Parental Age at Birth and Health of the Offspring in Later Adulthood

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Abstract

The current study examined the relationships between mother's and father's age at birth and health of the offspring in later adulthood. Though most medical literature suggested that advanced parental ages at birth were directly or indirectly associated with many medical conditions in childhood and birth defects, my findings supported that the timing of starting family was positively associated with health of the offspring in the long run. Mature men and women were healthier if their parents started family later. Also mother's age was equally important as father's age. My findings suggested that the mechanism was not limited to socioeconomic advantages of the older parents. Other mechanisms and further investigations were discussed in the end of the paper.

INTRODUCTION

In this paper, I studied the relationships between parental age at birth and health of the offspring in later adulthood. Parental age included paternal age and maternal age. Health outcomes include self-report general health status, number of physical symptoms in the past 6 months, number of (chronic) medical conditions, and cognitive ability. The following research questions were addressed: 1) whether paternal age and maternal age were associated with later health outcomes of the offspring; 2) whether the relationships were independent of parental socioeconomic, for example, parental education, occupation, maternal employment, and family income; and early family environment, for example, family structure, health environment in the household/family, and violence/abuse in the family; 3) whether the relationship was independent health and cognitive ability in childhood, that is, the influences of parental ages at birth were mainly in childhood; 4) whether father's age and mother's age were equally important.

BACKGROUND

The adverse consequences of advanced parental ages at birth were well-documented in medical literature. Advanced *maternal* age at birth was associated with birth outcomes such as still birth, fetal loss, spontaneous abortion, ectopic pregnancy, pre-mature delivery, Down syndrome, other chromosomal anomalies, and birth defects (for example, patent dictums arteries, hypertrophic pyloric stenos, and congenital dislocatable high hip click). It was also related to adult and childhood diseases, for example, onset of Type I diabetes, childhood leukemia, breast cancer, and Alzheimer disease. Advanced *paternal* age was associated with non-chromosomal anomalies, non-familial autosomal dominant diseases (for example, achondroplasia and Apert syndrome), onset of schizophrenia, prostatic cancer, brain or nerve-system cancers, onset of Type I diabetes, and Alzheimer disease.

The negative consequences of advanced *maternal* age on birth and childhood health outcomes might be caused by folate depletion, by the quality of oocyte, by the efficiency of uterus, or by maturation of the immune system. The level of folic acid was related to the birth outcome. Controlling for gestation age, Miller (1993) found that folate supplement intakes in conception interval and gestation interval affected the perinatal mortality and infant health for older pregnant women. The quality of oocyte and the efficiency of uterus were also commonly used to explain the negative birth consequences. Advanced *maternal* age adds the risk of trisomic oocyte, which led to most forms of Down syndrome (CITATION). Age also affected fetus loss before first missing period though it is difficult to separate fetus loss from failure to conceive (CITATION). Even if a woman was conceived, an aged uterus was less efficient to sustain the embryos, or the fetus, than a uterus of the normal age (CITATION). Parental age also affected maturation of immune system. Atopic disease was mediated via a predominant Th2 lymphocyte response whereas type 1 diabetes and other autoimmune diseases were mediated via Th1 responses. Children with type 1 diabetes had a lower prevalence of asthmatic symptoms while Th2 mediated diseases were associated with lower maternal age. The associations between *paternal* age and negative health outcomes were usually explained by gene mutation. At ages 20 and 40, a man's germ cell precursors had undergone about 200 and 660, respectively, divisions of spermatogonia accumulate mutation. Women usually went through 24 germ cell divisions (Crow 1986?). New mutations might replenish the population with genetic abnormalities. However, despite of many possible adverse birth conditions or defects, the chances to produce a child with any of the diseases or defects was fairly small. For example, it was about one out of 353 chance for women older than 35 to conceive a child with Down syndrome.

Parental age at birth, however, was positively associated with well-being, educational attainment and intellectual development of children and young adults (CITATION). Mountainous studies showed that children of teenager parents (mothers in specific) were more likely to grow up in poverty, to marry earlier, to become teenager parents themselves, to have less education, to have jobs of lower status, to earn less and to stay in welfare programs than children of adult parents (CITATION). Socioeconomic mechanism was the most obvious explanation. Older parents themselves were more likely to have higher socioeconomic status than younger parents. Children of higher status parents were more likely to achieve higher socioeconomic status and to have better health than children of lower status. Throughout the life course, men and women of higher socioeconomic status and with better childhood health were more likely to enjoy better health later. Naturally, in mortality research which used genealogical data, parental ages were often treated as an indicator of socioeconomic status and found to be significantly related to mortality (Smith et al., 2003; CITATION). Parental ages may influence children's well-being through other mechanisms. Mare and his colleagues, without controlling for mother's ages, found that father's age, not limited to teen fathers, had significant effects on years of schooling, but not on educational transitions (Mare and Tzeng 1989; CITATION). And, independent of socioeconomic status effects, parental age still influenced health and intellectual development (Chiang 1990; Leng 1991; CITATION). Parental ages might indicate birth conditions and the environment of growing up. Older parents were more resourceful socially, more mature psychologically and, thus, more ready to care for children and more likely to have stable environment of their offspring. For example, children of young parents were more subjective to maltreatment than children of older parents (CITATION). Children of young parents were less likely to have appropriate health insurance and to receive vaccination on schedule (CITATION).

The low birth weight (LBW) was a plausible mechanism and the most influential consequence of parental ages at birth. LBW was associated with childhood health and intellectual development, including low measured mental ability, substance abuse, delinquent behaviors, poor school performance, early sexual intercourse initiation, teenage pregnancy, poverty, and early or long-term welfare receipt of the offspring. Moreover, many chronic diseases in adulthood were also related to LBW, for example, cardiovascular diseases, diabetes, obesity, childhood respiratory infection, childhood chronic bronchitis, and childhood infectious diseases. Both maternal age and paternal age were associated with low birth weight, but the findings were inconsistent and the explanations for the relationships were not straightforward. Some found that parents of teenage were more likely to give birth to babies of low birth weight while others found parents of advanced age were more likely to give birth to babies of low birth weight (CITATION). Recently, Googins, Chan & Griffiths (2009) suggested a "r" shaped relationship between paternal age and birth weight. That is, infant birth weight was positively associated with paternal age until age 30. The curve turned plateau at age 30 and then downward after age 45. The latter was small and not statistically significant.

Birth order or number of siblings was another plausible explanation. Parental age at birth were related to birth order and number of siblings. In a group of children of the same age, children born to older parents were more likely to have higher birth order than those born to younger parents. Men and women from larger families were more likely to have higher birth order than those from smaller families. Birth order was related to birth type I diabetes (CITATION). Number of siblings was related to child/infant mortality, health status of young children, asthma, and allergy (CITATION). The relationships between birth order and non-health outcomes were mostly not supported. Though few studies found being first born increased intellectual development or educational attainment, most studies could not find any relationships. However, the evidence supporting inverse relationships between number of siblings and socioeconomic attainment was overwhelming with only few exceptions.

Many studies supported the importance of parental age, but the directions and effects were inconsistent. The subjects in most studies were newborns, young children and young adults, but not mature adults. Earlier medical and epidemiological studies mostly focused on specific diseases or birth conditions but ignored other aspects of adult and childhood health outcomes, such as general health status, physical symptoms, and health behaviors. Additionally, many studies did not examine maternal age and paternal age together. Some studied parental age at birth of the first child and other studied parental age at birth of the respondent. Data of aging and life course with good information on early family environment or socioeconomic origin were rarely seen. Medical studies usually had no or little information on family environment and socioeconomic origin other than parental age. Thus socioeconomic characteristics except mother's education and father's education were usually lacking. Birth conditions or childhood health were not controlled in most studies. Birth order and number of siblings were not included in most studies. Unmeasured family heterogeneity was also not controlled in almost all studies. A systematic examination on the relationships between parental age at birth and health, outcomes of mature men and women from the perspective of life course was in need.

RESEARCH QUESTIONS AND DESIGN

In summary, there are several possible mechanisms to explain whether and how parental ages at birth influence the health and well-being of the offspring in later adulthood. First, biologically, the offspring of older parents, especially older mothers, tends to have health problems in childhood or in adulthood since the quality of oocyte and sperms and the efficiency of the uterus decline along with parental age. Among them, father's age is related to neurological problems and mental health while mother's age is related to body size and childhood health. Second, older parents usually have better socioeconomic resources than younger parents. With better socioeconomic background in childhood and thus better socioeconomic achievement, children of older parents are more likely to have better health and less health risks in later adulthood. Third, older parents tend to be more mature and psychologically ready for parenting roles. Children of older parents are more likely to be well-adjusted psychologically and thus to have better physical and mental health. Fourth, the offspring of older parents tends to be born in higher birth orders; that is, parental age is a proxy of birth order or number of siblings. The effects of parental ages will disappear or decrease once the sibling composition is controlled in the equations. Fifth, children successfully born to older parents, given the higher risk of stillbirth and miscarriage, are healthier than or, at least, not different from other children.

The purposes of the current study are to establish the associations between parental ages at birth and first birth and health of the offspring at age 65; and to examine whether socioeconomic status of the offspring and parents explain the associations. The following questions were addressed,

1. Were parental ages at birth or first birth associated with health in later adulthood? in which direction?
2. Did the associations remain after parental socioeconomic and other early family environment measures are controlled?
3. Did the associations occur due to the influences of parental ages on early health?
4. Were the influences of parental ages operated through the associations between its influences on socioeconomic attainment?
5. Were effects of mother's ages equal to those of father's ages?

I first analyzed the bivariate relationship between paternal/maternal age (independently) and selective study and intermediate outcomes. I then run nested multivariate regressions of each study outcome on paternal age, maternal age, gender, and age. Several sets of early family environment were entered into each equation stepwise. By entering these sets of early family environment variables, I studied whether the paternal age and maternal age had effects on later health outcomes independent from other observed early family environment. Given the proven relationship between parental age and intellectual development of the young offspring, I also studied cognitive ability as the comparison.

DATA AND VARIABLES

The data are collected by Wisconsin Longitudinal Study. The study first surveyed a group of high school seniors in 1957. It collected information on residence, parental socioeconomic status, educational and occupational expectation, aspirations, family income, family structure, high school performance, intelligence, and curriculum. In 1964 and 1975, the study followed these seniors and continued to collect information on their schooling, work, marriage, fertility, social activities, and more early life circumstances. In 1977, a randomly selected sibling of each 1957 senior was interviewed. The 1977 interview of siblings, in large, was a parallel survey of the 1975 interview of the seniors. In 1993, WLS interviewed the original graduate respondents again; in 1994, it followed the 1977 siblings and an additional sample of siblings. In 2004, graduate respondents who were alive and interviewed in 1975 or 1993 were interviewed again; in 2005, a sample of living siblings were also interviewed. In 1993/4 and 2004/5 surveys, in addition to socioeconomic status, jobs, aspiration, family and social life, WLS also asked questions about physical health, mental health, retirement plans, family relationship, personality, psychological well-being, cognitive ability, financial transfers, social supports, and some early family circumstances.

The health outcomes in this study are from 2004 graduate survey. All studied outcomes were collected in both phone interviews and mail questionnaires. The 2004 graduate respondents who answered both mail and phone interviews were the analytical sample.

The description of dependent variables, explanatory variables, and selected control variables are reported in table 1. Health outcomes were physical health and mental health (depressive state and cognitive ability). The physical health included self-evaluation health, number of chronic conditions diagnosed by medical professionals, and number of somatic symptoms experienced by the respondents in the last 6 months prior to the study. The question of self-evaluated health was "How would you rate your health at the present time". The answer included five categories: very poor, poor, fair, good, and excellent. I also created a dichotomous variable: 1 was good and excellent and 0 was otherwise.

The list of diagnosed chronic conditions were heart attack, stroke, other heart problems, high blood pressure, diabetics, high blood sugar, cancer, allergy, asthma, chronic bronchitis, chronic sinus problem, fibromyalgia, circulation, high cholesterol, irritable bowel syndrome, kidney/bladder problems, multiple sclerosis, osteoporosis, back trouble, ulcer, and prostate problem (male only). The total number of chronic diseases ranged from 0 to 13 (or 14 for male).[1] The list of somatic symptoms included aching muscles, back pain/strain, bone pains, chest pain, constipation, coughing/wheezing, diarrhea, painful sexual intercourse, dizziness/faintness, numbness, pain in hands/wrists, pain in ankles/knees, excessive sweating, fatigue/exhaustion, headache, lack of energy, neck and/or shoulder pain, palpitations, ringing in ears, shortness of breath, skin problems, stiff/swollen joints, trouble sleeping, upset stomach and urination problems. The total number of somatic symptoms ranged from 0 to 25. The variable was constructed by the summary of symptoms experienced more than once or more per month.[2,3]

The WLS graduate and sibling respondents reported mother's and father's birth years since 1993 survey. In 1975, 'current' age of household head in childhood was also reported by the graduates. I used mainly from the graduates' report, supplemented by the sibling's report if graduate reports were missing and two siblings grew up together. The 1975 age of the childhood household head was used for accuracy check against inconsistency between siblings and graduates reports.[4] Mother's age and father's age at the first birth were constructed by age of the first survival sibling in 1975 and age/birth year of the parents.[5] Because parental age was

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[1] Major chronic conditions were studied separately in a different analysis. Results are available upon request.

[2] Women were more likely to report a symptom with frequency less than once per month.

[3] For each variable, I also created a dichotomous indicator to show whether the respondent had number of conditions or symptoms on the highest quartile of the sample. I also studied mental cognitive function. The cognitive function was measured by the summary score of 6 of the fourteen items from the Weschler Adult Intelligence Scale (WAIS).

[4] Early on I imputed 1975 household head age for missing values in either father's or mother's ages , with an indicator for the imputation. The coefficients of parental ages on health outcomes between with 1975 imputation and without were not different. Here I reported the coefficients without 1975 imputation.

[5] Additionally, I also constructed categorical variables of parental age. The categories are "18 and younger" (reference variable), "19-34", and "35 and older". They did not fit as well as continuous measures of parental age. A quadratic term of each parental age was also added in order to capture the possible non-linear

also a function of birth order and number of siblings, they were also controlled in the early stage of the study. Both variables were constructed from siblings rosters in 1975/1993 and 2004 interviews.

Other measures of early family circumstance other than parental age at birth were collected in various waves of WLS graduate and sibling surveys. The first set of early family environment includes measures of parental socioeconomic status: father's education, mother's education, father's occupational status at 1957, mother's employment status, family income and growing up with both parents. Father's occupation was measured by Duncan 1950 SEI. The family income variable is measured by a logrithm transformation of the family income which was collected from Wisconsin state tax data. Parental education is measured as years of schooling. Those variables were reported or collected by 1975.

Adverse childhood experiences, including an indicator of any problem drinker in the household while growing up, two or more smokers in the household, and physical and verbal abuses were also added. In both 1995 sibling and 2004 graduate surveys, three questions of household smokers were designed to identify whether the mother, the father, and another household member were smoking. In the current study, given the popularity of smoking in 1950s, an indicator of 2 or more smokers in the family was created. The variables of physical and verbal abuses were constructed from a series of type of action and subject- and object-specific questions.[6] The physical abuse was indicated by two questions regarding whether the mother and the father slapped, shoved, or threw things at the respondent a lot in the first 16 years of his/her live. The verbal abuse was indicated by two questions regarding whether the mother and the father insulted or swore at the respondent a lot. Only those admitting some degree of maltreatment were coded as being abused.

The uniqueness of the WLS not only lays on its extensive information on the respondent's childhood but also on the kinship. In 2004, the WLS asked a series of questions related to the respondent's health in childhood. Here I only used the general health status in childhood, which was coded from 1 (very poor) to 5 (excellent). Utilizing information on death of the first degree biological relations, I also constructed an indicator for each parent's death before age 60.[7]

The next group of independent variables is consisted of variables regarding the achievement and mental (academic) ability of the graduates in 1957. Back to 1950s, a Hemon-Nelson ability test was administered in junior and senior year (i.e., around 1956 or 1957 for our sample) to all Wisconsin high school students. The WLS obtained from the school record and normalized the score into percentile. Another variable was perceived parental encouragement for college education, reported in 1975 by graduate respondents.

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relationship between the outcomes and parental age. A quadratic term of each parental age is tested and added in order to capture the possible non-linear relationship between the outcomes and parental age.

[6] The abuses from parents to graduate respondents were first reported by the interviewed siblings in 1994 sibling survey and then reported by themselves in 2004 graduate survey. As usual, I used the graduate reports, supplemented by the sibling report.

[7] The WLS parents enjoyed good health and long life. I tried various categorization for the cutting point of the indicators.

Measures of socioeconomic attainment and major demographic events in adulthood were also included. The socioeconomic attainment included education in 1993 and occupational status of first job and current/last job in 1993. The life events include age at first marriage, number of marriage, ever being divorced, being single in 1992/3, age at first birth, and number of biological children in 1992/3.[8]

ANALYTICAL DESIGN

I first analyzed the bivariate relationship between paternal/maternal age (independently) and each outcomes. I then ran nested multivariate regressions of each outcome on individual measure of parental age one at a time, controlling for gender, birth order and total number of siblings. Several sets of early family environment were entered into each equation stepwise. By entering these sets of early family environment variables to study the change in effects of paternal age and maternal age on each outcome, I studied whether the paternal age and maternal age had effects on later health outcomes independent from other early family environment. The results were reported in table 3.

Next, I selected out insignificant control variables to obtain a more parsimonious equation and entered either father's age AND mother's age at first birth or father's age and mother's age at the respondent's. Usually, maternal age was highly correlated with the paternal age. The significant effects might be affected by this correlation. The independent effects of maternal age or paternal age on these outcomes might reduce significantly if both ages were entered in the same regression equation.

The multivariate regression was done separately for first born respondents and those of higher birth order. As addressed in the section of literature review, the differences between the parental ages at birth of the respondents and his/her oldest siblings were related to birth order. Those respondents of higher birth orders were more likely to be born to older parents. That is, the coefficients of parental age at the respondent's birth and at the first birth might be a function of number of older siblings and whether the respondents was the first born. But for first born respondents, parental ages at the first birth were the same as the ages at birth. In the analysis, I separated respondents by the status of being first born or not. In the analysis of first born respondents, I did not control for birth order; in the analysis of later born respondents, I controlled for birth order. In the multivariate regression analysis, I used only parental ages at the respondent's birth to analysis the sample of first born respondents. However, I used either parental ages at birth or parental ages at the first birth for the sample of later born respondents.

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[8] The final set of control variables were health risk factors in 2004: being obese, ever smoking, and problematic drinking behaviors/heavy drinking. Both height and weight were self-reported in 2004 mail questionnaire. The BMI was constructed by a ratio of height and weight: (kilometer)/(meters)2. The indicator of being obese was defined as BMI equal to or greater than 30. The indicators of smoking included ever smoking and ever smoking for 10 years or longer. I also controlled for 1993 health status/measures corresponding to the study outcomes, i.e., 1993 general health in 2004 general health equation, 1993 total number of medical conditions in 2004 medical condition equation, and 1993 total number of symptoms in 2004 symptom equation. They were entered into each corresponding equation after 1993 SES, family and marriage but before 2004 risk behaviors.

Lastly, to summarize the effects of parental ages, I pooled three continuous measures of physical health outcomes (general health status, number of illness and number of symptoms) as a general indicator of physical health in a two-group Multiple Cause Multiple Indicator (MIMIC) model to study the effects of all parental age measures (including paternal and maternal ages at first birth and at respondent's birth), controlling for other socioeconomic and family background variables. See figure 1 for the baseline model. Note that in the group of first born respondents, three data moments were missing, i.e., father's age at first birth, mother's age at first birth, and birth order (number of siblings before the respondent + 1). Their relationships with the latent health factor were indicated by dash lines. The model specification will be discussed later.

FINDINGS

Bivariate Relationship

Table 2 summarizes bivariate relationship between mother or father age and selected variables of socioeconomic status and health outcomes at age 65. Various functions were explored. The relationships between parental ages and socioeconomic outcomes were fairly consistent. The fact that the linear function fitted well in most outcomes lent me support to the continuous measures, instead of categorical measures, of parental age. The relationship with measures of physical health and cognitive ability were especially strong. Paternal age appeared to have less influences on the overall health outcomes than maternal age. This seemed to be in agreement with the popular notion that the maternal age was more important in the health of the offspring than the paternal age. Though, relationships of paternal age with self-evaluated health, number of diagnosed illness, and cognitive ability were strong (p<.05) enough to grant its inclusion in further analysis.

Multivariate Regression Analysis

[Table 3 Here]

Table 3 shows effects (coefficients) of individual measure of parental age on each health outcome for all models, controlling for the full set of independent variables for family background in childhood, socioeconomic status, marriage and fertility in adulthood. Only one measure of parental age was entered in each equation. The entrance of each set of independent (control) variables was discussed as "model" in the text while the columns represented the "equation" of various parental ages. There are three panels in the table to indicate three different outcomes.

The first panel reported the coefficients and t-values from the regression analysis of self-reported health status on each measure of parental age at birth or at first birth. For the first-born respondents, neither paternal age nor maternal age at birth was associated with health status at age 65. See the first two columns. The addition of several sets of control variables such as family background, childhood environment, childhood health and IQ, socioeconomic attainment, marriage and fertility in adulthood, did not change the insignificant relationships. For the later-born respondents, the positive relationships between parental ages and health status at age 65 were modest but significant. See columns 3 to 6. The relationships sustained after controlling for socioeconomic origin, childhood environment, childhood health and IQ, and parental age at death. The coefficients were 0.003 for paternal age at birth, 0.002 for maternal age at birth, 0.013 for paternal age at the first birth, and 0.015 for maternal age at the first birth in the baseline models; in the 6th model, the coefficients were 0.009, 0.007, 0.009, and 007 respectively. After controlling for socioeconomic status, marriage and fertility in the final model, the coefficients only changed slightly: 0.008 for paternal age at birth and at first birth, 0.005 for maternal age at first birth, and 0.006 for maternal age at the respondent's birth. Later-born respondents who were born to older parents were more likely to have better health at age 65 than those born to young parents.

The second panel reported the coefficients for the regressions of total number of diagnosed medical conditions. Columns 1 to 4 showed that neither paternal age nor maternal age at the respondent's birth was associated with total number of conditions at age 65 significantly. The findings were applied to both first born and later born respondents. Findings in columns 5 and 6, however, suggested that parental ages at the first birth were related to total numbers of conditions diagnosed for later-born men and women. That is, on average, the later-born respondents whose parents started family later had less medical conditions than those whose parents started family earlier. The coefficients were -0.029 for paternal age and -0.034 for maternal age in the baseline models, and -0.021 and -0.027 respectively in the final models.

The third panel reported the coefficients and standard erros for the equations of total number of symptoms experienced in the last 6 months. Columns 2 and 4 showed that maternal age at the respondent's birth was not associated with total number of symptoms for all respondents. However, paternal age at the birth was significantly related to total number of symptoms for all respondents. Men and women who born to older fathers experienced fewer symptoms than those who born to younger fathers did. The small but significant inverse relationships sustained after controlling for birth order, number of siblings, socioeconomic origin, family environment, health and IQ in childhood, parental age at death, socioeconomic status, marriage and fertility in adulthood. The coefficients of paternal ages at birth in the final models were -0.049 for first born respondents and -0.022 for the later born respondents. Each of paternal and maternal ages at first birth was inversely related to number of symptoms. The coefficients of paternal age were -0.055 for the baseline model and -0.041 for the final model; those of maternal age were -0.051 and -0.034 respectively.

Note that in all equations of parental age at the respondent's birth for later born respondents the coefficients increased in magnitude between models 1 and 2. Similar changes were observed neither in the equations for first born respondents nor in the equations of parental ages at first birth for later born respondents. This indirectly supported the earlier argument on the complicated relationships between effects of parental ages and effects of birth order or number of siblings. Thus it is necessary to control for birth order and number of siblings while studying the health consequences of parental ages on the offspring.

In the next step, I pooled paternal and maternal age together. Parental ages at the respondent's birth and those at the first birth were analyzed in separate equations. The analysis of first birth and later born respondents remained separated. Additionally, I selected out variables which did not explain health outcomes and appeared not to moderate the relationships between parental ages and health of the offspring. Those variables included parental age at death, growing up with problem drinkers, and 1993 marriage and fertility history. I also added the essential control variables such as age, sex, number of siblings ever born, and, for later born respondents, birth order to the baseline models. The results of the analysis were reported in Table 4.

[Table 4 Here]

The first panel showed coefficients and standard errors of father's and mother's age at birth or first birth on self-reported health status. Findings in columns 1 and 2 suggested that paternal age at birth was positively associated with health status for both first born and later born respondents while maternal age at birth was inversely associated with health status for first born respondents only. The positive relationship between paternal age at birth and health status and the negative relationship between maternal age at birth and health status sustained after controlling for socioeconomic origin, other family environment variables, health and IQ in childhood, and socioeconomic status in 1993. Column 3 showed that paternal age at first birth was also positively associated with the later-born respondent's health. In short, respondents born to older fathers were more likely to have better health than those born to younger fathers. And, respondents whose fathers started a family earlier were less healthy than other respondents.

In the second panel, the coefficients of paternal ages at the respondent's birth and at the first birth were inversely related to the total number of diagnosed medical conditions at age 65. But the relationships were only significant for later-born respondents (columns 2 and 3) but not for first-born respondents (column 1). In the final models for the later-born respondents, the coefficients of paternal age at birth were -0.011 while the coefficient of paternal age at the first birth was -0.013. Though coefficients of maternal ages at birth and at first birth were not statistically significant, they were in the same direction as the coefficients of paternal ages.

Findings in the third panels (total number of symptoms) showed respondents of older fathers reported fewer physical symptoms than those of younger fathers. And paternal ages starting the family were also inversely associated with total number of symptoms.

Two observations suggested that the approach of structural equation models may be useful to clarify the relationships and effects of parental ages. First, coefficients in most equations of table 4 showed that maternal ages were not significantly associated with health outcomes, and the directions of the coefficients were inconsistent. Second, the coefficients of paternal ages at birth or first birth in table 4 within each panel were very similar to one another while this was not the case for those of maternal ages. However, most of coefficients of maternal ages were very small and not statistically significant. Likely, each measure of parental age was simply an indicator of the timing of family starting. And due to the highly positive correlations between mother's and father's ages,[9] the coefficients of paternal ages should be taken into account while estimating the 'influences' of maternal ages

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[9] Multicollinearity has not been an issue in all regression analysis reported above.

"mathematically". This does not exclude the possibility that maternal ages were not as important as paternal ages in explanation of health outcomes in later adulthood. By using SEM, one may test whether each measure of parental ages had influences on health at age 65 independent of the other measures of parental age.

Structural Equation Model Analysis (MIMIC)

[Figure 1 Here]

Figure 1 is the path diagram for the structural equation model employed here. The baseline model is a two-group Multiple Indicator and Multiple Causes model (MIMIC) of three dependent variables. The MIMIC model specifies that exogenous social background characteristics affect the health outcomes of respondents through a single unmeasured common health factor. Alternatively, one may consider three observed health outcomes as the indicators of the common factor that the model is simply a regression analysis of the common factor on the exogenous variables. The two groups are groups of first born respondents and later born respondents.

The regression part of the model can be expressed as,

$$\eta = \Gamma\ \xi + B\ \eta + \zeta \qquad (1)$$

where η is the endogenous latent variable; ξ is a vector of exogenous latent variables with variance-covariance matrix Φ; ζ is a vector of disturbance, independent of η and ξ, with variance-covariance matrix Ψ; Γ is a parameter matrix of effects of ξ on η; and B is a parameter matrix of effects of η on η. In the model of Figure 1, there are 4 η's. The 4th η carries the effects of exogenous variables (including 4 measured of parental ages) to the three dependent variables. To identify the model, $\beta_{(1,4)}$, i.e., the loading of self-reported health status on the common health factor, was imposed as one while $\beta_{(3,4)}$ and $\beta_{(2,4)}$, i.e., loadings of symptoms and medical conditions on the common factor, were estimated freely. The measurement model for the exogenous variables (ξ's) is

$$X = \Lambda^x\ \xi + \delta \qquad (2)$$

where X is the vector of observable variables (indicators of ξ's); Λ^x is the parameter matrices giving the effects of ξ on X; and Θ^{δ} is the covariance matrices of δ's. Equation 2 was not shown in figure 1 because each exogenous variable ξ has only one x as the indicator so that all elements of Λ^x are equal to one and Θ^{δ} is equal to zero. In short, all ξ's are perfectly measured by corresponding x's. A similar measurement model for the dependent variables η_1, η_2, and η_3 are,

$$Y = \Lambda^y\ \eta + \varepsilon \qquad (3)$$

where Y, Λ^y, and ε are similar to X, Λ^x and δ in equation 2. Again, η_1, η_2, and η_3 are assumed to be measured perfectly by corresponding y's, so all elements of Λ^y are equal to one and Θ^ε is equal to zero. A conventional MIMIC model usually has only one η. I added η_1, η_2, and η_3 in order to allow additional effects of exogenous variables on specific health outcomes.

To follow the arrangement in multivariate regression analysis, the first born and later born respondents were also separated into two groups here. For first born respondents, because paternal age and maternal age at birth were equal to those at first birth; and there was only one value for birth order (1+ number of siblings ever born before the respondent), I treated them as missing data Thus they were treated as missing data. I then used methods for the estimation of structural equation models with missing data that were introduced in Allison (1987) to combine data for the first born and later born respondents. By combining equality constraints across subsamples with the introduction of null parameters for missing variables, I could estimate multiple group models simultaneously for groups defined by the presence or absence of certain observations. That is, I introduced pseudo-values for the moments of "missing" variables and specified innocuous fixed values for their factor loadings and variances. First, for the first born group, the corresponding values of λ^y's were specified as zeros, and the corresponding values of θ^δ were specified as one. The corresponding γ's were constrained as zero too. The imposed values were arbitrary because the variables were not observed and the fixed values did not affect the fit of the model or other parameter estimates. I did not impose any special arrangement for the later born group. There were 1624 first-born respondents and 2529 later born respondents. Note that I recoded the health status inversely so that the directions of coefficients for three dependent variables were consistent.

[Table 5 Here]

Table 5 showed the goodness of fit and the process of model selection. The model selection was evaluated by both χ^2 and *bic* statistics. The *bic* statistics was based on Bayesian theory for a posteriori tests: $bic = L^2 - df \times ln(\text{n})$. A satisfactory fit was indicated by negative value in *bic*. The change between two nested models should be greater than 10 and at least 7 (Raftery 1995). I first estimated the baseline model as figure 1. Except the specifications mentioned above and necessary for model identification, I did not impose any cross-group or within-group constraints on any estimated parameters. The baseline model did not fit well: χ^2 was 759.97 with 79 degrees of freedom. The *bic* statistics was 101.77. In the next model, I imposed cross-group constraints for all parameters, except the variance-covariance matrices of ξ's, i.e., Φ. The χ^2 statistics was 790.47 with 101 degrees of freedom. With an increase of 22 degrees of freedom, the χ^2 only increased for 30.5. The *bic* statistics was -51.02. In the second model nested to model 1, I allowed estimation of covariance terms between general health and symptoms and between medical conditions and symptoms. The value of χ^2 was 281.68 with 99 degrees of freedom. And the *bic* statistics was -543.15. After model 2, I systematically estimated the parameters between all exogenous variables and symptoms or medical conditions, that is, $\gamma_{(2,k)}$'s and $\gamma_{(3,k)}$'s, where k indicated the exogenous variables. Model 3 was a summary of the results. Sex of the respondents, whether growing up with smokers, whether being abused in childhood, and health in childhood all had significant direct effects on total number of medical conditions and total number of symptoms. The estimation of each individual set of the paths improved the model. The value of χ^2 was 136.52 with 91 degrees of freedom. And the *bic* statistics was -621.65.

Up to model 3, I mainly focused on establishing a reasonably well-fit model in order to examine the relationships between parental ages and their relationships between three health outcomes.[10] In model 4, I imposed equality constraints between paternal age and maternal age at the first birth, and between paternal age and maternal age at the respondent's birth. That is, I tested the hypothesis that the effects of parental age at the first birth and those at the respondent's birth were different, but there was no difference between mother's and father's ages. With an increase of 2 degrees of freedom, the value of χ^2 increased from 136.52 to 140.64. The *bic* statistics was -621.64 and -634.20 respectively. That is, model 4 fitted better than model 3 significantly according to *bic* statistics.. In model 5, nested to model 3, I tested the hypothesis that effects of mother's age were different from those of father's and there was no difference between age at first birth and age at the respondent's birth. The value of χ^2 was 136.60 with 93 degrees of freedom. The *bic* statistics was -638.24. In model 6, nested to model 3, I imposed equality constraints among all measure of parental ages at birth. Comparing to model 3, with an increase of 3 degrees of freedom, the χ^2 statistics increased from 136.52 to 140.79. The *bic* statistics was -642.38. Models 4, 5, and 6 fitted almost equally well, and significantly better than model 3, according to *bic* statistics. All three models were nested to model 3 and model 6 was also nested to either model 4 or 5. The χ^2 statistics barely differed between models 3 and 5 while it changed more between models 3 and 4. Model 6, as the most parsimonious model, was the preferred model. Estimated coefficients of parental ages of models 5 and 6 would be both discussed in the next section. Figure 2 is the path diagram of the preferred model.

[Figure 2 and Table 6 Here]

Table 6 shows the estimated coefficients of parental ages and other exogenous variables on each measure of physical health. Since the self-reported general health in 2004 was inversely coded, the negative coefficients indicated better health, fewer illnesses and fewer symptoms while the positive coefficients indicated the opposites. The loadings of health status, number of medical conditions, and number of symptoms were 1, 1.29 (s.e.= 0.07) and 1.51 (0.11) respectively (not reported here). Except socioeconomic origin (parental education, father's occupational status and family income in 1957), number of siblings ever born, and respondent's IQ in high school, all exogenous variables were significantly associated with health at age 65. Educational attainment in 1993, family income in 1993, and parental expectations for college were associated with the common family factor. The total effects on self-report health status were -0.047(0.008), -0.002 (0.001), and -0.104 (0.034) respectively; the total effects on number of medical conditions were -0.061 (0.010), -0.003 (0.001), and -0.135 (0.045) respectively; and the total effects on number of symptoms are -0.071 (0.013), -0.003 (0.001), and -0.158 (0.053) respectively.

Adverse experiences such as growing up with smokers and experiencing childhood

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[10] One might choose to test hypothesis one by one and in the end pooled all significant findings together. The sequence of model fitting did not change the goodness-of-fit.

abuses were significantly associated with the self-report health status, but their harms on number of medical conditions and symptoms were significantly stronger. That is, a common family factor was not enough to explain the relationship between those variables and the outcomes. The total effects of growing up with smokers and being abuse were 0.074(0.034) and 0.066 (0.032) on health status, 0.327 (0.081) and 0.510 (0.077) on number of medical conditions, and 0.387 (0.131) and 0.826 (0.124) in number of symptoms respectively. Women appeared to be healthier than men in self-reported health status, but they experienced much more medical conditions and symptoms. The total effects of sex were -0.065 (0.030) on health status, 0.255 (0.072) on number of medical conditions, and 0.758 (0.117) on number of symptoms. Being born to higher birth order was associated with poor health. The total effects were 0.025 (0.012) on health status, 0.033 (0.015) on number of medical conditions, and 0.038 (0.018) on number of symptoms. The childhood health status was associated with the health status in adulthood. Moreover, the relationships were even stronger in objective measures such as number of medical conditions and symptoms. The total effects were -0.143 (0.018) on health status, -0.269 (0.041) on number of conditions, and -0.499 (0.065) on symptoms.

All parental ages were associated with health in the preferred model. Parental ages were associated with health in model 5, but maternal ages were not. The relationships did not vary by health outcomes; that is, there were no direct influences from parental ages to either number of conditions or number of symptoms. Respondents who were born to older fathers were more likely to report being healthy and to have less medical conditions or physical symptoms than respondents who were born to younger fathers. However, since higher birth order was positively associated with poor health, the effects of paternal ages were mainly due to the timing of starting family. In the preferred model (i.e., model 6), the total effects of parental ages were -0.014 (0.006) on health status, -0.018 (0.008) on number of conditions, and -0.021 (0.010) on number of symptoms. In model 5 (paternal vs. maternal ages), the coefficients were -0.049 (0.019) for father's ages and 0.027 (0.022) for mother's ages (not reported in the tables). Thus, the total effects of paternal ages were -0.049 (0.019) on health status, -0.063 (0.024) on number of conditions, -0.073 (0.029) on number of symptoms; those of maternal ages were 0.027 (0.022), 0.036 (0.028), and 0.042(0.033) respectively.

DISCUSSION AND CONCLUSION

In summary, I found that parental ages at birth were associated with physical health of the offspring at age 60s. Mature men and women who were born from older parents fared better physically. Those relationships were independent of parental socioeconomic status, childhood adverse environment, childhood health and cognitive ability, one's own socioeconomic attainment, family formation and fertility behaviors.[11] The health outcomes were both subjective (e.g., self-report health status) and objective (e.g., total numbers of diagnosed chronic medical conditions and somatic symptoms in the past 6 months). The magnitude was small but robust.

Second, I found that, for health of the offspring in later adulthood, father's age and mother's age were equally good predictors, though father's age might appear to be a "better"

[11] They are also independent of risk factors in adulthood, e.g., smoking, problem drinking and obesity.

predictor than mother's age. Both were persistent and strong predictors of early socioeconomic achievement. Their associations with health might be largely due to social or psychological factors at birth, or even in prenatal stage which were not controlled in the analysis, for example, parental socioeconomic status at birth. I also argued that the timing of starting family explained the small but robust effects. The differences between effects of parental ages at the first birth and those at the respondent's birth were rejected in the preferred model. The significant and inverse relationships between birth order and health outcomes, however, suggested that the offspring of higher birth order tended not to be as healthy as that of lower birth order, after controlling for number of siblings ever born and parental ages at birth. That is, the advantage of advanced parental age was mainly due to the timing of family starting while the advantage would decrease with the increase of parental age.

Since I also did not find any effects of parental death before age 60, the selection of fecundity and parental health as a mechanism could not explain away the relative advantage of being born to older parents. Also, controlling for childhood health measures, the associations between parental age and health of elderly offspring sustained and did not change very much in the regression analysis. That is, the advantage of being born to parents who started family later rather than sooner could not be explained simply by the relationships between parental ages at birth and physical health in childhood.

The argument that parental age at birth was served as a proxy of unmeasured socio-psychological advantages of older parents might be part of the story. However, the current study did not deal with the issue of unmeasured family heterogeneity yet.

There are several ways to improve this study and our understandings on the relationships between parental ages at birth and health (or other outcomes) of the offspring in later adulthood. The birth weight would be a great indicator of health at birth. Though I controlled childhood health, but it was far from a perfect replacement of the birth weight. In the future, I plan to implement birth weight and other measures of childhood weight and health indicators into the models.

How to control for unmeasured heterogeneity is critical. I plan to employ sibling resemblance model for this purpose in a later stage of the project. To examine the relationship between parental age at birth and health (or other outcomes) of the offspring, sibling resemblance model can control for (partial) unmeasured heterogeneity, and it is also a great way to study the variation within the family, that is, birth order and parental age at birth in this case (Kuo and Hauser 1996; 1997).

Table 1. Descriptive statistics for dependent and selected independent variables

Variable	Mean	SD	Max	Min
Outcomes				
General health status 2004	3.78	0.97	5	1
Total Number of Illnesses 2004	3.20	2.34		
At top quartile of total number of illness 2004	0.25	0.43	1	0
Total number of symptoms 2004	3.70	3.79		
At top quartile of total number of symptoms 2	0.21	0.41	1	0
Cognitive ability, WAIS 6 items 2004	6.63	2.37		
At top quartile of WAIS (6 items) 2004	0.33	0.47	1	0
Key explanatory variables				
Father's age at first birth	27.44	5.52		
Father's age at respondent's birth	31.49	6.91		
Mother's age at first birth	23.65	4.77		
Mother's age at respondent's birth	27.65	5.94		
Basic control variables				
Sex of respondent (2:women; 1: men)	1.54	0.50	2	1
Number of siblings	2.96	2.24	11	0
Being first born	0.41	0.49	1	0
Family SES				
Family income in 1957	63.83	60.08		
Father's education	9.77	3.42		
Father's occupational status	3.47	2.32		
Mother's education	10.46	2.84		
Growing up with both parents	0.90	0.29	1	0
Other childhood variables				
Growing up with problem drinker	0.23	0.42	1	0
Growing up with 2 or more smokers	0.25	0.43	1	0
Verbal abused by parents	0.30	0.46	1	0
Physically abused by parents	0.32	0.47	1	0
IQ scores at jr/sr year	102.14	14.55		
Self-reported health status in childhood	4.28	0.84		
SES at 1993				
Highest schooling at 1993	13.68	2.30		
Family formation at 1993				
Ever divorced	0.09	0.28	1	0
Single	0.04	0.19	1	0
Age at first marriage	22.37	3.89		
Number of biological children	2.69	1.56		
Age at first child	23.74	3.83		

Table 2. Parental Age and Well-Being at Midlife, Bivariate Relationship				
Independent Variable	Maternal Age		Paternal Age	
	First Birth	R's Birth	First Birth	R's Birth
Dependent Variable				
BMI[a]	x	x	x	
General health status[b]	x	x	x	x
Comparison[c]	x	x	x	x
# of symptoms[d]	x	x		
# of conditions[e]	x	x	x	x
Neuroticism[f]	x	x		
Depression[g]	x	x	--	
Hostility[h]	x			
Cognitive Ability[i]	x	x	x	--
Age at first marriage[m]	x	x	x	x
Age at first birth[n]	x	x	x	x
Number of bio children[o]	x	x	x	x
Number of children[p]	x	x	x	x
Occ status -- first job[q]	x	x	x	x
Occ status -- 1975[r]	x	x	x	
Occ status -- 1992[s,t]	x/x	x/x	x/x	x/--
IQ in junior year[j]	x	x	x	--
HS grades[k]	x	x	x	x
Occ asp in senior year[l]	x	x	x	x

Note:

All functions also include a constant term.

x denotes p-values below 0.05 in 3 or more function forms.

-- denotes p-values below .05 in 2 or less function forms.

a. mother's age: p = .000/.001; father's age: p=.019 (p of S function =.008)/.106 (p of S =.067)

b. mother's age: p=.000/.001; father's age: p=.000/.007

c. mother's age: p=.000/.002; father's age: p=.003(p=.001 in inverse f)/.034(p=.015 in inverse f)

d. mother's age: p=.001/.008; father's age: p=.115/.204(p=.091 in quad)

e. mother's age: p=.001/.027; father's age: p=.004/.043(p=.038 in Inverse f)

f. mother's age: p=.002/.002; father's age: p=.103(p=.055 in S f)/.103(.054 in S)

g. mother's age: p=.035/.061(p=.024 in Inverse f); father's age: p=.842(.116 in quad f)/.849(.101 in quad)

h. mother's age: p=.005/.055; father's age: p=.691/.557

i. mother's age: p= .000/.004; father's age: p=.000/.057(.033 in Inverse f)

j. mother's age: p=.000/.000; father's age: p=.000/.374(.009 in cubic f)

k. mother's age: p=.000/.000; father's age: p=.000/.004 (.001 in S)

l. mother's age: p=.000/.000; father's age: p=.000/.287(.013 in quad & cubic fs)

m. mother's age: p=.000/.002; father's age=.000/.106(.004 in quad, .0101 in S & cubic)

n. mother's age: p=.000/.001; father's age: p=.000/.036 (.004 in quad & S fs, .007 in Invers)

o. mother's age: p=.000/.020 (p=.005 in quad f); father's age: p=.000/.042 (.015 in Inverse, .025 in cubic)

p. mother's age: p=.000/.018 (p=.004 in quad f); father's age: p=.000/.047 (.013 in quad, .015 in inverse)

q. mother's age: p=.000/.000; father's age: p=.000/.003(.000 in inverse, quad, cub)

r. mother's age: p=.000/.001; father's age: p=.000/.205(.084 in S, .097 in Inv)

s. mother's age: p=.000/.000; father's age: p=.000/.080(.013 in cub, .017 in inv)

t. mother's age: p=.000/.007(p=.001 in Inverse f); father's age: p=.000/.138 (.040 in Inv, .047 in cub)

Table 3. Adjusted relationships between each indicator of parental age at birth and health of the offspring at age 65

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Dependent Variable: Self-Reported Health Status

		First-born respondents				Later-born respondents							
		Equation 1		Equation 2		Equation 1		Equation 2		Equation 3		Equation 4	
		B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
1	Paternal age at r birth	0.006	0.003			0.003	0.002						
	Maternal age at r birth			0.005	0.004			0.002	0.003				
	Paternal age at first birth									0.013	0.003 ***		
	Maternal age at first birth											0.015	0.003 ***
2	Paternal age at r birth	0.006	0.004			0.009	0.003 **						
	Maternal age at r birth			0.004	0.004			0.008	0.003 *				
	Paternal age at first birth									0.011	0.003 ***		
	Maternal age at first birth											0.011	0.004 **
3	Paternal age at r birth	0.006	0.004			0.010	0.003 ***						
	Maternal age at r birth			0.001	0.004			0.008	0.003 *				
	Paternal age at first birth									0.010	0.003 ***		
	Maternal age at first birth											0.008	0.004 *
4	Paternal age at r birth	0.003	0.004			0.008	0.003 **						
	Maternal age at r birth			-0.004	0.004			0.005	0.003				
	Paternal age at first birth									0.009	0.003 **		
	Maternal age at first birth											0.007	0.004 *
5	Paternal age at r birth	0.003	0.004			0.008	0.003 **						
	Maternal age at r birth			-0.006	0.004			0.005	0.003				
	Paternal age at first birth									0.009	0.003 **		
	Maternal age at first birth											0.006	0.004
6	Paternal age at r birth	0.006	0.004			0.009	0.003 **						
	Maternal age at r birth			-0.002	0.005			0.007	0.003 *				
	Paternal age at first birth									0.009	0.003 **		
	Maternal age at first birth											0.007	0.004 *
7	Paternal age at r birth	0.005	0.004			0.008	0.003 **						
	Maternal age at r birth			-0.003	0.005			0.006	0.003				
	Paternal age at first birth									0.008	0.003 **		
	Maternal age at first birth											0.006	0.004
8	Paternal age at r birth	0.005	0.004			0.008	0.003 **						
	Maternal age at r birth			-0.004	0.005			0.006	0.003				
	Paternal age at first birth									0.008	0.003 **		
	Maternal age at first birth											0.005	0.004

Model 1: Baseline model included a single indicator of parental age at birth
Model 2: Controlling for sex, age, birth order (later born sample) and number of siblings ever born
Model 3: Controlling for parental educaiton, father's occupation, and family income in 1957
Model 4: Controlling for abuse, growing up wth problem dranker, grow up with parents as smokers
Model 5: Controlling for IQ at jr/sr year of high school and childhood health
Model 6: Controlling for parental age at death if applicable
Model 7: Controlling for educational attainment and family income in 1993
Model 8: Controlling for 1993 family and marriage variables

Table 3. Adjusted relationships between each indicator of parental age at birth and health of the offspring at age 65

		First-born respondents				Later-born respondents							
		Equation 1		Equation 2		Equation 1		Equation 2		Equation 3		Equation 4	
		B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Continued ...		Dependent Variable: Total Number of Diagnosed Medical Conditions											
1	Paternal age at r birth	-0.013	0.009			-0.002	0.006						
	Maternal age at r birth			-0.015	0.010			0.001	0.007				
	Paternal age at first birth									-0.029	0.007 ***		
	Maternal age at first birth											-0.034	0.008 ***
2	Paternal age at r birth	-0.016	0.009			-0.019	0.007 **						
	Maternal age at r birth			-0.021	0.011 *			-0.020	0.008 *				
	Paternal age at first birth									-0.029	0.007 ***		
	Maternal age at first birth											-0.035	0.009 ***
3	Paternal age at r birth	-0.016	0.009			-0.020	0.007 **						
	Maternal age at r birth			-0.017	0.011			-0.020	0.008 *				
	Paternal age at first birth									-0.029	0.007 ***		
	Maternal age at first birth											-0.035	0.009 ***
4	Paternal age at r birth	-0.008	0.009			-0.011	0.007						
	Maternal age at r birth			-0.008	0.011			-0.011	0.009				
	Paternal age at first birth									-0.022	0.007 **		
	Maternal age at first birth											-0.028	0.009 **
5	Paternal age at r birth	-0.009	0.009			-0.012	0.007						
	Maternal age at r birth			-0.007	0.011			-0.011	0.008				
	Paternal age at first birth									-0.022	0.007 **		
	Maternal age at first birth											-0.027	0.009 **
6	Paternal age at r birth	-0.012	0.009			-0.014	0.007						
	Maternal age at r birth			-0.012	0.011			-0.015	0.009				
	Paternal age at first birth									-0.023	0.007 **		
	Maternal age at first birth											-0.030	0.009 **
7	Paternal age at r birth	-0.011	0.009			-0.013	0.007						
	Maternal age at r birth			-0.010	0.011			-0.014	0.009				
	Paternal age at first birth									-0.022	0.007 **		
	Maternal age at first birth											-0.028	0.009 **
8	Paternal age at r birth	-0.010	0.009			-0.012	0.007						
	Maternal age at r birth			-0.009	0.011			-0.014	0.009				
	Paternal age at first birth									-0.021	0.007 **		
	Maternal age at first birth											-0.027	0.009 **

Model 1: Baseline model included a single indicator of parental age at birth
Model 2: Controlling for sex, age, birth order (later born sample) and number of siblings ever born
Model 3: Controlling for parental educaiton, father's occupation, and family income in 1957
Model 4: Controlling for abuse, growing up wth problem dranker, grow up with parents as smokers
Model 5: Controlling for IQ at jr/sr year of high school and childhood health
Model 6: Controlling for parental age at death if applicable
Model 7: Controlling for educational attainment and family income in 1993
Model 8: Controlling for 1993 family and marriage variables

Table 3. Adjusted relationships between each indicator of parental age at birth and health of the offspring at age 65

		First-born respondents				Later-born respondents							
		Equation 1		Equation 2		Equation 1		Equation 2		Equation 3		Equation 4	
		B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Continued ...		Dependent Variable: Total Number of Symptoms											
1	Paternal age at r birth	-0.049	0.014 **			-0.011	0.010						
	Maternal age at r birth			-0.051	0.017 **			0.005	0.012				
	Paternal age at first birth									-0.055	0.012 ***		
	Maternal age at first birth											-0.051	0.014 ***
2	Paternal age at r birth	-0.046	0.014 **			-0.033	0.012 **						
	Maternal age at r birth			-0.048	0.017 **			-0.015	0.014				
	Paternal age at first birth									-0.055	0.012 ***		
	Maternal age at first birth											-0.051	0.015 ***
3	Paternal age at r birth	-0.046	0.015 **			-0.034	0.012 **						
	Maternal age at r birth			-0.043	0.018 *			-0.014	0.014				
	Paternal age at first birth									-0.055	0.012 ***		
	Maternal age at first birth											-0.048	0.015 **
4	Paternal age at r birth	-0.031	0.015 *			-0.020	0.012						
	Maternal age at r birth			-0.025	0.018			0.003	0.014				
	Paternal age at first birth									-0.044	0.012 ***		
	Maternal age at first birth											-0.036	0.015 *
5	Paternal age at r birth	-0.033	0.015 *			-0.024	0.012 *						
	Maternal age at r birth			-0.028	0.018			-0.001	0.014				
	Paternal age at first birth									-0.045	0.012 ***		
	Maternal age at first birth											-0.036	0.015 *
6	Paternal age at r birth	-0.035	0.015 *			-0.026	0.012 *						
	Maternal age at r birth			-0.031	0.019			-0.005	0.015				
	Paternal age at first birth									-0.045	0.012 ***		
	Maternal age at first birth											-0.040	0.015 **
7	Paternal age at r birth	-0.035	0.015 *			-0.024	0.012 *						
	Maternal age at r birth			-0.028	0.019			-0.003	0.015				
	Paternal age at first birth									-0.043	0.012 ***		
	Maternal age at first birth											-0.037	0.015 *
8	Paternal age at r birth	-0.037	0.015 *			-0.022	0.012						
	Maternal age at r birth			-0.029	0.019			-0.002	0.015				
	Paternal age at first birth									-0.041	0.012 **		
	Maternal age at first birth											-0.034	0.015 *

Model 1: Baseline model included a single indicator of parental age at birth
Model 2: Controlling for sex, age, birth order (later born sample) and number of siblings ever born
Model 3: Controlling for parental educaiton, father's occupation, and family income in 1957
Model 4: Controlling for abuse, growing up wth problem dranker, grow up with parents as smokers
Model 5: Controlling for IQ at jr/sr year of high school and childhood health
Model 6: Controlling for parental age at death if applicable
Model 7: Controlling for educational attainment and family income in 1993
Model 8: Controlling for 1993 family and marriage variables

Table 4. Relationships between parental ages at birth and health of the offspring at age 65

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		First-born respondents			Later-born respondents					
		(1)			(2)			(3)		
		B	SE		B	SE		B	SE	
		Panel A. Dependent Variable: Self-Reported Health Status								
1	Paternal age at r birth	0.006	0.005		0.007	0.003	*			
	Maternal age at r birth	0.000	0.005		0.003	0.004				
	Paternal age at first birth							0.008	0.004	*
	Maternal age at first birth							0.006	0.004	
2	Paternal age at r birth	0.007	0.004		0.008	0.003	*			
	Maternal age at r birth	-0.009	0.005		-0.001	0.004				
	Paternal age at first birth							0.008	0.004	*
	Maternal age at first birth							0.001	0.004	
3	Paternal age at r birth	0.009	0.004	*	0.008	0.003	*			
	Maternal age at r birth	-0.011	0.005	*	-0.002	0.004				
	Paternal age at first birth							0.009	0.004	*
	Maternal age at first birth							-0.001	0.004	
4	Paternal age at r birth	0.009	0.004	*	0.008	0.003	*			
	Maternal age at r birth	-0.013	0.005	*	-0.002	0.004				
	Paternal age at first birth							0.008	0.003	*
	Maternal age at first birth							-0.002	0.004	
5	Paternal age at r birth	0.010	0.004	*	0.008	0.003	*			
	Maternal age at r birth	-0.015	0.005	**	-0.003	0.004				
	Paternal age at first birth							0.008	0.003	*
	Maternal age at first birth							-0.002	0.004	

Model 1: Baseline model included indicators of parental age at birth, controlling for sex, age, birth order (later born sample) and number of siblings ever born

Model 2: Controlling for parental educaiton, father's occupation, and family income in 1957

Model 3: Controlling for abuse, grow up with parents as smokers, and parental encouragement for college

Model 4: Controlling for IQ at jr/sr year of high school and childhood health

Model 5: Controlling for educational attainment and family income in 1993

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

To continue...

Table 4. Relationships between parental ages at birth and health of the offspring at age 65

		First-born respondents			Later-born respondents					
		(1)			(2)			(3)		
		B	SE		B	SE		B	SE	
Continued...		Panel B. Dependent Variable: Total Number of Diseases								
1	Paternal age at r birth	-0.009	0.011		-0.015	0.009	*			
	Maternal age at r birth	-0.014	0.013		-0.009	0.010				
	Paternal age at first birth							-0.018	0.009	*
	Maternal age at first birth							-0.022	0.011	*
2	Paternal age at r birth	-0.008	0.011		-0.010	0.009	*			
	Maternal age at r birth	-0.003	0.013		-0.005	0.010				
	Paternal age at first birth							-0.014	0.009	*
	Maternal age at first birth							-0.020	0.011	
3	Paternal age at r birth	-0.010	0.011		-0.012	0.008	*			
	Maternal age at r birth	-0.001	0.013		-0.004	0.010				
	Paternal age at first birth							-0.015	0.009	*
	Maternal age at first birth							-0.018	0.011	
4	Paternal age at r birth	-0.009	0.011	*	-0.011	0.009	*			
	Maternal age at r birth	0.000	0.013		-0.003	0.010				
	Paternal age at first birth							-0.014	0.009	*
	Maternal age at first birth							-0.017	0.011	
5	Paternal age at r birth	-0.011	0.011	*	-0.011	0.008	*			
	Maternal age at r birth	0.002	0.013		-0.003	0.010				
	Paternal age at first birth							-0.013	0.009	*
	Maternal age at first birth							-0.017	0.011	

Model 1: Baseline model included indicators of parental age at birth, controlling for sex, age, birth order (later born sample) and number of siblings ever born

Model 2: Controlling for parental educaiton, father's occupation, and family income in 1957

Model 3: Controlling for abuse, grow up with parents as smokers, and parental encouragement for college

Model 4: Controlling for IQ at jr/sr year of high school and childhood health

Model 5: Controlling for educational attainment and family income in 1993

* p < 0.05; ** p < 0.01; *** p < 0.001

To continue...

Table 4. Relationships between parental ages at birth and health of the offspring at age 65

		First-born respondents			Later-born respondents				
		(1)			(2)			(3)	
		B	SE		B	SE		B	SE	
Continued...		Panel C. Dependent Variable: Total Number of Symptoms								
1	Paternal age at r birth	-0.034	0.018		-0.039	0.015	*			
	Maternal age at r birth	-0.023	0.022		0.013	0.017				
	Paternal age at first birth							-0.046	0.015	*
	Maternal age at first birth							-0.018	0.018	
2	Paternal age at r birth	-0.033	0.018		-0.036	0.015	*			
	Maternal age at r birth	-0.007	0.022		0.026	0.018				
	Paternal age at first birth							-0.042	0.015	*
	Maternal age at first birth							-0.009	0.018	
3	Paternal age at r birth	-0.034	0.018		-0.038	0.014	*			
	Maternal age at r birth	-0.007	0.022		0.024	0.017				
	Paternal age at first birth							-0.043	0.015	*
	Maternal age at first birth							-0.007	0.018	
4	Paternal age at r birth	-0.036	0.018	*	-0.036	0.014	*			
	Maternal age at r birth	-0.003	0.022		0.025	0.017				
	Paternal age at first birth							-0.042	0.015	*
	Maternal age at first birth							-0.005	0.018	
5	Paternal age at r birth	-0.040	0.018	*	-0.036	0.014	*			
	Maternal age at r birth	0.002	0.022		0.026	0.017				
	Paternal age at first birth							-0.039	0.015	*
	Maternal age at first birth							-0.005	0.018	

Model 1: Baseline model included indicators of parental age at birth, controlling for sex, age, birth order (later born sample) and number of siblings ever born

Model 2: Controlling for parental educaiton, father's occupation, and family income in 1957

Model 3: Controlling for abuse, grow up with parents as smokers, and parental encouragement for college

Model 4: Controlling for IQ at jr/sr year of high school and childhood health

Model 5: Controlling for educational attainment and family income in 1993

* p < 0.05; ** p < 0.01; *** p < 0.001

Figure 1. Two-Group Baseline MIMIC Model, Parental Ages at Birth and Health of Offspring at Age 65, WLS

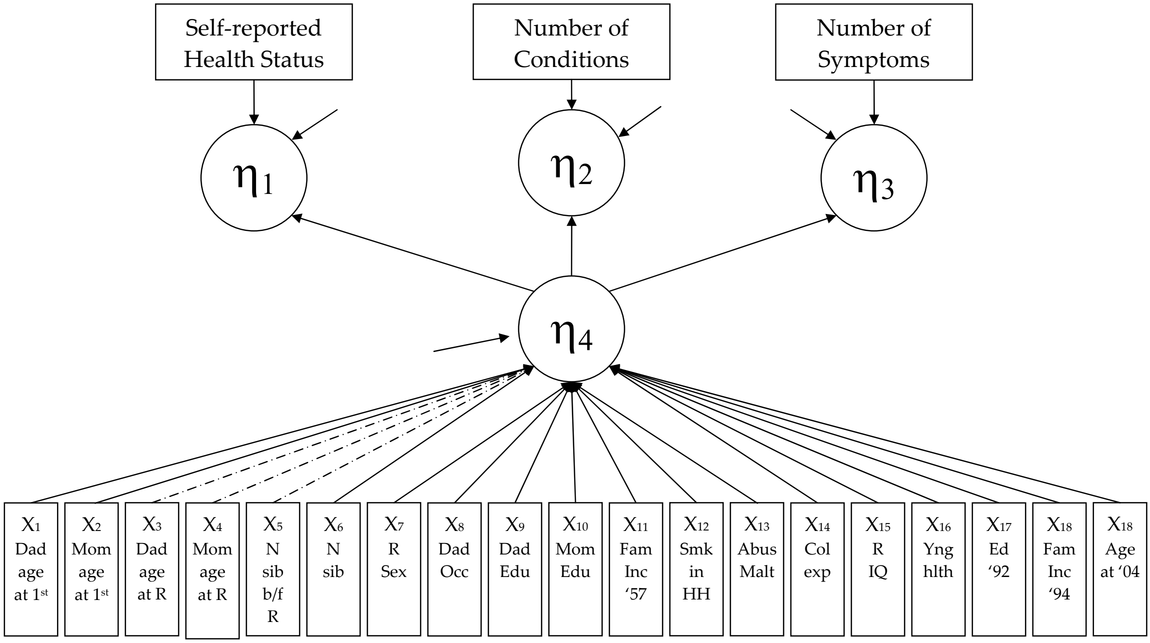

Figure 2. Preferred Model of Parental Ages at Birth and Health of Offspring at Age 65, WLS

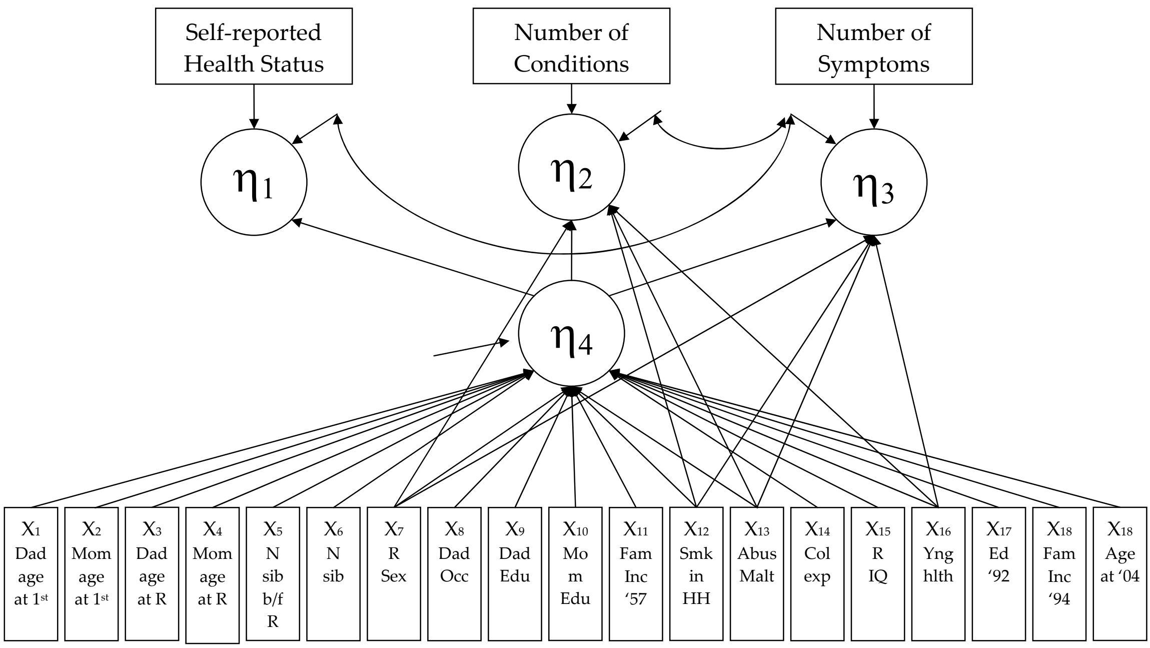

Table 5. Goodness of fit statistics for MIMIC models estimating relationships between parental ages at birth and health of the offspring at age 65

	Model specification	χ^2	*df*	*bic*
Baseline	A standard 2-group MIMIC model with pseudo-values for missing parameters and moments in the first-born group	759.97	79	101.77
Model 1	Baseline + cross-group 'invariant' constraints in corresponding parameters between first-born and later born groups	790.47	101	-51.02
Model 2	Model 1 + estimating ζ(health,symptoms) and ζ(illness,symptoms)	281.68	99	-543.15
Model 3	Model 2 + estimating γ(sex,symptoms), γ(sex,illness), γ(smokers,symptoms), γ(smokers,illness), γ(abuse,symptoms), γ(abuse,illness), γ(health in childhood,symptoms) and γ(health in childred,illness)	136.52	91	-621.65
Model 4	Model 3 + γ(paternal age at first birth, health) = γ(maternal age at first birth, health), and γ(paternal age at birth, health) = γ(maternal age at birth, health)	140.64	93	-634.20
Model 5	Model 3 + γ(paternal age at first birth, health) = γ(paternal age at birth, health), and γ(paternal age at first birth, health) = γ(maternal age at birth, health)	136.60	93	-638.24
Model 6	Model 3 with equality constraints between all measures of parental age at (first) birth.	**140.79**	**94**	**-642.38** ✔

γ indicates the estimated coefficients between two variables in the paratthese.

ζ indicates the covariance of the error terms between two latent factors.

Table 6. Estimated coefficients of explanatory variables on health outcomes in the preferred model

	Dependent Variables								
	General Health			Illness			Symptoms		
Independent Variables	Coef.	S.E.		Coef.	S.E.		Coef.	S.E.	
Dad age, first birth	-0.014	0.006	*						
Mom age, first birth	-0.014	0.006	*						
Dad age at birth	-0.014	0.006	*						
Mom age at birth	-0.014	0.006	*						
R's birth order	0.027	0.012	*						
R's # of siblings, ever born	-0.008	0.008							
Sex	-0.064	0.030	*	0.338	0.064	***	0.860	0.102	***
R's age in 2004	0.060	0.003	***						
Dad's education, 1957	-0.005	0.005							
Dad's occupation, 1957	-0.001	0.008							
Mom's education, 1957	-0.008	0.006							
Family income, 1957	0.001	0.003							
Growing up with smokers	0.072	0.034	*	0.231	0.074	**	0.278	0.119	*
Being abused in childhood	0.068	0.032	*	0.424	0.071	***	0.730	0.114	***
Parental expectation for college	-0.105	0.034	***						
IQ in high school	-0.080	0.113							
Health in childhood	-0.142	0.018	***	-0.085	0.029	*	-0.281	0.047	***
Education at age 55	-0.047	0.008	***						
Family income at age 55	-0.002	0.001	**						

* p value < 0.05
** p value < 0.01
*** p value < 0.001