Fertility History and Biomarkers: Evidence from the 1958 National Child Development Study

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National Child Development Study



Fertility and Health

- Parenthood is a major event in people's life, and can lead to changes in activities, lifestyles and allocation of resources. For women it also involves considerable physiological changes
- Parity
 - J-shaped association between overall parity and mortality/health: higher risks for childless and high parity parents (*Hurt et al. 2006; Zeng et al. 2016; Hognas et al. 2017*)

• Age at Childbearing

- Increased mortality and poorer health outcomes among those entering parenthood at a young age (Henretta 2007; Pirkle et al. 2014; Read et al. 2011)
- Similar, but less strong, results for **men**: underlying biosocial pathways

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Motivation

- The existing literature on fertility and health, rather than mortality, has mainly focused on self-reported indicators
- Only a few studies used more objective and unbiased measures like biomarkers, e.g.:
 - Hardy et al. (2007): No consistent relationship between parity and biomarkers for coronary heart diseases (1946 NSHD)
 - Grundy and Read (2015): Earlier ages at first birth associated with worse allostatic load; No association between childlessness and allostatic load (ELSA)
- **Research Objective:** Investigate the relationship between fertility histories and several biomarkers representing cardiovascular disease and respiratory function risk factors

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Possible Mechanisms

• Positive:

- Children provide an incentive to healthier behaviors (Umberson 1987), and a source of social interaction and social support (Grundy and Shelton 2001).
- e.g. Less smoking among parents, and lower risks for cardiovascular disease + better respiratory function

• Negative:

- Parenthood involves stresses (for women also physiological stress), and substantial economic costs (Joshi 2002; Murphy 1984)
- e.g. Pregnancy, parturition, and lactation(W), sleep deprivation, financial stress

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Hypothesis

- Higher parity has been found to lead to higher risks of obesity, a well-established cardiovascular risk factor (Sowers 2003)
- Young parents less resilient to stress and have fewer social and economic resources (*Falci, Mortimer, and Noel 2010*)
- Early parenthood leads to disruption of educational and career progression, and increased risk of partnership breakdown (*Grundy and Read 2015*)

Hypothesis

Cumulative effects of these stresses outweigh positive effects of parenthood for **young parents** and **large family sizes**

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Data

- Problem: Selection into fertility pathways (e.g childhood health and early life socioeconomic conditions). It is essential to use high quality prospective data
- **1958 National Child Development Study**: ongoing study started in 1958, follows more than 17,000 infants born in England, Scotland and Wales in a single week in March 1958
 - Ten additional sweeps have been collected since 1958 when respondents were aged 7, 11, 16, 23, 33, 42, 46, 50, and 55
 - In 2002 a biomedical survey was collected for more than 9,000 respondents
 - 8,018 blood samples were received from subjects who gave consent to extraction of DNA

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Biomarkers

- We selected measures that are related to accumulated stress and to lifestyle factors: cardiovascular disease and respiratory function risk factors
 - Fibrinogen and C-reactive Protein: indicators of inflammation and cardiovascular disease;
 - **Glycated haemoglobin**: index of glucose metabolism, correlated with the presence of diabetes mellitus;
 - Cholesterol Ratio: Total cholesterol/HDL ratio;
 - High blood pressure: Blood pressure above 140/90;
 - Obesity: BMI greater than 30;
 - Waist to Hip Ratio: Waist over hip circumference;
 - Forced expiratory volume: how much air a person can exhale during forced breath in the first second (lt).

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Fertility Pathways

- Number of Children: Childless, 1 child, 2 children, 3 children, 4+ children;
- Age at 1st Birth:
 - *Men*: < 23, 23-27, 28-32, 33-38, ≥ 39;
 - Women: $< 20, 20-24, 25-29, 30-34, \ge 35.$
- Age at 'Last' Birth: < 25, 25-29, 30-34, 35-39, ≥ 40

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Control Variables

• Early Life SES:

• Social class at birth; Parents' education; Financial hardship (Age 11); Overcrowding (11); Housing conditions (11); Family difficulties (7); Divorced parents (11); Parents' interest in respondent education (11)

• Early Life Health:

• Birth weight; Mother smoking when pregnant; Out of school for 1+ month (11); Times hospitalized (11); BSAG score (11); Rutter scale (7 and 11); Enuresis (7 and 11); Physical coordination (11); Teenage smoking (16)

• Cognitive Abilities:

- General ability test score (11); Educational level (23)
- Sociodemographic Characteristics:
 - Age at interview (Biomed); # of marriages (Biomed); # of cohabitations (Biomed); # months unemployed 1978-2001

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Sample & Analytical Startegy

- A complete case sample including respondents who provided blood samples, information on fertility histories, and all background variables, would comprise only 2,424 individuals (51.5% women)
- We performed Multiple Imputation with chained equations, with 50 imputed datasets using all variables in the substantive model as well as auxiliary variables
 - Sample of 15,252 respondents for the **parity** analysis (49% women)
 - Sample of 11,754 respondents for age at first and last birth analysis (51.5% women)

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Sample Characteristics

Biomarkers (Mean or %)	Men	Women	Normal Range/Values
Fibrinogen (g/L)	2.88	3.03	1.5-3
C-Reactive Protein (mg/L)	1.97	2.38	1-3
Glycated Haemoglobin	5.32	5.19	< 6%
Total Cholesterol	6.07	5.70	
HDL Cholesterol	1.43	1.69	
LDL Cholesterol	3.57	3.29	
Cholesterol Ratio (Total/HDL)	4.42	3.54	~ 3.5
% with High Blood Pressure	16.0	5.58	> 90-140
BMI	27.8	26.9	
% Obese	25.3	23.5	BMI > 30
Waist to Hip Ratio	0.93	0.81	< 0.90, < 0.85
Forced Expiratory Volume (lt.)	3.73	2.75	3-5, 2-4
N in Biomed. Sweep	4,665	4,712	

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Sample Characteristics

Fertility Measures (Mean or %)	Men	Women
Number of Children	1.73	1.90
% Childless	19.7	14.9
% 1 Child	20.6	18.2
% 2 Children	36.4	40.8
% 3 Children	16.3	18.1
% 4+ Children	7.0	8.0
Age at First Birth (N=4,854/5,407)	27.9	25.4
% < 23(M)/ < 20(W)	22.4	16.8
% 23-27 (M)/20-24 (W)	31.4	35.6
% 28-32 (M)/25-29 (W)	26.5	27.3
% 33-38 (M)/30-34 (W)	15.6	14.1
% 39+ (M)/35+ (W)	4.1	6.1
Age at Last Birth (N=3,608/4,253)	32.1	30.1
% < 25	9.2	17.7
% 25-29	27.2	32.4
% 30-34	33.7	30.4
% 35-39	21.3	15.8
% 40+	8.7	3.8
N w/ fertility info at Biom.	6,048	6,356

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Number of Children and Biomarkers

Number of Children (Ref: 2 children)



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Age at 1st Birth and Biomarkers



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Age at Last Birth and Biomarkers



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Discussion

- Once early life SES, childhood health and socioeconomic characteristics are taken into account, results show no significant association between **parity** and most of the biomarkers
- Inverted J-shape relationship between **age at first birth** and certain biomarkers, with better outcomes for intermediate ages. Particularly clear for Chol. Ratio, High BP, and Obesity
- A very low **age at last birth** is associated with negative outcomes, especially among women
- **Mechanisms**: results support the hypothesis that for very young parents the cumulative effects of stress associated with parenthood > positive consequences of becoming a parent
 - Partly confirms findings from the small **existing literature** on fertility history and biomarkers

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Limitations & Next Steps

- Large number of missing values
 - Multiple imputation with chained equations
- Confounding and selection into fertility pathways
 - We included in the analysis as many variables related to childhood health and early life conditions as possible
 - We also used negative controls (e.g. hair color; ear tested first; arm blood was taken from) (Lipsitch, Tchetgen, and Cohen 2010)
- Reproductive age: Respondents are 44-45 years old when the biomedical sweep was conducted
 - Second biomedical study when the respondent are 60 years old (2018)
 - Comparison with 1946 NSHD and with 1970 BCS

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Questions or Comments?

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National Child Development Study



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Additional Slides

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Number of Children and Biomarkers

Number of Children (Ref: 2 children)



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Number of Children and Negative Controls

Number of Children (Ref: 2 children)





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Blood Taken From Left Arm (vs Right), OR



Age at First Birth and Negative Controls

Age at 1st Birth (Ref: 23-27(M)/20-24(W))



Age at Last Birth and Negative Controls

Dark Hair Color (vs Light), OR Left Ear Tested First (vs Right), OR <25 <25 25-29 25-29 35-39 35-39 40+ 40+ 1.2 1.6 1.5 2.5 .6 .8 1.4 .5 ż ġ. Blood Taken From Left Arm (vs Right), OR <25 25-29-35-39-40+ 1.5 .5 Men Women

Age at last Birth (Ref:30–34)

Confounders I

	Men				Women			
	Mean or %	SD	N	N in the Sweep	Mean or %	SD	Ν	N in the Sweep
Early Life Socioeconomic								
Background								
Social Class at Birth - % Manual	68.2		7,227	9,004	68.1		6,887	8,411
% in Financial Hardship - Age 11	11.1		6,857	7,887	11.6		6,506	7,450
% Overcrowding - Age 11	12.0		7,065	7,887	12.1		6,727	7,450
Housing: % NO Access to 1+								
(Bathroom; Indoor WC; Cooking								
Facilities; Hot water) - Age 11	10.82		6,989	7,887	10.9		6,640	7,450
% with Family Difficulties - Age 7	4.46		7,152	7,917	4.03		6,794	7,508
% with Divorced Parents - Age 11	4.53		7,886	7,887	4.66		7,450	7,450
% Mother in School after Minimum								
Age - Age 0	24.8		8,970	9,004	25.1		8,383	8,411
Parents' Years of Education - Age 16	11.3	(1.81)	5,901	7,547	11.4	(1.84)	5,623	7,107
% Parents interested in R								
Education - Age 11	76.1		7,206	7,887	77.9		6,830	7,450
Early Life Health								
Birth Weight (ounces)	119.0	(22.0)	8,959	9,004	114.1	(21.1)	8,382	8,411
% Mother smoking when pregnant	33.2		9,004	9,004	33.2		8,411	8,411
% Out of school for 1+								
months - Age 11	4.88		7,803	7,887	5.51		7,370	7,450

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Confounders II

# times hospitalized - Age 11	0.74	(0.98)	7,089	7,887	0.57	(0.85)	6,736	7,450
% with Enuresis - Age 7	14.0		7,467	7,917	11.6		7,074	7,508
% with Enuresis - Age 11	7.37		7,069	7,887	4.73		6,723	7,450
Physical Coordination								
Problems - Age 11	17.2		7,028	7,887	13.5		6,624	7,450
BSGA Tot 'Syndrome'								
Score - Age 11	9.88	(9.67)	7,273	7,887	7.03	(7.95)	6,883	7,450
Rutter Scale - Age 7	-0.01	(1.00)	7,506	7,917	0.01	(1.00)	7,102	7,508
Rutter Scale - Age 11	0.06	(1.01)	7,078	7,887	-0.07	(0.98)	6,727	7,450
% Smoking - Age 16	37.5		6,114	7,547	34.0		5,855	7,107
Cognitive Ability								
General ability test score - Age 11	41.8	(16.3)	7,253	7,887	44.1	(15.9)	6,878	7,450
Education Level - Age 23								
% Low	25.5				29.8			
% Medium	56.0		5,205	6,267	50.7		5,457	6,270
% High	18.5				19.5			
Sociodemographic Characteristics								
Age at Interview - Biomed Sweep	45.2	(0.39)	4,659	4,665	45.2	(0.39)	4,709	4,712
# Marriages Age Biom., Avg.	0.81	(0.69)	7,779	7,780	0.89	(0.68)	7,516	7,516
# Cohabitations Age Biom., Avg.	0.68	(0.92)	7,779	7,780	0.66	(0.90)	7,516	7,516
# Months Unemployed (1978-2001)	8.6	(26.0)	7,780	7,780	4.3	(17.5)	7,516	7,516

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Variables Included in the MI

- Variables in the substantive model
- Complete variables measured at birth: social class at birth; birth weight; mother smoking during pregnancy
- Strong predictor of the outcomes: SRH at age 33
- Auxiliary variables associated with the outcomes: Need for special education treatment at age 11; General motor handicap at age 16; Current main activity at age 42 (full-time employment, part-time employment, other); Accommodation type at age 23 (owner or not).
- Auxiliary variables strongly predicting non-response: Currently member of union/Staff association at age 42

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Family structure and physical activity: a life-course perspective

Benedetta Pongiglione, Mark Hamer, David Bann, Alice Sullivan, George B. Ploubidis

CENTRE FOR LONGITUDINAL STUDIES

60 Years of our Lives Conference

London, 9 March 201

Outline

- Background & Aims
- Methods
- Results
- Discussion

Background

- Regular physical activity (PA) contributes to prevention of several chronic diseases and is associated with a reduced risk of premature death
- Nevertheless, large proportion of population does not meet PA recommendations
- Over the life course the level of PA tends to change with adults less active than adolescents.
- Most of research on changes in PA has focused on transitions between adolescence and early adulthood, while events occurring in mid and late adulthood are almost unexplored.





- Understanding why PA level changes across the life course may provide useful insight for the targeting of interventions to promote active lifestyles and sport practice.
- The most common reason given by adults for not being active is lack of time (Sallis and Hovell, 1990; Sallis et al., 1992).
- Factors that limit time availability include life events that increase responsibilities and obligations, e.g. start or stop employment or college, acquire a mortgage, becoming married or having children (Hull et al., 2010).



Background: Marriage



- Literature on how partnership impacts PA:
 - Cohabitation associated with being less active than remaining single in Sweden (Barnekow-Bergkvist, 1996).
 - Australian women who married increase their risk of inactivity, compared with those who remained single (Brown et al., 2009).
 - Becoming married does not significantly change PA in young adults (Hull et al., 2010).
 - Transitions to being married (from single to married or from divorced to remarried) associated with a modest reduction in fitness levels, and divorce with a modest increase in men (Ortega et al., 2010).

Background: Parenthood

- Parenthood found to have a clear affect on PA. New parents often have reduced time once used for sport and exercise.
 - Decreasing PA associated with marriage and childbirth in young women (Brown et al., 2009)
 - For women having children increased the risk of being physically inactive in adulthood (Barnekow-Bergkvist et al., 1996).
 - Having children associated with decreased levels of PA among Australian women aged 18-23 (Brown et al., 2003).
 - Decreases in physical activity strongly associated with becoming a mother, for women aged 18-23 in Australia (Bell and Lee, 2005).

Aim

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To examine the relationships between life events related to family structure and PA changes over a 22-year period, in the cohort of British born in 1958.

- Key contributions
 - Considering multiple events related to family structure occurring from early to mid-late adulthood
 - Including an event never considered before, that is looking after own parents or inlaws
 - → Extend the concept of family structure considering both upward and downwards bonds.

Hypothesis

 Family-related life events which impact on people's use of time are related to changes in PA from early to late adulthood.

Life transitions - hypotheses

Hypothesis on life transitions and physical activity



Methods

Data

- NCDS, using data collected at ages 33, 42, 50 and 55.
- Sweep 7 (age 46) excluded due to inconsistency with other sweeps

Analytic Sample

 NCDS participants alive at age 55 (n deaths=1,659) and who have not migrated (n emigrants=2,062), corresponding to 14,841 observations.

Methods

Measures

- Outcome
 - Physical activity from age 33 to age 55: frequency of regular exercising (1=once a week or more; 0=less than once a week)
- Exposure
 - Partnership status: single never married, married/cohabiting, separated/divorced/widowed
 - Number of children in and outside household
 - Hours per week spent helping parent or in-laws
- Confounders
 - time-varying variables: long-lasting illness, psychological distress (malaise 9 items scale), smoking, income, time of interview, age of oldest child

Methods

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STUDIES

Analysis

Fixed Effects Model to answer the question "do changes in family structure affect changes in level of PA?"

 $y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_{it} + \alpha_i + u_{it}$

 y_{it} is PA of individual *i* at time *t* (0/1 inactive/active); X_{it} denotes family structure of respondent *i* at time *t*. Z_{it} is a vector of observed time-varying individual characteristics; α_i is the unobserved time-invariant individual effect; u_{it} is an iid error term.

Issue: Correlation between α_i and $X_{it} \rightarrow \beta_1$ biased

Key identifying assumption: there are no time-varying unobserved variables affecting both changes in family structure over time and changes in PA. This would be violated if, for instance, unobserved time-varying shocks affect both family structure and PA.

• Missing data: Multiple Imputation with chained equation, 20 imputations





Hypothesis on life transitions and physical

activity

LONGITUDINAL STUDIES

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Descriptive Statistics of Outcome and Exposures

	Ag	je 33	Age 42		Ag	Age 50		Age 55	
	Men	Women	Men	Women	Men	Women	Men	Women	
Marital status									
Single never married	15.4	10.2	10.1	7.4	12.1	9.5	11.4	8.8	↓
Married/cohabiting	g 78.9	81.1	80.9	80.0	70.1	68.2	73.6	69.9	\sim
Sep/divorced/widowed	5.7	8.7	9.0	12.6	17.7	22.3	15.1	21.4	1
Children in HH (at least 1 child)	61.7	75.6	70.5	80.2	59	59.6	46.1	43.4	ŧ
Children outside HH (at least 1 child)	9.1	2.0	11.8	18.1	51.1	56.5	67.8	73.1	1
Help parents or in-laws									
yes (%))				29.7	21.7	51.7	43.4	1
hours (mean))				0.88	0.83	2.47	2.91	1

* at age 50 and 55 among marital status category there is not cohabitation

Partnership & Parenthood: outcome PA

	Men & Women		Μ	en	Women	
	(1)	(2)	(1)	(2)	(1)	(2)
Married/cohabiting	-0.061***	-0.062***	-0.070***	-0.069***	-0.050**	-0.052**
Sep/divorced/widowed	-0.041*	-0.042*	-0.036	-0.037	-0.041	-0.043*
N children in HH	-0.013***	-0.014***	-0.015***	-0.015***	-0.011	-0.012
Age oldest child in HH		0.000		0.000		-0.001
N children outside HH	-0.011**	-0.011	-0.014**	-0.012	-0.008	-0.010
Age oldest child outside HH		-0.001		-0.002		0.000
Having illness/disability	-0.033***	-0.033***	-0.031***	-0.031***	-0.034***	-0.034***
Psychological distress	-0.027**	-0.027**	-0.026	-0.026	-0.027**	-0.027**
Smoking	-0.066***	-0.065***	-0.063***	-0.063***	-0.068***	-0.067***
Observations Number of id	59,364 14,841	59,364 14,841	30,024 7,506	30,024 7,506	29,340 7,335	29,340 7,335



Other controls include age at interview and log HH income

Helping parents/in-laws: outcome PA

	Men & Women	Men	Women
Hours helping parents/in-laws	-0.002*	-0.002	-0.001
Married/cohabiting	0.029	0.037	0.018
Sep/divorced/widowed	0.047	0.05	0.04
N children in HH	-0.015	-0.027*	-0.003
N children outside HH	-0.013	-0.030**	0.003
Having illness/disability	-0.031***	-0.026*	-0.036**
Psychological distress	0.000	-0.017	0.013
Being a smoker	-0.059**	-0.049	-0.070*
Observations	29,682	15,012	14,670
Number of id	14,841	7,506	7,335

Other controls include age at interview and log HH income



Discussion

- Descriptive evidence for non-linear trend in physical activity throughout adulthood
- → Is it coincidental or depends on the hypothesis that life-change events, and in particular changes in family structures, have implications for changes in PA?
- Being married or cohabiting reduces the chance of being active, for men and women
- The higher the number of children living in household the lower the probability of being active, but this was true only for men, not in women.
- Helping parents and in-laws does not change the level of PA in adults.

Discussion

- Negative effect of being married/cohabiting on PA discordant with accepted evidence that marital status has a positive impact on individuals' health
- Effect of marital status on BMI and smoking? → those married or cohabiting significantly less likely to smoke and have lower BMI compared to divorced/ separated and widowed individuals.
- The beneficial effect of stable partnership on health may act through mechanisms different form PA, such as social support in sharing stressful events, healthier lifestyle in terms of smoking, health seeking behaviour.

Conclusions

- Some events related to family structure occurring in adulthood affect activity level.
- Choices related to intimate relationships are not a sphere of direct intervention. Being married as well as having children are related to greater happiness and subjective wellbeing.
- Encouraging parents to take part in physical activities with their children would represent an effective intervention beneficial to both parts:
 - Promoting active lifestyle in children since early ages
 - Keeping parents active while they look after their children



Limitations

- Self-report of PA (measurement error, recall bias, etc)
- Measures of PA: no time frame for frequency of activity, no mention of intensity
- No information on partner's PA

Next steps

- Analysis of helping parents/in-laws constrained to two observation points → extend it to older ages when data will become available.
- Relax the assumption of non-reciprocal association between exposure and outcome and time-varying confounders, implied in FE → Dynamic fixed effects using 'xtaband' in Stata

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Thank you!



Appendix



Preliminary Results - LCA

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Women

Preliminary Results - LCA

STUDIES

Men



		age 33	age 42	age 50	age 55
Exercising (once a week or more)	Ν	11343	11371	9734	9011
	%	68.7	65.5	69.6	63.6
marital status	Ν	10,993	11356	9786	9,126
Single, never married	%	17.83	8.88	10.87	9.95
Married/ Remarried	%	70.63	80.06	68.91	71.72
Divorced/ separated/ widowed	%	11.54	11.06	20.21	18.33
N children in HH	Ν	11,469	11419	9790	4080
	mean	1.3	1.6	1	1.5
N children outside HH	Ν	11469	11419	9790	6446
	mean	0.1	0.2	1	2
Looking after parents/in laws	Ν			9,788	9,119
look after parents/in laws (Y/N)	%	NA	NA	25.30%	47%
hrs pw spent looking after parents/in laws	mean			0.85	2.65

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Discussion

The 10 most common reasons adults cite for not adopting more physically active lifestyles are (Sallis and Hovell, 1990; Sallis et al., 1992)

- 1. Do not have enough time to exercise
- 2. Find it inconvenient to exercise
- 3. Lack self-motivation
- 4. Do not find exercise enjoyable
- 5. Find exercise boring
- 6. Lack confidence in own ability to be physically active (low self-efficacy)
- 7. Fear being injured or have been injured recently
- 8. Lack self-management skills, e.g. set personal goals
- 9. Lack support, from family and friends
- **10**. Not have facilities convenient to home or office.