The effect of having children on women's health: evidence from Australian twins

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Abstract:

This thesis examines the causal effect of having children on various indicators of women's health. Existing literature presents mostly only associations. Using a dataset of Australian identical twins allows us to control for (un)observed characteristics such as genes and much of the socioeconomic and demographic environment that potentially affect both having children and health. Isolating the influence of these characteristics, we find that having children has a negative effect on alcohol use. Having children reduces subjective wellbeing and smoking prevalence. The effects are robust for various specifications and checks. We do not find a causal link between having children and BMI, overweight or obesity.

1. Introduction

Labor force participation of women has increased the past decades and has been accompanied by changes in fertility patterns. Couples are postponing childbearing and the proportion of childless couples has increased (United Nations; 2010). This trend is consistent with the change in societal attitudes towards having children. Although the majority of the couples have children, there has been greater acceptance for other lifestyle decisions. Decisions about having children are based on the utility gains achieved by having children compared to the utility gains that are incurred from alternative allocations of resources. The outcome of these decisions has important implications for various life domains.

The relationship between having children and labor supply has been studied extensively. Angrist & Evans (1998) use the sex mix of the first two children and twin births as instruments for a third birth to establish a causal link between fertility and labor supply. Having children leads to a reduction in female labor supply. This effect is smaller for college-educated women and women whose husbands have high wages. There is no significant effect of the birth of a third child on father's labor supply. Other researchers have found that fertility-induced withdrawals from the labor force is negatively associated with women wages (Korenman & Neumark, 1992; Lundberg & Rose, 2000). Anderson, Binder & Krause (2002) estimate the total motherhood wage gap of about 15 percent per child. So having children might keep women from developing their career. The lifestyles of childless couples differ significantly from those of parent couples.

In light of the optional nature of the decision about having children, an intriguing question arises concerning the extent to which this decision affects women's health. Intuitively, the effects of having children on women' health is ambiguous. Having a child may discourage unhealthy behaviors, such as drinking and smoking. It may also lead to less sleep, more stress and other health deteriorating behaviors. Women may also devote fewer financial resources to their own health (Stanca, 2012). Rational choice approaches in standard economic models assume that the utility gain of parenthood is positive. In sharp contrast, the predominant view in the sociological and psychological literature is that there is a negative effect of parenthood.

The focus in this thesis is to identify the causal effect of having children on women's health. Body Mass Index (BMI) is considered as a good proxy for health, whereas alcohol-intake and

smoking are also strongly related to someone's health. Good health is a major source for social, economic and personal development and an important dimension of quality of life. Alcohol use, smoking, overweight and obesity are strongly associated with poor health.

The majority of the research about the effect of children on health has focused on subjective wellbeing, as measured by happiness and life satisfaction. Although most of the research indicates a negative association between having children and subjective wellbeing (Di Tella et al., 2003; Alesina et al., 2004), positive effects are obtained at least in some regressions in several papers (Saraceno et al., 2005; Frey & Stutzer 2006; Haller & Hadler, 2006). Research on the effects of having children on objective health is scarcer. The effect of having children on alcohol-intake after childbearing is unexplored, whereas there is only some research on whether BMI and smoking are influenced by parenthood. Weng et al. (2004) and Bakhshi et al. (2008) found that the number of children is positively associated with obesity in both women and men. Brenner & Mielck (1993), Jarvis (1996) and Johansson & Harling (2003) show that parenthood is associated with smoking behavior of parents. The health indicators are interconnected with each other. For example smoking cessation, which often occurs once women are pregnant, will also make women retain more weight.

All these studies are based on cross-sectional data, which means that though informative, they are not sufficient to draw conclusions about the direction of causality. For instance parents may give up smoking because of concerns about its effects on their children or smoking may cause people not to have children, or other factors might mediate both having children and giving up smoking, for example personal characteristics.

This study overcomes several limitations of earlier studies on the effects of having children on women's health by exploiting within twin differences. The effect of having children on women's health is estimated using a data set from Australia that includes identical twins. These twins have been asked in two or three survey waves about their socioeconomic and demographic background as well as their alcohol-intake, smoking and other health related factors. By using within twin differences it is possible to control for all genetic inheritance and for much of the socioeconomic and demographic environment that could bias the estimates. These unobserved characteristics such as family background and the neighborhood in which the twins grew up can potentially affect the decision whether or not to have children and health.

As will be shown below, this thesis finds a negative effect of having children on alcohol use. There are clear indications that having children reduces subjective wellbeing and smoking prevalence. We do not find a causal link between having children and BMI, overweight or obesity. The robustness of the findings are checked by addressing the issues of reverse causality, peer effects and measurements errors that could potentially bias the estimates.

This thesis is organized as follows. The next section reviews the existing literature in more detail. Section 3 describes the data and explains the empirical strategy. The main estimation results and the robustness checks are shown in Section 4. Section 5 concludes.

2. Literature review

This section reviews previous literature about the effects of having children on the health indicators subjective wellbeing, body mass index and smoking. The effects of parenthood on alcohol-intake are unexplored. The majority of the cited articles are published in psychological and medical journals.

Subjective wellbeing

The effect of having children is extensively researched in the happiness literature. Conclusions are often drawn based on associations between having children and subjective wellbeing, rather than causal relations. Many papers include the number of children as a potential determinant of happiness. A majority of these papers find a negative or null effect associated with this variable (for example Di Tella et al., 2003; Alesina et al., 2004). This result has prompted authors to conclude that having children makes people less happy or does not make them any happier. Positive effects are obtained at least in some regressions in several papers (for example Saraceno et al., 2005; Frey & Stutzer 2006; Haller & Hadler, 2006). The effect of having children on subjective wellbeing largely depends on individual characteristics such as gender, marital status and income. Having children has a positive effect on the happiness of married couples but a clear negative effect on single parents (Frey & Stutzer 2006). High income may eliminate some of the stress associated with raising children, by allowing for more help, such as day care, nannies etc. (Alesina et al., 2004). A twin study on this issue was conducted by Kohler et al. (2005). They use a dataset of approximately 2,000 identical Danish

twins to investigate the impact of children and partnership status on life satisfaction. Their results show that the first child increases happiness for women but not for men, and that the magnitude of the effect is considerable. The positive effects of children on happiness is present for females aged 25–45, but tends to disappear for females aged 50–70.

BMI

Several investigators have found an association between reproductive history and BMI among women. Weng et al. (2004) show that the number of children is positively associated with obesity in both women and men. They use a sample of 9,046 men and women (4,523 couples) from The Health and Retirement Study, a national survey of US households. Among women, a 7 percent increase in risk of obesity was noted for each additional child, adjusted for age, race, household income, work status, physical activity, tobacco use, and alcohol use. Bakhshi et al. (2008) obtain similar results. Their analysis is based on data of 2,728 women and men (1,364 couples) from the Iranian National Health Survey. For each additional child, the odds of obesity increased by 16 percent among women. Similar associations between number of children and obesity have been observed by among others Lahmann et al. (2000) and Wilsgaard et al. (2005). Socioeconomic status has been proposed as a significant confounder in the number of children and obesity relationship (Weng et al., 2004). A twin study on this topic was conducted by Cederlof & Kaij (1970). They use a dataset of more than 2,000 identical Swedish twin pairs to demonstrate that childbearing results in an average body-weight increase of about 2 kg compared with childless controls. This weight increase is permanent. It does not disappear with increasing age.

Smoking

Brenner & Mielck (1993) and Jarvis (1996) have investigated the effect of having children on smoking cessation. They compared cessation rates of individuals with and without children. Their results are based on a large national household survey. Among women, child birth is associated with smoking cessation. The odds of cessation estimates range in these papers from 1.42 until 2.98. The majority of smoking mothers do no succeed in giving up smoking definitely. Two-third starts smoking again after one year abstained. Johansson & Harling (2003) examined the effect of having children at home on adult smoking prevalence and

behavior at home. They sent questionnaires to a randomly selected sample, including 1,735 men and women in the age of 20-44, residing in the south-east of Sweden. Logistic regression models showed that parenthood did not seem to be associated with lower smoking prevalence. Smoking behavior, as well as attitudes to passive smoking, seemed to be influenced by parenthood. Parents of young children (0-19 years old) smoked outdoors significantly more than adults without children. To my knowledge, there are no twin studies conducted on the relation between having children and smoking.

3. Data and method

Source of data

The data come from the Australian Twin Register (ATR) and include two cohorts of Australian twins. The first 'older' cohort contains three survey waves of the same twins, labelled Canberra (collected in 1980–1982), Alcohol-1 (1988–1989) and Semi- Structured Assessment for the Genetics of Alcoholism (SSAGA) collected in 1993. All 5,967 twin pairs aged over 18 enrolled in the Australian National Health and Medical Research Council Twins Registry in 1980-1982 were asked to complete the Canberra survey. The questionnaires was returned by 8,196 individual twins (68% individual response rate), including 3,810 pairs (64% pair-wise response rate). The follow-up questionnaire (Alcohol-1) was mailed in 1988-1989 to all 3,810 complete twin pairs. 6,234 individual twins (82% individual response rate), including 2995 pairs (79% pair-wise response rates) returned the questionnaire. In 1993, all twins from the Alcohol-1 sample and 206 twin pairs from an earlier laboratory study were invited to participate in SSAGA survey. In all, 5,963 individual twins (89% individual response rate) were interviewed, including 2,722 pairs (85% pair-wise response rate).

The second 'younger' cohort contains two survey waves of the same twins, labelled Alcohol-2 (1989-1992) and Semi- Structured Assessment for the Genetics of Alcoholism (SSAGA-OZ) or TWIN89 collected in 1996-2000. All 4,262 twin pairs, born between 1964 and 1971 and registered at the ATR were invited to complete the Alcohol-2 survey. Questionnaires were returned by 5,058 individual twins (59% individual response rate), including 2,270 pairs (53% pair-wise response rate). 8020 twins (4010 pairs) were re-contacted for the SSAGA-OZ survey.

6,257 twins (78% individual response rate), including 2723 pairs (68% pair-wise response rates) participated in this survey. The dataset contains unfortunately insufficient observations of the alcohol-2 survey to make use of twin fixed effects. In particular the values for having children are frequently missing. Using twin fixed effects is crucial for the analysis. Therefore the alcohol-2 data is completely excluded from the analysis.

The surveys of the 'older' and 'younger' cohorts gathered information on the respondent's family background (parents, siblings, marital status, and children), socioeconomic status (education, employment status, and income), health behavior (body size, smoking and drinking habits), personality, feelings and attitudes. Zygosity was determined by a combination of diagnostic questions plus blood grouping and genotyping (Waldron et al., 2008).

Having children

The respondents were asked in the surveys about the number of children or whether or not they have children. A dummy variable for children indicating whether or not a twin has children is created based on the survey questions. The number of missing values of this variable is reduced by assuming that a twin with children at t=1, also has children at t=2 and by assuming that a twin does not have children at t=1, when it does not have children at t=2. Table 1 reports the number of twin pairs without having children, the number of twin pairs with only one of the twin having children and the number of twin pairs with both twins having children.

The left side on the table shows the values for the older cohort including the survey waves Canberra (1980–1982), Alcohol-1 (1988–1989) and SSAGA (1993). The right side of table shows the values for the younger cohort including the survey SSAGA-OZ (1996-2000). As explained before Alcohol-2 (1989-1992) is excluded.

The top panel reports the number of twin pairs for the full sample including identical and non-identical twins. The middle panel shows the values for non-identical twin pairs and the bottom panel shows the values for identical twin pairs. There are slightly more non-identical twins than identical twins.

Not surprisingly we see that the twin pairs that have children increase over time. The number of twin pairs with both twins having children has almost doubled from 1980–1982 until 1993. Twins pairs without children have in the same period rapidly declined. This trend is also present for the subgroups non-identical twins and identical twins. We should be careful with determining time trends because the sample differs across surveys. There are no indications, but there might be selective dropout which influences trends over time. Although the numbers slightly differ between non-identical twins and identical twins, we cannot conclude that identical twins differ significantly from non-identical twins with respect to having children.

The focus in the analysis is on identical twin pairs with only one of the twins with children. The number of these particular twin pairs ranges from 126 to 287 across the survey waves. The comparison of the twins in a twin pair allows to identify the causal effect of having children on health.

Table 1. Twin pairs and children

	Older cohort						Younger cohort	
	Canberra (1980–1982)		Alcohol-1 (1988–1989)		SSAGA (1993)		SSAGA-OZ (1996-2000)	
	N	in %	N	in %	N	in %	N	in %
Full Sample[1]								
Both twins do not have children	1,498	38.35%	482	14.18%	89	3.05%	708	31.34%
Only one of the twins has children	686	18.02%	689	20.28%	377	12.91%	561	24.83%
Both twins have children	1,623	42.63%	2,227	65.54%	2,454	84.04%	990	43.82%
Total:	3,807	100%	3,398	100%	2,920	100%	2,259	100%
Non-identical twins								
Both twins do not have children	824	40.95%	255	14.51%	48	3.16%	389	28.84%
Only one of the twins has children	399	19.83%	410	23.34%	251	16.53%	364	26.98%
Both twins have children	789	39.21%	1,092	62.15%	1,219	80.30%	596	44.18%
Total:	2,012	100%	1,757	100%	1,518	100%	1,349	100%
Identical twins								
Both twins do not have children	674	37.55%	227	13.83%	41	2.92%	319	35.05%
Only one of the twins has children	287	12.99%	279	17.00%	126	8.99%	197	21.65%
Both twins have children	834	46.46%	1,135	69.17%	1,235	88.09%	394	43.30%
Total:	1,795	100%	1,641	100%	1,402	100%	910	100%

[1] Only complete twin pairs are included. Twin pairs with at least one missing value are excluded.

Health

The measurement of health is crucial for the analysis. The surveys contain various questions about health which are used to construct health indicators.

BMI

Body Mass Index (BMI) is considered as a good proxy for health. It is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). BMI values are based on self- and clinical reported height and weight. BMI values are age-independent and the same for both sexes. It is common to rely on the cutoff points used by the World Health Organization: <18.50 (underweight), 18.50 – 24.99 (normal weight), 25.00 – 29.99 (overweight), 30.00 – 34.99 (low obesity), 35.00 – 39.99 (medium obesity), and ≥40.00 (extreme obesity). The purpose of a BMI cut-off point is to identify, within each population, the proportion of people with a high risk of an undesirable health state. Individuals with a BMI greater than or equal to 25.00 and less than or equal to 29.99 are considered as overweighted and individual with a BMI greater than or equal to 30.00 are considered as obese in the analysis. Although BMI is a clear and simple health indicator, it is not a perfect proxy for someone's health status. Health risks may vary in different ethnic or racial populations for given levels of the BMI. For example, it appears that Asians experience higher risks of hypertension and cardiovascular disease at lower levels of BMI compared to other racial groups (World Health Organization, 2004).

Alcohol

Alcohol consumption is considered as one of the most important risk factors for disease, disability and death throughout the world. Besides the large health burden through intoxication and dependence, alcohol consumption is also a causal factor for social and economic problems (World Health Organization, 2014). The following measures of alcohol intake are calculated: the number of times a respondent had alcohol drinks during the past twelve months ('every day or more than once a day'= 1 point '3-4 times each week'= 2 points 'once or twice a week'= 3 points 'once or twice a month'= 4 points 'less often'= 5 points 'not all'= 6 points), the number of alcohol drinks on a typical day and the maximum number of alcoholic drinks in a single day during the past 12 months. Alcohol intake can be seen as an objective measure of individual exposure to the potentially harmful effects of alcohol on health.

Smoking

The number of cigarettes a respondent usually smokes in a day is included as another health indicator ('never smoked' = 1 point 'Smoked 1-4/day' = 2 points '5-10/day' = 3 points '11-20/day'= 4 points '21-40/day'= 5 points 'More than 40/day'= 6 points). Additionally, a dummy variable indicating whether or not someone smokes is created. Smoking has significant health deteriorating effects. It is the main risk factor for a number of chronic diseases, including cancer, lung diseases, and cardiovascular diseases (World Health Organization, 2007).

Subjective wellbeing

Unfortunately the surveys lack useful questions about subjective wellbeing. They does however include the category 'feelings' with statements about feelings people may have. These statements allows to construct a feel indicator. This feel indicator is based on fourteen statement about among others feeling depressed, feelings of panic and worrying about everything ('Not at all' = 1 point 'A little' = 2 points 'A lot' = 3 points 'Unbearably'= 4). A factor analysis makes clear that one factor has an eigenvalue equal or higher than 1. The Kaiser criterion suggests to retain those factors with eigenvalues equal or higher than 1. This factor explains most of the variation in the fourteen variables. The feel indicator equals this factor.

In the SSAGA-OZ (1996-2000) survey respondents were asked about how they would describe their general physical health ('Excellent = 1 point 'Good' = 2 points 'Fair' = 3 points 'Poor= 4). This is used as another indicator for subjective wellbeing.

The number of sick days in past 12 months is included as a general health indicator. It is expected that individuals with bad health are kept more days at home from normal work because of illness.

Controls

To account for other influences on having children which may also be correlated with health, we include control variables. This is a less favorable way to correct for differences between twins, because the inclusion of control variables might distort the estimates of the effect of having children. The effect of having children may be mediated through other variables and we are interested in the overall effect of having children. Control variables can potentially be endogenous variables, since they may in turn affect each other. If so, the specification with

the control variables included would underestimate the effect of having children. The aim is therefore to include only a few exogenous control variables.

The only control variable is birth weight (in grams) of the twin. This variable has been shown to affect health. Hoy, Bill & Sykes (1988) found that very low birth weight can result in an early development setback with prolonged health consequences. Black, Devereux & Salvanes (2007) establish a causal relationship between birth weight and adult outcomes using twin fixed effects. Based on a dataset from Norway, they find significant longer-run effects of birth weight on BMI, IQ, earnings, and education.

In case there is no information about the birth weight of one of the twin, the missing value is replaced by the birth weight of the non-missing co-twin. If the birth weight of the twin pair is unknown, the missing values are replaced by the sample mean. So no observations will be lost in the analysis.

Descriptive statistics

Table 2 reports the descriptive statistics of the dummy for children, birth weight and the health indicators across the survey waves for the full sample female identical twins and for female identical twins with children. This gives already some insight in how women with children differ from the full sample. It is just a naïve comparison because it does not take into account the influence of (un)observed characteristics.

The left side of the table shows the values for the older cohort including the survey waves Canberra (1980–1982), Alcohol-1 (1988–1989) and SSAGA (1993). The right side of table shows the values for the younger cohort including the survey SSAGA-OZ (1996-2000).

The top panel reports the values for the various health indicators. The surveys consist of different questions, so not every health indicator is present at every survey. The middle panel shows values for the dummy children and the bottom panel shows the birth weight. There is no information available about the birth weight of twins from the younger cohort.

As age increases, BMI, obesity and the number of days sick at home increase. Subjective wellbeing and alcohol use remains more or less constant with age. Smoking seems to decrease over time. The number of women with children is in line with the observations in table 1. The proportion of women with children increases over time.

Table 2. Descriptive statistics: female identical twins

	Older cohort						Younger cohort	
	Canberra (1980–1982)		Alcohol-1 (1988–1989)		SSAGA (1993)		SSAGA-OZ (1996-2000)	
	Full sample	With children	Full sample	With children	Full sample	With children	Full sample	With children
Health Indicators:								
Body Mass Index (BMI)[1]	22.235 (3.296)	22.848 (3.406)	23.012 (3.738)	23.232 (3.701)	25.127 (4.614)	25.137 (4.595)	23.341 (4.771)	23.559 (5.107)
Dummy overweight	0.133 (0.340)	0.177 (0.382)	0.189 (0.392)	0.210 (0.407)	0.294 (0.456)	0.296 (0.457)	0.183 (0.387)	0.180 (0.385)
Dummy obesity	0.026 (0.164)	0.036 (0.186)	0.049 (0.217)	0.052 (0.222)	0.135 (0.342)	0.136 (0.343)	0.076 (0.265)	0.093 (0.291)
Number of sick days in the past 12 months	5.122 (11.470)	5.080 (13.199)	6.715 (21.018)	6.603 (21.636)	-	-	-	-
Feel indicator	0.052 (0.984)	0.025 (1.016)	0.039 (0.956)	0.032 (0.950)	-	-	-	-
Subjective general physical health	-	-	-	-	-	-	1.904 (0.665)	1.915 (0.658)
How often alcohol drinks during the past 12 months	3.762 (1.502)	3.807 (1.617)	3.721 (1.565)	3.802 (1.565)	3.653 (1.381)	3.669 (1.386)	4.003 (1.219)	4.116 (1.199)
Number of alcohol drinks on a typical day	-	-	-	-	-	-	2.231 (1.499)	2.111 (1.424)
Maximum number of drinks per day during the past 12 months	-	-	-	-	3.339 (2.763)	3.266 (2.713)	-	-
Cigarettes per day	3.526 (0.933)	3.605 (0.921)	2.060 (1.424)	2.068 (1.440)	-	-	2.488 (1.439)	2.467 (1.465)
Dummy smoking	0.987 (0.115)	0.987 (0.112)	0.423 (0.494)	0.416 (0.493)	-	-	0.634 (0.482)	0.614 (0.487)
Independant variable:								
Dummy children	0.577 (0.494)	1 (0)	0.795 (0.404)	1 (0)	0.969 (0.174)	1 (0)	0.811 (0.392)	1 (0)
Control variable:								
Birth weight	486.747 (153.599)	482.276 (170.166)	-	-	-	-	-	-

[1] Self reported values for Canberra (1980-1982), Alcohol-1(1988-1989) Alcohol-2 (1989-1992). The values of SSAGA (1993) and partially SSAGA-OZ (1996-2000) are clinically determined.

The table provides valuable insights about the difference between the full sample of women and women with children. BMI is slightly higher for women with children across all survey waves. Overall, the incidence of overweight and obesity is a somewhat higher for women with children compared with the full sample. The only exception of this observation is the incidence of overweight among women in the SSAGA-OZ (1996-2000) survey.

The number of sick days in the past 12 months is only slightly lower for women with children. Subjective wellbeing measured by the feel indicator does not seem to be affected by having children. The values for alcohol use during the past 12 months are higher for women with children across all survey waves. A higher value means less often alcohol use. So women with children might drink less often alcohol. There are also indications that once they drink on a typical day, they drink less alcohol.

The table shows mixed results for the number of cigarettes per day. In some surveys women with children smoke more cigarettes per day and in other surveys they smoke less cigarettes per day. The differences are however very small.

A research design that controls for (un)observed characteristics affecting motherhood and health may provide a more credible and more informational view on the relation between having children and women's health.

The appendix contains more detailed information about the survey questions with the corresponding response options.

Empirical strategy

The problem with the causal interpretation of the effect of having children on women's health is that both these variables may be co-determined by (un)observed characteristics such as genes or family background. In order to identify the causal effect of having children, we will compare the health status of identical twins. An identical twin shares the same genes as her co-twin and is very likely to be similar in terms of many (un)observed characteristics such as family background and the neighborhood in which the twins grew up. These characteristics potentially affect both having children and health.

This simple model assumes that health (*y)* of twin *i* in pair *j* can be related to having children (*c)* of twin *i* in pair *j*:

$$y_{ij} = \beta_0 + \beta_1 c_{ij} + x_{ij} + \mu_j + \varepsilon_{ij} \quad (1)$$

β_1 is the parameter of interest: it provides an estimate of the causal effect of having children on health. c_{ij} is a dummy variable indicating whether or not the twin has children. x_{ij} denote the observed characteristics. The term μ_j represents the influence of unobserved characteristics that are common to both twins in pair *j.* This captures characteristics such as genes, the family background and the neighborhood in which the twins grew up. The term ε_{ij} represents additional unobserved influences on health that are specific to twin *i* in pair *j*.

Genes co-determining health and having children will induce a correlation between having children and the error term, resulting in a biased estimate of the effect of having children. The term μ_j can be removed from the equation by taking within twin pair differences. The within-twin estimation identifies the causal effect and allows for unobserved differences affecting the treatment and control group:

$$\Delta y_j = \beta_0 + \beta_1 \Delta c_j + \Delta x_j + \Delta \varepsilon_j \quad (2)$$

This method provides unbiased estimates if (i) both twins share the same unobserved characteristics (μ_j) and (ii) μ_j is the only source of endogeneity in the having children variable. Identical twins are used to satisfy the first assumption. Although identical twins share the same genes and the same social environment they are not exactly identical. Personality for example may be different between identical twins.

In a one period model there is a possibility of reverse causality. Health may influence the decision to have children. We can avoid possible reverse causality, by taking twin pair differences over two periods:

$$(\Delta y_{j,t} - \Delta y_{j,t-1}) = \beta_0 + \beta_1 (\Delta c_{j,t} - \Delta c_{j,t-1}) + \Delta x_j + (\Delta \varepsilon_{j,t} - \Delta \varepsilon_{j,t-1}) \quad (3)$$

$(\Delta y_{j,t} - \Delta y_{j,t-1})$ represents the difference in health between period *t* and *t–1* between the twins. $(\Delta c_{j,t} - \Delta c_{j,t-1})$ is a dummy variable indicating the differences of having children between period *t* and *t–1* between the twins. This variable takes the value one if one of the twin has a child in period *t* and no child in period *t–1*, and the other twin did not experience a change in having children between period *t* and period *t–1* (having children in both periods or not having children in both periods). Otherwise, this variable equals zero. The dataset allows

to estimate equation (3) because twin pairs have participated in the surveys at three points in time.

4. Results

From the existing literature we know that the effect of having children on subjective wellbeing and smoking is ambiguous and on BMI and obesity positive. The effect of having children on alcohol-use is unexplored.

In this section we estimate the effect of having children on various health outcomes based on data from Australian twins. We estimate the one-period model of equation (2) using three different specifications. The first specification is a simple ordinary least square regression. The second specification uses twin fixed effects. The third specification is the same as the second specification including the control variable birth weight.

Table 3 presents the regression coefficients. The left side of the table shows the estimations for the older cohort including the survey waves Canberra (1980–1982), Alcohol-1 (1988–1989) and SSAGA (1993). The right side of table shows the estimations for the younger cohort including the survey SSAGA-OZ (1996-2000).

The estimations of the first specification suggest that having children has generally a positive effect on BMI, overweight and obesity. We observe significant effects in the Canberra (1980–1982) survey and the Alcohol-1 (1988–1989) survey. The estimations of having children on the number of sick days and the feel indicator are consistently negative and not significant. Significant positive estimations are obtained for the effects of having children on alcohol use across all surveys. Having children might reduce the maximum number of drinks in the past twelve months. The effects on smoking are mixed.

The second specification is our preferred specification because it allows in contrast with the first specification for (un)observed characteristics that potentially affect health and having children. Taking twin differences (column 2) has important effects on the estimations. It changes the magnitude and in some cases the sign of the estimations. It seems likely that (un)observed characteristics affect health and having children. We observe a positive significant effect of having children on obesity in the Canberra (1980–1982) survey and the

Table 3. The effect of having children on women's health

	Older cohort									Younger cohort		
	Canberra (1980–1982)			Alcohol-1 (1988–1989)			SSAGA (1993)			SSAGA-OZ (1996-2000)		
Specification	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Dependant variable	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls
Body Mass Index (BMI)	1.463***	0.229	0.220	0.984***	0.244	0.247	0.298	-1.309	-1.310	1.072**	0.801	-
	(0.133)	(0.179)	(0.179)	(0.203)	(0.225)	(0.225)	(0.817)	(0.853)	(0.854)	(0.491)	(0.792)	
Dummy overweight	0.104***	-0.017	-0.019	0.095***	0.037	0.037	0.053	0.111	0.111	-0.022	-0.100*	-
	(0.014)	(0.026)	(0.026)	(0.021)	(0.036)	(0.036)	(0.081)	(0.131)	(0.131)	(0.029)	(0.060)	
Dummy obesity	0.020***	0.028**	0.028**	0.013	-0.019	-0.018	0.015	-0.111	-0.111	0.085***	0.167**	-
	(0.007)	(0.013)	(0.013)	(0.012)	(0.018)	(0.018)	(0.061)	(0.081)	(0.081)	(0.027)	(0.066)	
Number of sick days in the past 12 months	-0.072	-0.196	-0.194	-0.498	-1.174	-1.178	-	-	-	-	-	-
	(0.601)	(1.463)	(1.464)	(1.145)	(2.373)	(2.375)						
Feel indicator	-0.064	-0.084	-0.082	-0.031	-0.216**	-0.218	-	-	-	-	-	-
	(0.040)	(0.078)	(0.078)	(0.052)	(0.089)	(0.089)						
Subjective general physical health	-	-	-	-	-	-	-	-	-	0.057	-0.122	
										(0.058)	(0.106)	
How often alcohol drinks during the past 12 months	0.108*	0.553***	0.555***	0.358***	0.491***	0.491***	0.440**	0.343	0.348	0.671***	0.286	-
	(0.061)	(0.098)	(0.098)	(0.083)	(0.112)	(0.112)	(0.180)	(0.246)	(0.247)	(0.120)	(0.210)	
Number of alcohol drinks on a typical day	-	-	-	-	-	-	-	-	-	-0.380*	-0.914	-
										(0.226)	(0.678)	
Maximum number of drinks per day during the past 12 months	-	-	-	-	-	-	-1.931***	-0.500	-0.513	-	-	-
							(0.358)	(0.467)	(0.468)			
Cigarettes per day	0.183***	-0.085	-0.087	0.034	0.025	0.023	-	-	-	-0.107	0.103	-
	(0.060)	(0.119)	(0.119)	(0.077)	(0.095)	(0.095)				(0.138)	(0.214)	
Dummy smoking	0.002	-0.033*	-0.033*	-0.028	-0.006	-0.006	-	-	-	-0.111*	-0.051	-
	(0.007)	(0.018)	(0.018)	(0.027)	(0.033)	(0.033)				(0.046)	(0.071)	

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator. Standard errors are in parentheses. Only identical twins are included.

Control variable: birth weight. The data of the younger cohort (SSAGA-OZ (1996-2000)) lacks information about birth weight.

***: significant at 1%. **: significant at 5%. *: significant at 10%.

SSAGA-OZ (1996-2000) survey. In contrast, the estimations in other surveys are negative and not significant. We observe almost consistently positive and significant effects of having children on alcohol use. The higher the value of this variable, the less often a respondent had alcohol drinks during the past twelve months. Thus, a positive effect means that women with children drink less often alcohol. There are also indications that once they drink, they drink less alcohol.

In line with Johansson & Harling (2003) we cannot convincingly prove a relation between having children and smoking behavior. The estimations for the number of cigarettes per day are not significant and the signs differ across surveys. There are indications that women with children quit smoking. The dummy smoking is negative and significant in the Canberra (1980–1982) survey. There is no consensus in the literature about the effect of having children on subjective wellbeing. The estimated effect of having children on the feel indicator provides some evidence that having children might negatively influence subjective wellbeing.

The inclusion of the control variable birth weight (column 3) changes the magnitude of the estimated effects only slightly. For some estimations the magnitude increases somewhat, for others it decreases somewhat. There is no general change in the estimations of having children on health caused by the inclusion of the control variable birth weight.

The size and the sign of estimations may differ over time, because the relation between having children and health may have changed due to for example information and prevention campaigns by the government. Awareness of health risks may lead to behavior adjustment.

Effects for subgroups

In the literature, it has been argued that the effects of having children on health is specific for certain age groups. For instance, Kohler et al. (2005) show that positive effects of children on happiness are present for younger females, but the effects tend to disappear for older females. This may also be the case for other health indicators. In subsequent analysis the effect of having children on health is estimated for various age groups using twin fixed effects. The distinction of age is based on the median age of the population. This leads to a subsample of twins younger than 30 and a subsample of twins older than 30.

This additional analysis reveals that the effect of having children on health is a bit more specific for the younger part of the population. The effects of having children on obesity is positive and significant for the younger part in the population in the Canberra (1980–1982) survey and the SSAGA-OZ (1996-2000) survey. The magnitude of the significant estimated effects of having children on alcohol use are somewhat higher for the younger females than for the older females. Based on the results, it can be argued that having children has a negative effect on subjective wellbeing of younger women. The other estimated effects of having children are not significant and differ across the surveys.

Table 4. The effect of having children on women's health by age group

	Older cohort[1]						Younger cohort[2]	
	Canberra (1980–1982)		Alcohol-1 (1988–1989)		SSAGA (1993)		SSAGA-OZ (1996-2000)	
Dependant variable	≤30	>30	≤30	>30	≤30	>30	≤30	>30
Body Mass Index (BMI)	-0.049	0.523*	0.141	0.475	-1.226	-1.601	1.421	-0.508
	(0.191)	(0.298)	(0.245)	(0.434)	(0.880)	(1.912)	(1.098)	(1.322)
Dummy overweight	-0.022	-0.011	0.054	0.000	0.071	0.250	-0.077	-0.150
	(0.022)	(0.046)	(0.038)	(0.070)	(0.128)	(0.301)	(0.086)	(0.092)
Dummy obesity	0.033***	0.023	-0.027	0.000	-0.071	-0.250	0.167*	0.200
	(0.012)	(0.023)	(0.021)	(0.033)	(0.075)	(0.189)	(0.095)	(0.103)
Number of sick days in the past 12 months	-0.474	0.257	0.375	-4.714	-	-	-	-
	(1.481)	(3.144)	(2.639)	(4.558)				
Feel indicator	-0.050	-0.118	-0.255**	-0.127	-	-	-	-
	(0.100)	(0.117)	(0.107)	(0.161)				
Subjective general physical health	-	-	-	-	-	-	-0.115	0.000
							(0.161)	(0.152)
How often alcohol drinks during the past 12 months	0.632***	0.473***	0.530***	0.400*	0.222	0.750	0.316	0.071
	(0.107)	(0.161)	(0.115)	(0.229)	(0.239)	(0.565)	(0.304)	(0.313)
Number of alcohol drinks on a typical day	-	-	-	-	-	-	-1.206	-0.500
							(1.196)	(0.582)
Maximum number of drinks per day during the past 12 months	-	-	-	-	-0.462	-0.625	-	-
					(0.677)	(0.706)		
Cigarettes per day	-0.150	0.053	0.089	-0.122	-	-	0.555*	-0.158
	(0.144)	(0.211)	(0.109)	(0.179)			(0.332)	(0.292)
Dummy smoking	-0.024	-0.050	0.018	-0.061	-	-	-0.056	0.000
	(0.016)	(0.037)	(0.037)	(0.063)			(0.105)	(0.101)

[1] The median age for the older cohort is based on the variable 'age in 1980'.

[2] The median age for the younger cohort is based on the variable: 'age at completing the SSAGA-OZ survey'.

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator using twin fixed effects.

Standard errors are in parentheses.

Only identical twins are included.

***: significant at 1%. **: significant at 5%. *: significant at 10%.

Check for reverse causality

Previous estimations were obtained from the one period model of equation (2). In a one period model there is a possibility of reverse causality. At first sight, one might conclude that having children has an effect on health. It may however also be the case that health influences the decision to have children. We can avoid possible reverse causality, by taking twin pair differences over two periods. This allows us to identify the causal effect of having children on health.

Table 5 provides the estimations of equation (3) based on the three surveys of the older cohort. The left side on the table shows the estimations for the period Canberra (1980–1982) – Alcohol-1 (1988–1989), the middle panel for the period Canberra (1980–1982) – SSAGA (1993) and the right side for the period Alcohol-1 (1988–1989) – SSAGA (1993). Note that the length of these period differ.

Table 5. The effect of a change in having children on a change in women's health

	Older cohort		
Dependant variable	Canberra (1980–1982) - Alcohol-1 (1988–1989)	Canberra (1980–1982) – SSAGA (1993)	Alcohol-1 (1988–1989) – SSAGA (1993)
Body Mass Index (BMI)	0.237 (0.200)	0.122 (0.436)	0.162 (0.640)
Dummy overweight	0.025 (0.041)	0.075 (0.091)	0.150 (0.143)
Dummy obesity	0.025 (0.020)	-0.019 (0.050)	-0.050 (0.069)
Number of sick days in the past 12 months	-1.120 (3.185)	-	-
Feel indicator	-0.187* (0.098)	-	-
How often alcohol drinks during the past 12 months	0.403*** (0.105)	0.358** (0.157)	0.310 (0.194)
Cigarettes per day	-0.057 (0.155)	-	-
Dummy smoking	-0.074** (0.032)	-	-

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator using twin fixed effects.
Standard errors are in parentheses.
Only identical twins are included.
***: significant at 1%. **: significant at 5%. *: significant at 10%.

From the estimations we learn that having children significantly reduces alcohol use. In two of the three periods this causal effect is significant. Having children significantly reduces

subjective wellbeing and smoking prevalence. Although the estimations are not significant, there are indications that having children increases BMI and the chances of being overweight. The effects of having children on obesity, subjective wellbeing and smoking are less clear.

Limitations

There are some concerns about the external validity of the results. The dataset of the Australian twins may not be representative for the general population. Waldron et al. (2008) show that the individuals from European ancestry and well-educated individuals are over-represented. This may influence the occurrence of health problems. Besides that, we may have to do with selective dropout. It can however unlikely also be the case that identical twins have very different causal relationships between having children and health. Both options will possibly lead to biased estimates.

Peer effects

Another concern is the possibility that twins' behaviors affect one another. Having a twin brother or sister with bad health habits may as a behavioral response increase the probability of having good own health habits. This may lead to overestimation of the effects of having children. On the other hand, good (bad) health habits of a twin brother or sister may have positive (negative) effects of own health habits. This may lead to underestimation of the effects of having children on health. We are not sure whether peer effects lead to over- or underestimation of the effects of having children health, but we can safely conclude that they lead to biased estimates. Although these peer effects cannot be identified, we can compare the health outcomes of twins with frequent contact with their co-twin with the health outcomes of twins with less frequent contact with their co-twin. The strength of the peer effects presumably depend on the frequency of contact.

Table 6 shows the comparison for twins from the three surveys of the older cohort. The health outcomes differ between the twins who have at least once a week contact with their co-twin and twin who have less than once a week contact with their co-twin. We are however unable to identify a clear trend in magnitude or sign of the differences. The effect of having children on BMI is positive for twins with frequent contact with their co-twin, but zero or negative for

twins with less frequent contact with their co-twin. In contrast, the odds of having overweight is higher for twins with less frequent contact with their co-twin. Most of these estimated effects are not-significant. If we turn to the significant effect of having children, we observe clear significant effects on alcohol use. Having children reduce the frequency of drinking alcohol. In one of the three surveys this effect is smaller for twins with less frequent contact with their co-twin. In the other two surveys this effect is bigger for twins with less frequent contact with their co-twin. So it is hard to identify precisely the effect of frequency of contact on health for identical twins. Although there is a possibility that twin peer effects may bias the estimates, we are not able to obtain evidence for this. This does not mean that twin peer effects are not present.

Table 6. The effects of having children by frequency of contact between twins

	Older cohort					
	Canberra (1980–1982)		Alcohol-1 (1988–1989)		SSAGA (1993)	
Dependant variable	At least once a week	Less than once a week	At least once a week	Less than once a week	At least once a week	Less than once a week
Body Mass Index (BMI)	0.245	0.002	0.281	-0.624	0.765	-14.218***
	(0.211)	(0.425)	(0.416)	(1.126)	(0.907)	(3.595)
Dummy overweight	-0.033	0.024	0.047	0.125	0.067	1.000*
	(0.030)	(0.059)	(0.070)	(0.159)	(0.142)	(0.581)
Dummy obesity	0.033**	0.000	-0.047	-0.125	0.000	-1.000***
	(0.014)	(0.035)	(0.033)	(0.091)	(0.089)	(0.336)
Number of sick days in the past 12 months	2.076	-3.824	-1.610	-25.750**	-	-
	(1.785)	(2.488)	(4.353)	(9.764)		
Feel indicator	-0.087	-0.052	-0.340*	-0.192	-	-
	(0.090)	(0.163)	(0.194)	(0.446)		
How often alcohol drinks during the past 12 months	0.603***	0.476**	0.432*	1.100**	0.308	1.000
	(0.110)	(0.239)	(0.221)	(0.527)	(0.274)	(0.741)
Number of alcohol drinks on a typical day	-	-	-	-	-	-
Maximum number of drinks per day during the past 12 months	-	-	-	-	-1.040**	-1.400
					(0.489)	(1.153)
Cigarettes per day	-0.095	-0.077	0.048	0.750	-	-
	(0.135)	(0.298)	(0.171)	(0.537)		
Dummy smoking	-0.023	-0.071*	0.048	0.125	-	-
	(0.019)	(0.040)	(0.064)	(0.201)		

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator using twin fixed effects.
Standard errors are in parentheses.
Only identical twins are included.
***: significant at 1%. **: significant at 5%. *: significant at 10%.

Measurement error

Using twin fixed effects makes the results vulnerable to measurement errors in the having children variable. Differences in health are compared within a twin pair with only one of the twins with children. In the unlikely case that the having children variable is incorrect, the estimates are biased. We can detect the presence of a bias by instrumenting the own-reported having children variable with a twin-reported having children variable holding the sample size constant. The twin-reported information about whether the co-twin has children is only available in the SSAGA (1993) survey. The dummy for having children is constructed based on survey questions about the number of children a (co-)twin has. The twin-reported dummy for having children differs in 22.09% of the cases from the self-reported dummy for having children. In roughly two-third of the cases, the co-twin thinks that her twin sister is childless, while her twin sister reports that she has children. In one-third of the cases, the co-twin assumes that her twin sister has children, while her twin sister reports that she is childless. The differences between the self-reported and twin-reported values are large. It is far more likely that the self-reported values are correct because having children is easy to report. In particular when the twins do not frequently have contact with each other, it is more likely that the twin-reported values are wrong. Mistakes when filling in the survey will probably account for only a small part of differences. It is therefore highly uncertain that using the twin-reported values provides valuable insights.

Table 7 shows surprisingly that instrumenting own-reported with twin-reported dummy for having children changes the sign of the estimates. In previous analysis we found consistently a significant positive effect of having children on alcohol use. Using the twin-reported dummy for having children gives a significant negative effect of having children on alcohol use. Although it is hard to explain these observations we can learn from this that we should be very cautious when interpreting the results.

Table 7. The effects of having children with instumented independent variable

Dependant variable	Older cohort	
	SSAGA (1993)	
	Self-reported dummy children	Twin-reported dummy children
Body Mass Index (BMI)	-1.632*	1.011
	(0.908)	(0.675)
Dummy overweight	0.125	-0.069
	(0.140)	(0.104)
Dummy obesity	-0.125	0.103
	(0.086)	(0.064)
How often alcohol drinks during the past 12 months	0.324	-0.537***
	(0.251)	(0.198)
Maximum number of drinks per day during the past 12 months	-0.394	0.54
	(0.476)	(0.386)

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator using twin fixed effects.
Standard errors are in parentheses.
Only identical twins are included.
The sample is the same for both specifications.
***: significant at 1%. **: significant at 5%. *: significant at 10%.

5. Conclusions

In this thesis, we have examined the effects of having children on various indicators of women's health. Using a dataset of Australian identical twins allows us to control for (un)observed characteristics that potentially affect the decision whether or not to have children and health.

We can safely conclude that having children reduces alcohol use. This effect persists in different specifications, surviving a variety of robustness checks. In line with the majority of the happiness literature, we find clear indications that having children has negative effects on women´s subjective wellbeing. Having children is unrelated with the number of cigarettes a woman smoke, but it has positive effects on smoking cessation among women.

According to the existing literature, having children has a positive effect on BMI and obesity. We can obtain similar associations by using a simple ordinary least square regression. Taking twin differences changes the size and the sign of the estimates. The results do not prove a causal link between having children and BMI, overweight or obesity.

The majority of the literature on having children presents associations and lacks a research design that allows to establish a causal link between having children and health. This thesis

contributes to the literature by establishing a causal link between having children and health using twin fixed effects. We have seen that using twin fixed effects has important implication for the size and the sign of the estimated effects.

The data provides the opportunity to convincingly address the issue of reverse causality. Taking twin differences over two periods allows to identify the causal effect of having children on health. As a methodological contribution we addressed potential peer effects and a measurement error in having children.

In the ageing population debate, every now and then politicians come up with policies that give parents greater financial incentives to have children. Apart from the question whether these policies are desirable or effective, policy makes should be aware of the health consequences of having children. This thesis gives some insights in this relation. Policy makers can use these insights to identify health risks related with having children and improve current outcomes.

This thesis has some limitations that could be addressed in future research. First of all, more research is needed to identify the causal effect of having children on subjective wellbeing. The data does not allow for extensively research on this relation. The used feelindicator is based on a simple set of statements and lacks a firm scientific basis. Second, we have been unable to properly address the issue of a measurement error in having children. Third, the used data is fourteen to thirty-four years old. During that time essential things may have changed resulting in a different causal relation between having children and health. One could try to replicate this study with a more recent dataset. Fourth, it might be valuable for policy makers to get a deeper understanding of the relation between having children and health.

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7. Appendix

A1. Variable Definitions

Table A1.1 Variable Definitions Canberra (1980–1982)

Variable	Description
Number of sick days in the past 12 months	**stayhome** In the past 12 months, on how many days would you have stayed home from work because of illness? XX=Number of days
Feel indicator	**feel1** Recently I have worried about every little thing. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel2** Recently I have been so miserable that I have had difficulty with my sleep. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel3** Recently I have been breathless OR had a pounding of my heart. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel4** Recently I have been so "worked up" that I couldn't sit still. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel5** Recently I have been depressed without knowing why. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel6** Recently I have gone to bed not caring if I never woke. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel7** Recently, for no good reason, I have had feelings of panic. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel8** Recently I have been so low in spirits that I have sat for ages doing absolutely nothing. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel9** Recently I have had a pain OR tense feeling in my neck/head. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel10** Recently the future has seemed hopeless. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel11** Recently worrying has kept me awake at night. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel12** Recently I have lost interest in just about everything. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel13** Recently I have been so anxious that I couldn't make up my mind about the simplest thing. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel14** Recently I have been so depressed that I have thought of doing away with myself. 1=Not at all 2=A little 3=A lot 4=Unbearably
Cigarettes per day	**cigarett** How many cigarettes do (or did) you usually smoke in a day? 1=Never smoked 2=Smoked 1-4/day 3=5-10/day 4=11-20/day 5=21-40/day 6=More than 40/day

Contact frequency	**confreq** How frequently do you and your twin contact each other? Frequent = We live together, almost every day & at least once a week. Less frequent = Once or twice a month, a few times a year, less often & not at all.
Age in 80	**agein80** What was your age in 1980? XX=Age in 1980

Table A1.2 Variable Definitions Alcohol-1 (1988–1989)

Variable	Description
Number of sick days in the past 12 months	**sickdays** During the past 12 months, approximately how many days has illness kept you away from your normal work (including housework)? XXX=Number of days
Feel indicator	**feel1** Recently I have worried about every little thing. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel2** Recently I have been so miserable that I have had difficulty with my sleep. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel3** Recently I have been breathless OR had a pounding of my heart. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel4** Recently I have been so "worked up" that I couldn't sit still. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel5** Recently I have been depressed without knowing why. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel6** Recently I have gone to bed not caring if I never woke. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel7** Recently, for no good reason, I have had feelings of panic. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel8** Recently I have been so low in spirits that I have sat for ages doing absolutely nothing. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel9** Recently I have had a pain OR tense feeling in my neck/head. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel10** Recently the future has seemed hopeless. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel11** Recently worrying has kept me awake at night. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel12** Recently I have lost interest in just about everything. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel13** Recently I have been so anxious that I couldn't make up my mind about the simplest thing. 1=Not at all 2=A little 3=A lot 4=Unbearably **feel14** Recently I have been so depressed that I have thought of doing away with myself. 1=Not at all 2=A little 3=A lot 4=Unbearably
How often alcohol drinks during the past 12 months	**drinkyou** Write in below the number which best describes how often the following people have had alcoholic drinks during the past 12 months, or in a typical year if the person is deceased. 1=more than once a day & everyday 2=3-4 times each week 3=once or twice a week 4=once or twice a month 5=less often 6=not all
Cigarettes per day	**numsmoky** Write in the number which expresses your best estimate of the average daily cigarette consumption for each of the following during his/her lifetime. 1=Never smoked 2=Smoked 1-4/day 3=5-10/day 4=11-20/day 5=21-40/day 6=More than 40/day

Contact frequency	**connow** How often do you and your twin contact each other during the last few years? Frequent = We live together, almost every day & at least once a week. Less frequent = Once or twice a month, a few times a year, less often & not at all.

Table A1.3 Variable Definitions SSAGA (1993)

Variable	Description
How often alcohol drinks during the past 12 months	**b1b** During the past 12 months, how often have you had alcoholic drinks? 1=every day 2=5-6 days per week & 3-4 days per week 3=2 days per week & 1 day per week 4=2-3 days per month & 1 day per month 5=3-6 days per year & less often 6=no alcohol in past 12 months
Max drinks per day during the past 12 months	**b1d** What is the most drinks of alcohol you have had in a single day during the past 12 months? XX=number of drinks
Contact frequency	**a16** How often do you and your twin contact each other? Frequent = We live together, almost every day & at least once a week. Less frequent = Once or twice a month, a few times a year, less often & not at all.
Children of co-twin	**a12** How many children has your twin had, not counting any who are by adoption, who are stepchildren, or who were stillborn? How many sons? How many daughters?

Table A1.5 Variable Definitions SSAGA-OZ (1996-2000)

Variable	Description
How often alcohol drinks during the past 12 months	**b1b** During the past 12 months, how often have you had alcoholic drinks? 1=every day 2=5-6 days per week & 3-4 days per week 3=2 days per week & 1 day per week 4=2-3 days per month & 1 day per month 5=3-6 days per year & less often 6=no alcohol in past 12 months
Number of alcohol drinks on a typical day	**b1c** Think of the times you've used alcohol during the past 12 months. How many drinks do you typically drink, on these days when you had an alcoholic drink. By a drink, I mean a can or stubbie of beer, a glass of wine, or a nip of spirits. XX=number of drinks
Subjective general physical health	**b2** How would you describe your general physical health? Would you say excellent, good, fair or poor? 1=Excellent 2=Good 3=Fair 4=Poor
Age at completing the SSAGA-OZ survey	**a1** What was your age at completing the SSAGA-OZ survey? XX=Age at completing the SSAGA-OZ survey

Table 4A. The effect of having children on women's health age: ≤30

	Older cohort									Younger cohort		
	Canberra (1980–1982)			Alcohol-1 (1988–1989)			SSAGA (1993)			SSAGA-OZ (1996-2000)		
Specification	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Dependant variable	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls
Body Mass Index (BMI)	0.730***	-0.049	-0.064	0.401	0.141	0.164	0.072	-1.226	-1.220	1.288*	1.421	-
	(0.200)	(0.191)	(0.192)	(0.249)	(0.245)	(0.245)	(1.027)	(0.880)	(0.883)	(0.668)	(1.098)	
Dummy overweight	0.025	-0.022	-0.020	0.037*	0.054	0.053	-0.007	0.071	0.073	-0.027	-0.077	-
	(0.017)	(0.022)	(0.022)	(0.022)	(0.038)	(0.038)	(0.087)	(0.128)	(0.128)	(0.039)	(0.086)	
Dummy obesity	0.027***	0.033***	0.032***	0.010	-0.027	-0.023	0.020	-0.071	-0.072	0.087**	0.167*	-
	(0.009)	(0.012)	(0.012)	(0.014)	(0.021)	(0.021)	(0.066)	(0.075)	(0.075)	(0.034)	(0.095)	
Number of sick days in the past 12 months	-0.348	-0.474	-0.485	0.639	0.375	0.380	-	-	-	-	-	-
	(0.824)	(1.481)	(1.483)	(1.340)	(2.639)	(2.647)						
Feel indicator	0.051	-0.050	-0.053	-0.058	-0.255**	-0.266**	-	-	-	-	-	-
	(0.069)	(0.100)	(0.101)	(0.070)	(0.107)	(0.107)						
Subjective general physical health	-	-	-	-	-	-	-	-	-	0.019	-0.115	-
										(0.079)	(0.161)	
How often alcohol drinks during the past 12 months	0.433***	0.632***	0.622***	0.513***	0.530***	0.527***	0.569***	0.222	0.228	0.674***	0.316	-
	(0.084)	(0.107)	(0.107)	(0.090)	(0.115)	(0.115)	(0.185)	(0.239)	(0.240)	(0.150)	(0.304)	
Number of alcohol drinks on a typical day	-	-	-	-	-	-	-	-	-	-0.359	-1.206	-
										(0.372)	(1.196)	
Maximum number of drinks per day during the past 12 months	-	-	-	-	-	-	-1.986***	-0.462	-0.519	-	-	-
							(0.489)	(0.677)	(0.679)			
Cigarettes per day	0.320***	-0.150	-0.155	0.249**	0.089	0.084	-	-	-	0.128	0.555*	-
	(0.093)	(0.144)	(0.145)	(0.099)	(0.109)	(0.109)				(0.184)	(0.332)	
Dummy smoking	0.009	-0.024	-0.024	0.044	0.018	0.018	-	-	-	-0.072	-0.056	-
	(0.012)	(0.016)	(0.016)	(0.034)	(0.037)	(0.037)				(0.060)	(0.105)	

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator. Standard errors are in parentheses.

Only identical twins are included.

Control variable: birth weight.

***: significant at 1%. **: significant at 5%. *: significant at 10%

Table 4B. The effect of having children on women's health age: >30

	Older cohort									Younger cohort		
	Canberra (1980–1982)			Alcohol-1 (1988–1989)			SSAGA (1993)			SSAGA-OZ (1996-2000)		
Specification	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Dependant variable	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls
Body Mass Index (BMI)	0.345	0.523*	0.533*	0.504	0.475	0.500	-0.619	-1.601	-1.586	0.764	-0.508	-
	(0.280)	(0.298)	(0.298)	(0.386)	(0.434)	(0.435)	(1.392)	(1.912)	(1.916)	(0.746)	(1.322)	
Dummy overweight	0.038	-0.011	-0.008	0.048	0.000	0.000	0.057	0.250	0.251	-0.012	-0.150	-
	(0.032)	(0.046)	(0.045)	(0.045)	(0.070)	(0 .070)	(0.153)	(0.301)	(0.302)	(0.044)	(0.092)	
Dummy obesity	-0.005	0.023	0.023	0.007	0.000	0.002	-0.044	-0.250	-0.250	0.087*	0.200	-
	(0.015)	(0.023)	(0.023)	(0.024)	(0.033)	(0.033)	(0.116)	(0.189)	(0.190)	(0.046)	(0.103)	
Number of sick days in the past 12 months	-1.546	0.257	0.118	-3.037	-4.714	-4.690	-	-	-	-	-	-
	(1.460)	(3.144)	(3.149)	(2.339)	(4.558)	(4.573)						
Feel indicator	0.021	-0.118	-0.121	0.076	-0.127	-0.128	-	-	-	-	-	-
	(0.079)	(0.117)	(0.117)	(0.094)	(0.161)	(0.162)						
Subjective general physical health	-	-	-	-	-	-	-	-	-	0.114	0.000	-
										(0.088)	(0.152)	
How often alcohol drinks during the past 12 months	0.082	0.473***	0.467	0.126	0.400*	0.387*	0.237	0.750	0.752	0.748***	0.071	-
	(0.138)	(0.161)	(0.160)	(0.176)	(0.229)	(0.230)	(0.379)	(0.565)	(0.566)	(0.196)	(0.313)	
Number of alcohol drinks on a typical day	-	-	-	-	-	-	-	-	-	-0.322	-0.500	-
										(0.230)	(0.582)	
Maximum number of drinks per day during the past 12 months	-	-	-	-	-	-	-0.520	-0.625	-0.621	-	-	-
							(0.555)	(0.706)	(0.707)			
Cigarettes per day	-0.042	0.053	0.073	-0.134	-0.122	-0.111	-	-	-	-0.355*	-0.158	-
	(0.124)	(0.211)	(0.215)	(0.144)	(0.179)	(0.179)				(0.212)	(0.292)	
Dummy smoking	-0.014	-0.050	-0.047	-0.067	-0.061	-0.059	-	-	-	-0.147**	0.000	-
	(0.014)	(0.037)	(0.038)	(0.050)	(0.063)	(0.064)				(0.073)	(0.101)	

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator. Standard errors are in parentheses.

Only identical twins are included.

Control variable: birth weight.

***: significant at 1%. **: significant at 5%. *: significant at 10%

Table 5A. The effect of a change in having children on a change in women's health

	Older cohort								
	Canberra (1980–1982) - Alcohol-1 (1988–1989)			Canberra (1980–1982) - SSAGA (1993)			Alcohol-1 (1988–1989) – SSAGA (1993)		
Specification	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Dependant variable	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls
Body Mass Index (BMI)	0.138	0.237	0.233	-0.218	0.122	0.124	0.103	0.162	0.167
	(0.124)	(0.200)	(0.200)	(0.213)	(0.436)	(0.437)	(0.328)	(0.640)	(0.641)
Dummy overweight	0.014	0.025	0.025	0.008	0.075	0.077	0.088	0.150	0.149
	(0.022)	(0.041)	(0.041)	(0.037)	(0.091)	(0.090)	(0.073)	(0.143)	(0.143)
Dummy obesity	-0.001	0.025	0.025	-0.064***	-0.019	-0.019	-0.037	-0.050	-0.049
	(0.011)	(0.020)	(0.020)	(0.022)	(0.050)	(0.050)	(0.038)	(0.069)	(0.069)
Number of sick days in the past 12 months	-2.494	-1.120	-1.060	-	-	-	-	-	-
	(1.641)	(3.185)	(3.194)						
Feel indicator	-0.146***	-0.187*	-0.186*	-	-	-	-	-	-
	(0.055)	(0.098)	(0.098)						
How often alcohol drinks during the past 12 months	0.250***	0.403***	0.404***	0.073	0.358**	0.358**	0.419***	0.310	0.305
	(0.064)	(0.105)	(0.105)	(0.067)	(0.157)	(0.157)	(0.103)	(0.194)	(0.194)
Cigarettes per day	-0.057	-0.057	-0.057	-	-	-	-	-	-
	(0.072)	(0.155)	(0.155)						
Dummy smoking	-0.004	-0.074**	-0.074**	-	-	-	-	-	-
	(0.020)	(0.032)	(0.032)						

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator. Standard errors are in parentheses.

Only identical twins are included.

Control variable: birth weight.

***: significant at 1%. **: significant at 5%. *: significant at 10%

Table 5B. The effect of a change in having children on a change in women's health: age: ≤30

	Older cohort								
	Canberra (1980–1982) - Alcohol-1 (1988–1989)			Canberra (1980–1982) - SSAGA (1993)			Alcohol-1 (1988–1989) – SSAGA (1993)		
Specification	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Dependant variable	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls
Body Mass Index (BMI)	0.144	0.260	0.263	0.210	0.451	0.469	0.294	0.162	0.164
	(0.148)	(0.212)	(0.211)	(0.323)	(0.510)	(0.512)	(0.350)	(0.670)	(0.673)
Dummy overweight	0.044**	0.061*	0.061*	0.089*	0.128	0.129	0.109*	0.150	0.152
	(0.021)	(0.037)	(0.037)	(0.047)	(0.083)	(0.083)	(0.064)	(0.117)	(0.117)
Dummy obesity	-0.002	0.015	0.016	-0.035	-0.026	-0.024	-0.004	-0.050	-0.049
	(0.012)	(0.021)	(0.020)	(0.028)	(0.051)	(0.052)	(0.031)	(0.055)	(0.055)
Number of sick days in the past 12 months	-2.861*	-2.519	-2.468	-	-	-	-	-	-
	(1.600)	(3.222)	(3.230)						
Feel indicator	-0.136*	-0.187*	-0.187*	-	-	-	-	-	-
	(0.071)	(0.110)	(0.110)						
How often alcohol drinks during the past 12 months	0.477***	0.421***	0.421***	0.311***	0.356**	0.357**	0.485***	0.310*	0.306*
	(0.076)	(0.109)	(0.109)	(0.090)	(0.157)	(0.158)	(0.102)	(0.179)	(0.179)
Cigarettes per day	-0.120	-0.122	-0.124	-	-	-	-	-	-
	(0.092)	(0.170)	(0.170)						
Dummy smoking	-0.007	-0.080**	-0.080**	-	-	-	-	-	-
	(0.027)	(0.032)	(0.032)						

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator. Standard errors are in parentheses.

Only identical twins are included.

Control variable: birth weight.

***: significant at 1%. **: significant at 5%. *: significant at 10%

Table 5C. The effect of a change in having children on a change in women's health: age: >30

	Older cohort								
	Canberra (1980–1982) - Alcohol-1 (1988–1989)			Canberra (1980–1982) - SSAGA (1993)			Alcohol-1 (1988–1989) – SSAGA (1993)		
Specification	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Dependant variable	OLS	Twin differences	With controls	OLS	Twin differences	With controls	OLS	Twin differences	With controls
Body Mass Index (BMI)	0.561 (0.373)	0.119 (0.504)	0.102 (0.506)	-0.382 (0.664)	-0.794 (0.846)	-0.803 (0.849)	1.374 (2.225)	omitted	omitted
Dummy overweight	-0.066 (0.074)	-0.154 (0.112)	-0.169 (0.111)	-0.137 (0.131)	-0.071 (0.197)	-0.085 (0.197)	-0.123 (0.554)	omitted	omitted
Dummy obesity	0.056 (0.037)	0.077 (0.051)	0.078 (0.051)	-0.044 (0.079)	0.000 (0.106)	0.000 (0.106)	-0.099 (0.299)	omitted	omitted
Number of sick days in the past 12 months	-3.066 (5.967)	10.077 (10.343)	10.301 (10.483)	-	-	-	-	-	-
Feel indicator	0.022 (0.153)	-0.189 (0.235)	-0.192 (0.235)	-	-	-	-	-	-
How often alcohol drinks during the past 12 months	-0.016 (0.194)	0.310 (0.275)	0.322 (0.275)	-0.188 (0.242)	0.364 (0.353)	0.387 (0.352)	0.013 (0.999)	omitted	omitted
Cigarettes per day	-0.226 (0.223)	0.750 (0.520)	0.748 (0.521)	-	-	-	-	-	-
Dummy smoking	0.044 (0.064)	0.000 (0.121)	0.001 (0.121)	-	-	-	-	-	-

Note: Each cell contains the estimate of a regression of a dummy for children on a health indicator. Standard errors are in parentheses.

Only identical twins are included.

Control variable: birth weight.

***: significant at 1%. **: significant at 5%. *: significant at 10