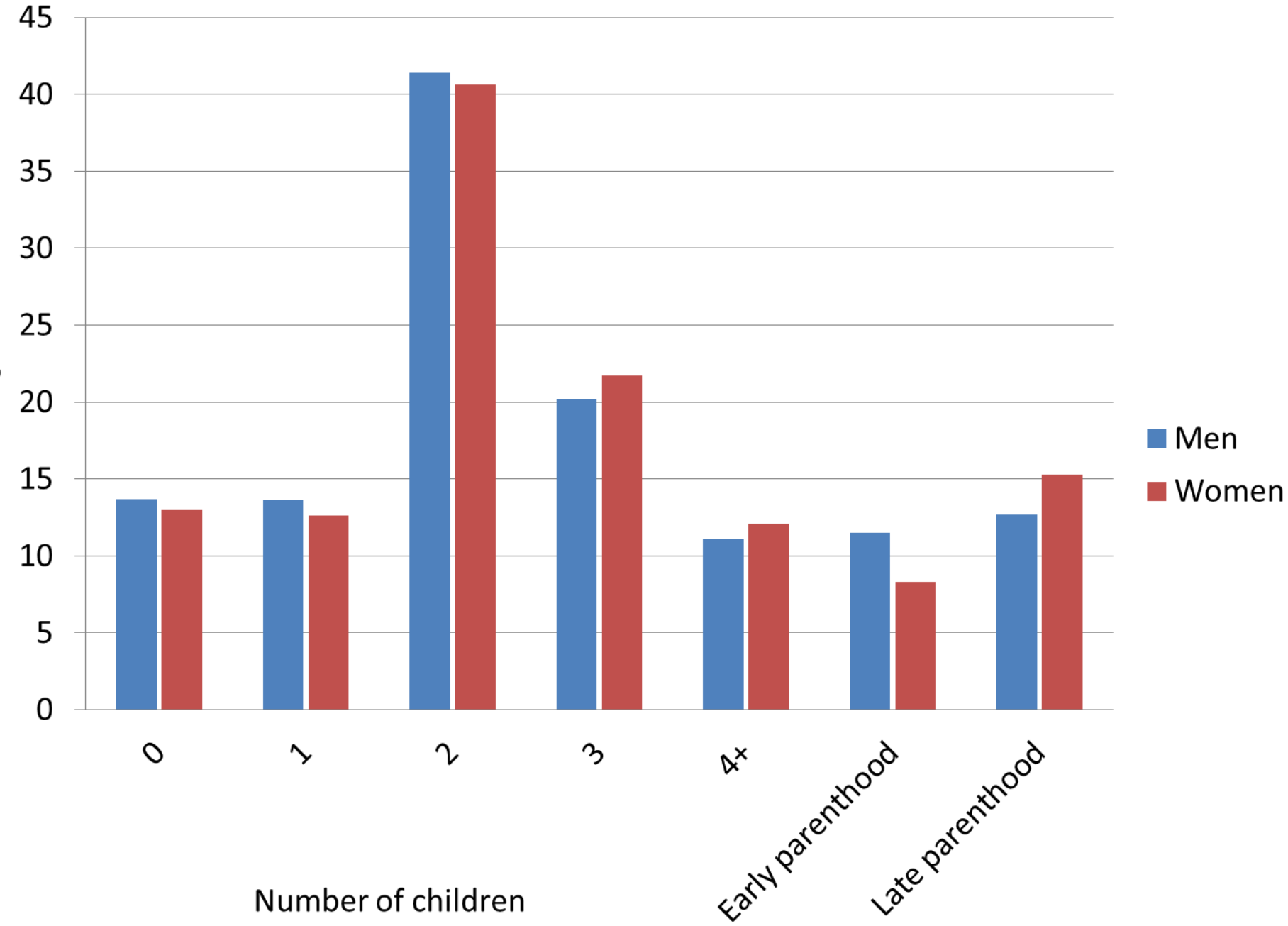
	Men		Women	
	Aged 51-65	Aged 65+	Aged 51-65	Aged 65+
Inflammation	(*n* = 1008-1017)	(*n* = 982-986)	(*n* = 1219-1232)	(*n* = 1190-1196)
C-reactive protein	>2.9	>3.4	>3.4	>3.9
Fibrinogen	>3.4	>3.7	>3.5	>3.8
Cardiovascular	(*n* = 1074)	(*n* = 1106)	(*n* = 1319)	(*n* = 1398)
Systolic blood pressure	>143	>149	>140	>151
Diastolic blood pressure	>85	>80	>83	>79
Lipid metabolism	(*n* = 1001-1017)	(*n* = 965-983)	(*n* = 1219-1233)	(*n* = 1187-1196)
HDL/Total cholesterol ratio	>5.0	>4.6	>4.4	>4.5
Triglycerides	>2.5	>2.2	>2.1	>2.1
Glycosylated haemoglobin	>5.7	>5.9	>5.6	>5.8
Body fat	(*n* = 1216)	(*n* = 1231)	(*n* = 1486)	(*n* = 1527)
Waist/hip ratio	>1.00	>1.00	>0.88	>0.89
Respiratory	(*n* = 1197)	(*n* = 1190)	(*n* = 1415)	(*n* = 1437)
Peak expiratory flow	<506	<406	<344	<265

Distribution of the sample by demographic & life history variables





Distribution of the sample by fertility history variables



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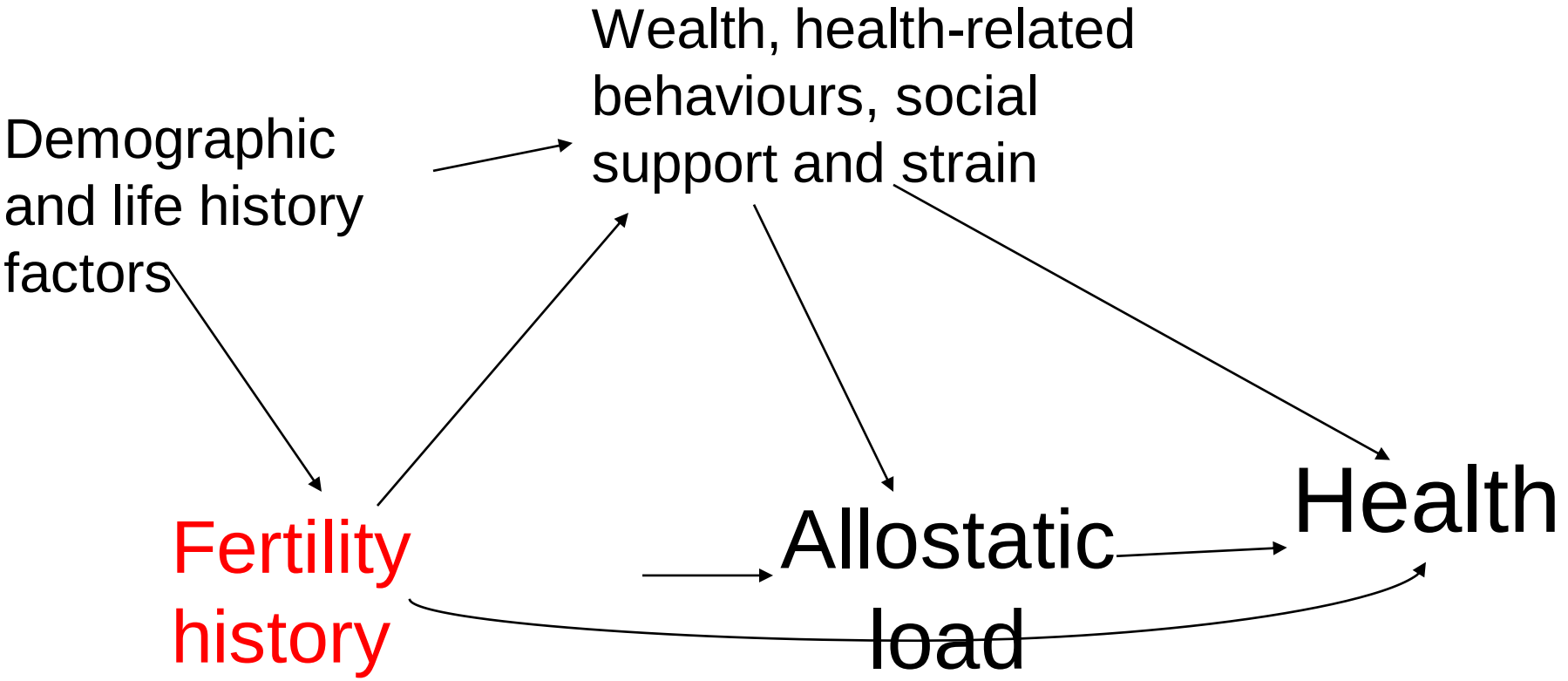
Distribution of the sample by intermediate variables and health outcomes

	Men (*n* = 1996)	**Women (*n* = 2382)**
Intermediate variables		
Wealth, wave 1	3.4 (1.38)	3.2 (1.39)
Physical activity, wave 1	2.2 (0.73)	2.1 (0.78)
Current smoking, wave 1	13.9	15.5
Perceived social support, wave 1	4.2 (0.50)	4.3 (0.49)
Perceived social strain, wave 1	2.7 (0.42)	2.6 (0.45)
Health outcomes		
Allostatic load weighted mean score, wave 2		
<0.1	18.3	18.4
0.1	15.2	15.5
0.2	19.7	19.0
0.3	14.8	15.3
0.4	12.0	11.4
0.5	10.3	9.0
0.6	4.1	5.5
0.7	3.4	4.1
0.8-1.0	2.2	1.8
Limiting long-term illness, wave 3	30.6	35.3

The model to be tested

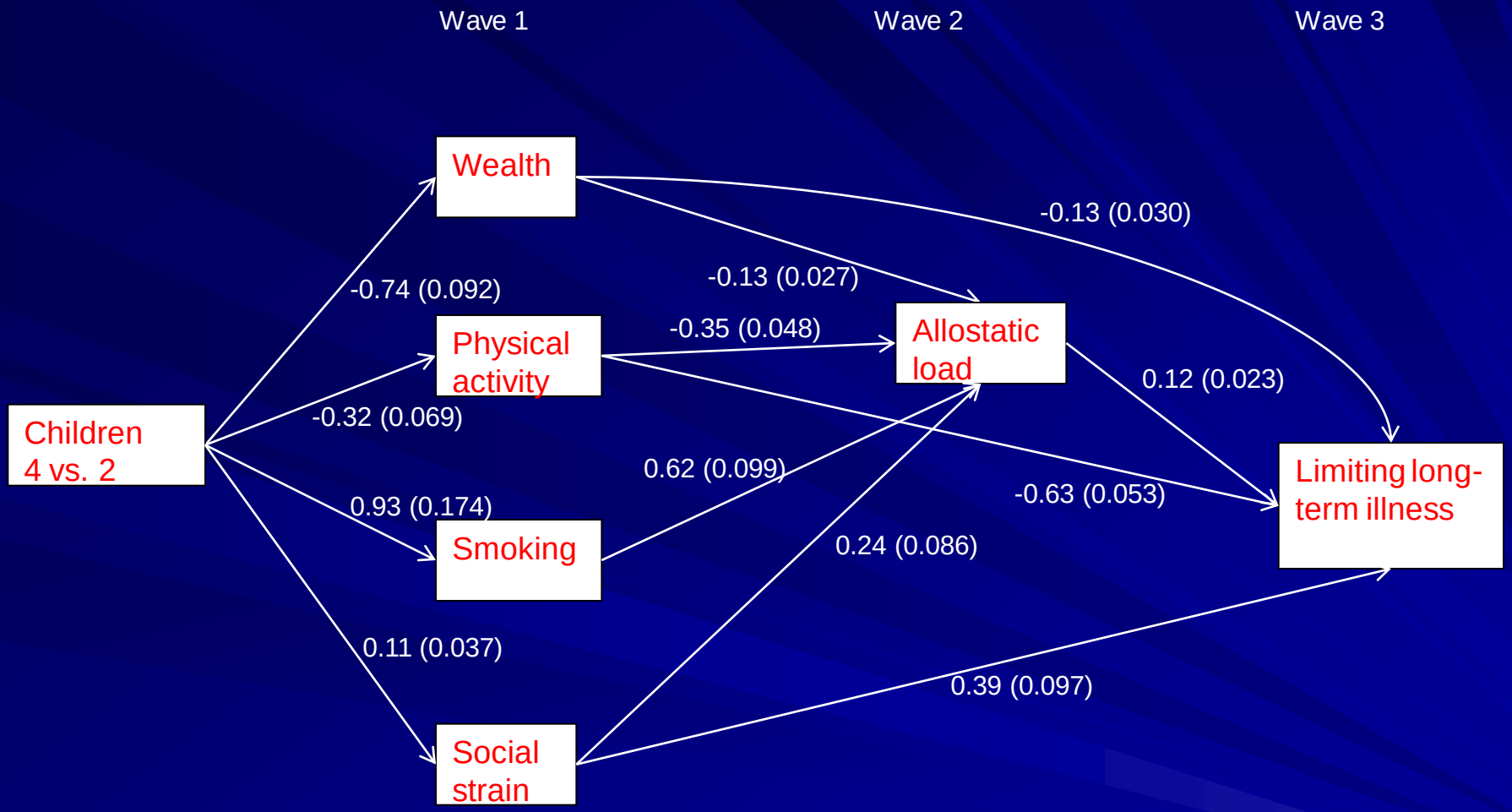
Is the association between fertility history and health mediated by allostatic load?



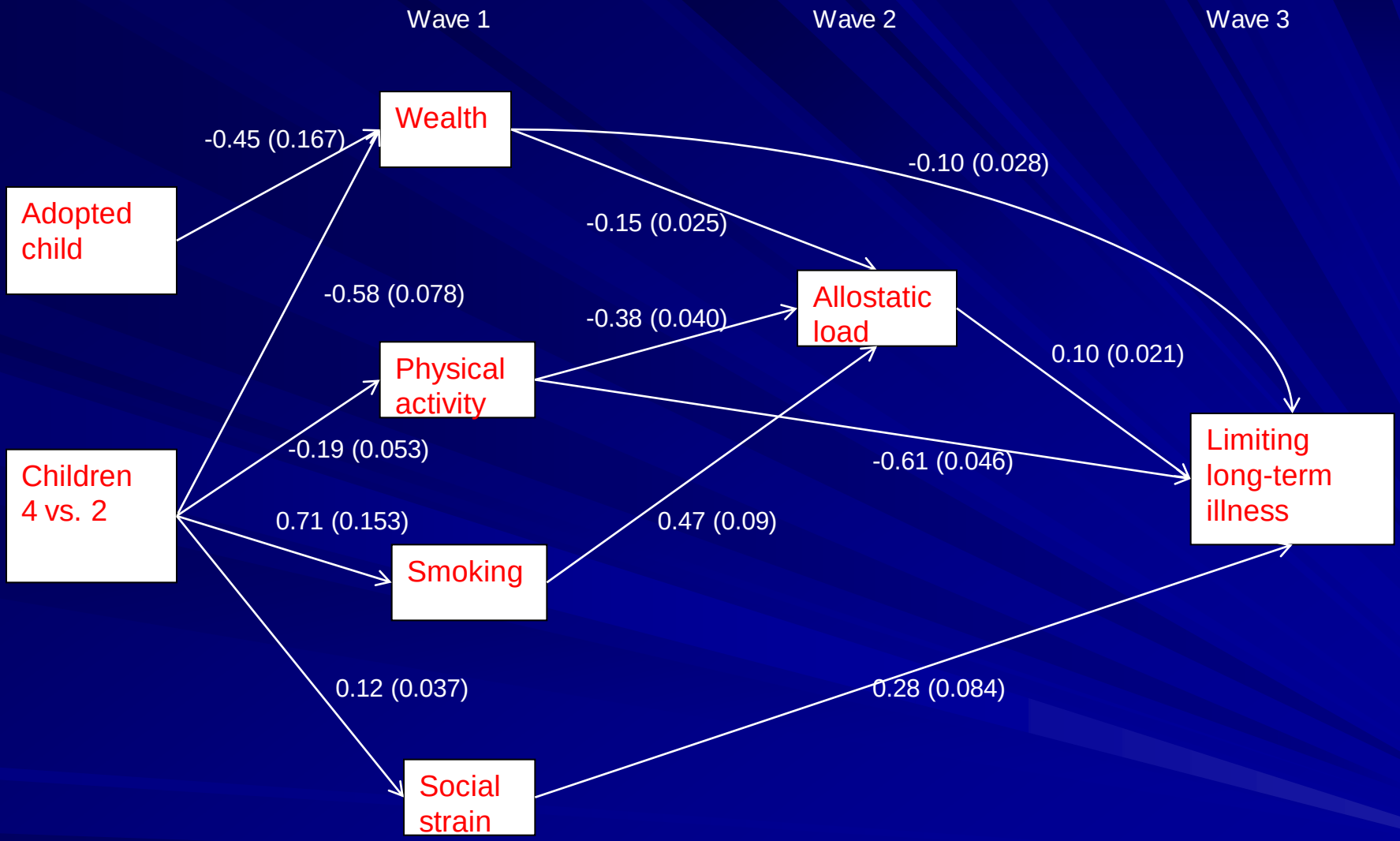
Associations between fertility & parenthood variables, allostatic load and health limitation among men (n=2071) and women (n=2519) in ELSA

	Allostatic load		Health limitation	
No. Natural children (ref = 2)	Men	Women	Men	Women
0	-0.05	0.04	0.10	0.18
1	0.04	-0.14	0.14	0.07
3	0.01	0.18	0.07	-0.01
4	**0.34***	**0.29***	**0.29***	**0.23***
Early child birth[a]	**0.51*****	**0.58*****	**0.46*****	**0.43****
Late childbirth[a]	0.10	-0.16	**0.29***	**-0.23***
Adopted child	-0.15	**0.55****	-0.24	0.09
Step child	0.08	0.03	**0.30***	-0.09
Child died	0.22	0.03	0.21	0.19

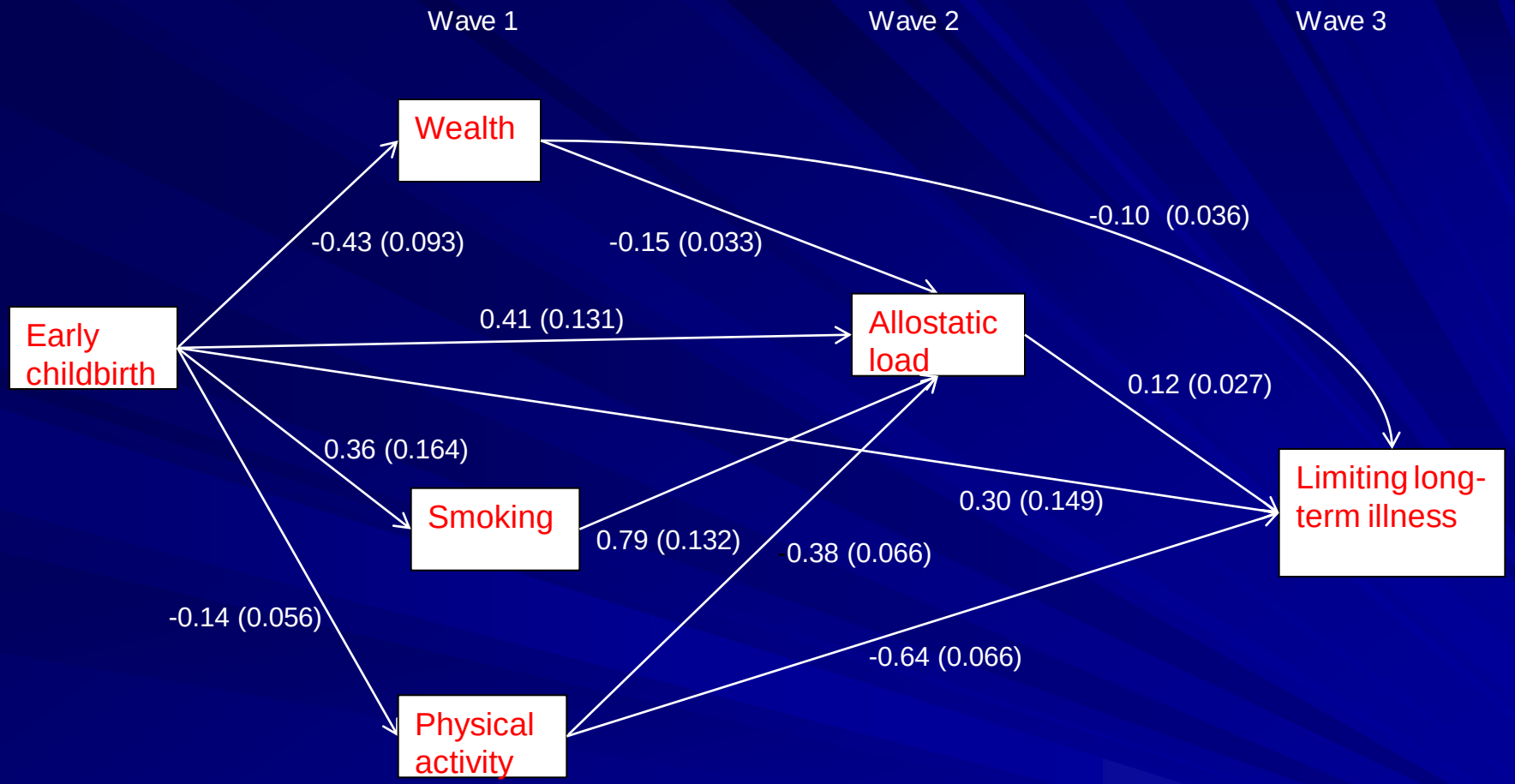
Models include health in childhood; age; education; married/not married; ever widowed; ever divorced; intergenerational contact. Allostatic load adjusted for fasting & inhaler use. [a] parents only.



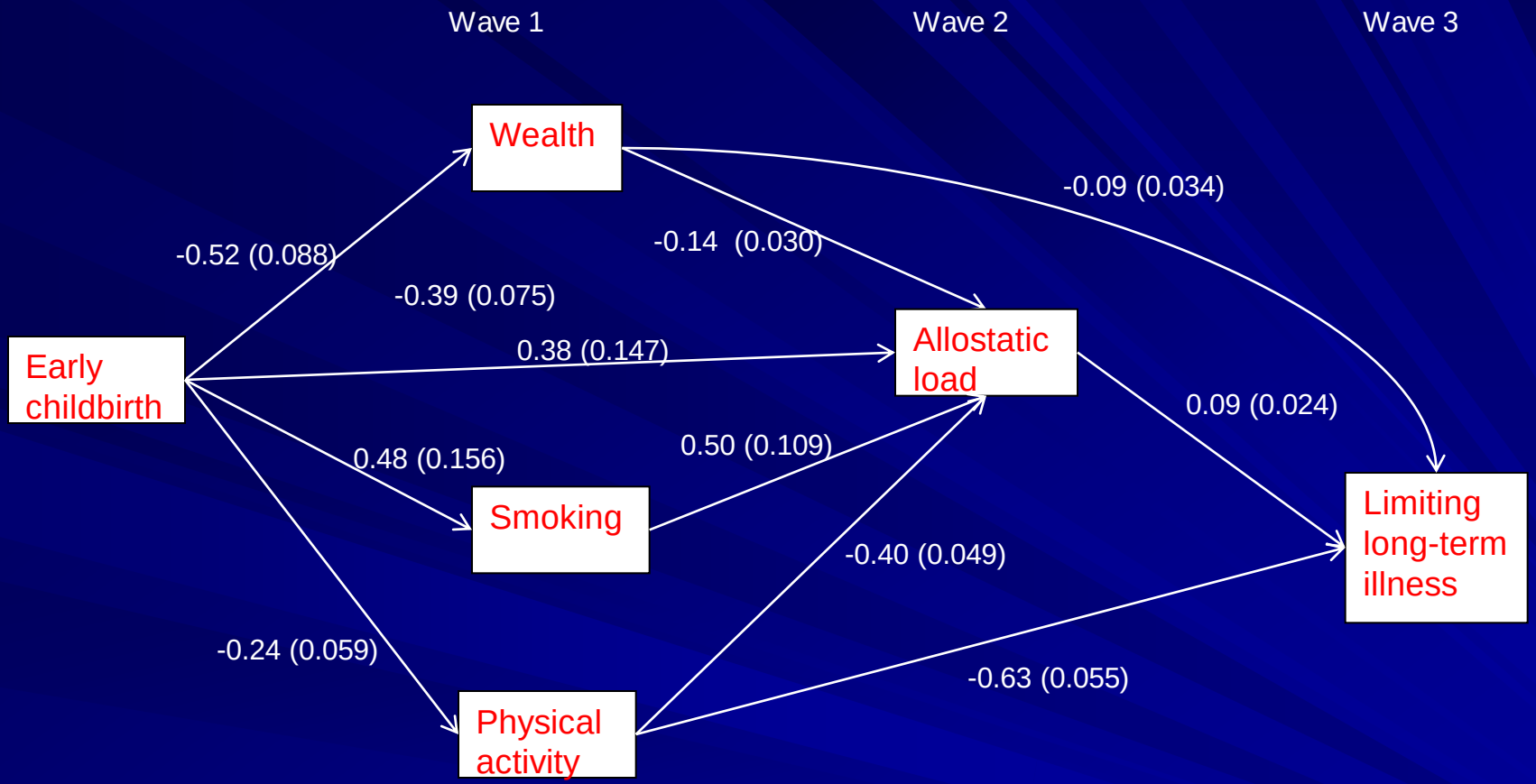
Path model for all men in ELSA. Model adjusted for age, education, being married, ever divorced, ever widowed and childhood health. Significant paths are shown (unstandardized estimate and standard error).



Path model for all women in ELSA. Model adjusted for age, education, being married, ever divorced, ever widowed and childhood health. Significant paths are shown (unstandardized estimate and standard error).



Path model for biological fathers in ELSA. Model adjusted for age, education, being married, ever divorced, ever widowed, childhood health, and coresidence with child. Significant paths are shown (unstandardized estimate and standard error).



Path model for parous women in ELSA. Model adjusted for age, education, being married, ever divorced, ever widowed ,childhood health, and coresidence with child. Significant paths are shown (unstandardized estimate and standard error).

Conclusions & Discussion

- Association between large family size and allostatic load and health is mediated largely by wealth (M&F), and smoking and social strain (F)– i.e. no direct association once all intermediate factors entered in model
- Mothers – still a direct association between early motherhood and allostatic load, but otherwise associations mediated by wealth, physical activity and smoking.
- Among fathers, direct effects remain to some extent, although some mediated by wealth and physical activity.
- Some effects on health mediated by allostatic load, but not all
- So, as hypothesised, biosocial pathways from parenthood history to health include economic, social support and health related behaviours – need now to examine in more detail pathways to particular fertility trajectories- especially childhood SES and broader environmental influences (e.g. support from the state).

So are children the key to a healthy and happy old age?

Yes

- More children and having a daughter increases social contacts
- More children associated with more help from children; parents have lower risks of entry to nursing homes
- Parents (of smallish families) have lower mortality, better health and better cognition than the childless

No

- High parity associated with higher mortality and worse health – but not in Norway
- 'Intensive' family formation patterns – early parenthood and short birth intervals- associated with worse physical and mental health, faster decline in health, and raised mortality

BUT the context is very important –variations and interactions by gender, country, education etc AND we need to consider selection.