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Childhood heart problems, adulthood emotional stability and sex associated with self-report heart conditions in adulthood

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Abstract

Objective: To investigate biomedical, social, and psychological factors associated with self-reported heart conditions in adulthood in a British cohort.

Method: In total, 5697 (50.7% males) participants with data on parental socioeconomic status, childhood cognitive ability, childhood heart problems, educational qualifications, current occupational levels, adulthood personality traits, and the prevalence of self-reported heart conditions in adulthood were included in the study. The prevalence of self-reported heart conditions measured at age 54 was the outcome variable.

Results: Logistic regression analysis showed that childhood heart problems identified by physicians (OR=3.47: 1.74-6.92, $p<.001$) and trait emotional stability (OR=0.83: 0.75-0.93, $p<.001$) were the significant and independent predictors of self-reported heart conditions in adulthood. There were also significant sex effects on the prevalence of the outcome variable (OR=0.53: 0.42-0.63, $p<.001$). Both a biomedical and a psychological factor were significantly associated with self-reported heart conditions in adulthood.

Key words: Heart Conditions in Adulthood; Childhood Heart Problems; Childhood Cognitive Ability; Adulthood Personality Traits; Longitudinal; UK

Introduction

Although cardiovascular disease (heart and circulatory) mortality in the UK is declining, the disease causes more than a quarter (26 per cent) of all deaths in the UK (Bhatnagar, Wickramasinghe, Wilkins, Townsend, 2016). Heart conditions, such as heart attack (myocardial infarction), coronary heart disease, angina, congestive heart failure, have been found to be associated with depression (Carney, Freedland, Sheline, & Weiss, 1997; Dawood, Lambert, Barton, & Lambert, 2008; Summers, Martin, & Watson, 2010), mental stress (Esler, Lambert, & Alvarenga, 2008a; Esler, Schwarz, & Alvarenga, 2008b; Goble & Le Grande, 2008), pessimism (Pänkäläinen, Kerola, & Hintikka, 2015; Pänkäläinen, Kerola, Kampman, Kauppi, & Hintikka, 2016) as well as personality traits (McCann, 2014; Jokela, Pulkki-Råback, Elovainio, & Kivimäki, 2014; Almas, Moller, Iqbal, & Forsell, 2017; Čukić & Bates, 2015).

Personality traits, especially traits neuroticism (adversely) and conscientiousness (protectively) have been found to be associated with various health outcomes (Martin, Friedman, & Schwartz, 2007; Bogg & Roberts, 2004; Roberts, Walton, & Bogg, 2005; Koelsch, Enge, & Jentschke, 2012). Trait neuroticism has also been found to be associated with cardiovascular disease, stroke and coronary heart disease and mortality (McCann, 2014; Jokela, et al., 2014; Almas, et al., 2017; Čukić & Bates, 2015).

Using a large sample, one study examined the relations between state-aggregated responses to the neuroticism items of the Big Five Inventory and age-adjusted heart disease mortality rates for the 50 states in the US (McCann, 2014). Partial correlations (controlling for a set of demographic variables and other risk variables) showed that neuroticism correlated significantly with heart disease mortality. Hierarchical regression showed that neuroticism has accounted for an additional significant 4.6% of heart disease mortality variance, suggesting

higher neuroticism is associated with higher heart disease mortality when a set of demographic and risk variables are controlled.

In another study which examined the associations between personality traits and coronary heart disease (Jokela, et al., 2014), participants were pooled from three prospective cohort studies (Health and Retirement Study, Wisconsin Longitudinal Study graduate and sibling samples). Results showed that high neuroticism was significantly related to the risk of coronary heart disease, and higher conscientiousness was related to lower risk of coronary heart disease.

A number of studies have attempted to examine the biological processes between personality traits and physiological conditions such as CVD. One study investigated whether amplitude patterns of the electrocardiogram (ECG) waves correlate with the NEO Five Factor Inventory in a sample of 425 healthy individuals (university students aged between 18 and 33 years, excluding individuals with previous diagnosis of any CVD, or any mental or psychiatric disorder) (Koelsch, Enge, & Jentschke, 2012). Results showed that individuals with lower E_k values had significantly higher neuroticism and lower positive emotion. These results, as the authors claimed, were the first to demonstrate that ECG amplitude patterns provide information about the personality of an individual as measured with NEO personality inventory (Koelsch, et al., 2012).

One study examined the associations between temperament (personality related factors) traits and autonomic cardiac regulation (measured by heart rate and heart rate variability) in a resting situation. It was found that harm avoidance was associated with lower level of high-frequency variation and the higher heart rate, suggesting that harm avoidance is related to low parasympathetic activity. Which in turn, is linked with various health problems including increased coronary heart disease incidence (Puttonen, Elovainio, Kivimäki, Koskinen, Pulkki-Råback, Viikari, . . . Keltikangas-Järvinen, 2008).

Using a clinical sample of long QT syndrome (LQTS) mutation carriers from the Finnish LQTS registry, and individuals from a representing general population (the Young Finns Study) serving as control subjects, Määttänen and colleagues found the significant association between the LQTS mutation carriers and their harm avoidance (HA) temperament (Määttänen, Hintsanen, Toivonen, Swan, Pulkki-Råback, Hintsanen, . . . Keltikangas-Järvinen, 2011). The long QT syndrome (LQTS) is an inherited cardiac disorder which predisposes the mutation carrier to ventricular arrhythmias and sudden cardiac arrest. The study concluded that LQTS mutation carriers may have higher stress proneness because of their high HA, which in turn may predispose them to the effects of environmental loading and thus increase the risk of arrhythmias (Määttänen, et al., 2011). These findings may indicate that altered cortisol levels or activation of autonomic nervous system could explain the found associations.

Neuroticism and depression are strongly inter-correlated (Eaves, Eysenck, & Martin, 1989; Cheng & Furnham, 2003), and there seem to have common genetic covariation between neuroticism and the symptoms of anxiety and depression (Jardine, Martin, Henderson, Rao, 1984; Hettema, JAn, Neale, Bukszar, van den Oord, Kendler, & Chen, 2006).

The relationship between neuroticism, depression and cardiovascular disease (CVD) is complex. A recent study set out to determine whether neuroticism is an effect-modifier in the association between depression and cardiovascular disease. Data derived from a longitudinal cohort study on mental health in Sweden. Results showed that both depression and high levels of neuroticism were associated with increased risk of CVD (Almas, et al., 2017).

Another study addressed the extent to which neuroticism accounted for the excess heart disease risk associated with depression and tested whether cardiac autonomic tone (measured by heart rate variability) plays a role as mediator (Čukić & Bates, 2015). Participants were derived from the MacArthur Foundation Survey for Midlife Development in the U.S cohort (MIDUS) follow-up study. Results showed that higher neuroticism was associated with

reduced heart rate variability equally under rest and stress. The baseline structural equation model revealed significant paths from neuroticism to heart rate variability, cardiovascular disease and depression, and between depression and cardiovascular disease. Dropping either neuroticism to heart rate variability, or neuroticism to heart disease paths significantly reduced the model fit ($p < .001$ in each case), suggesting that neuroticism has independent associations with both heart rate variability and cardiovascular disease, over and above its associations with depression and other related variables.

Childhood intelligence has been found to be strongly associated with educational achievement and occupational attainment (Deary & Johnson, 2010). Childhood intelligence is also associated with health outcomes such as type 2 diabetes (Olsson, Hultin, & Montgomery, 2008), adult obesity (Chandola, Deary, Blane, & Batty, 2006), and coronary heart disease and stroke risk in adulthood (Batty, Mortensen, Nybo Andersen, & Osler, 2005).

The link between socio-economic conditions and health outcomes have been well documented (Marmot, 2007; Wilkinson & Pickett, 2006). There is also evidence that occupational stress is associated with cardiovascular disease (Byrne & Espnes, 2008). In general, socio-economic deprivation in childhood, lower occupational levels, and lower childhood cognitive ability are all associated with adult health outcomes and mortality risk.

The Present Study

The present study investigates biomedical, social, and psychological factors in childhood and adulthood associated with self-reported heart conditions in adulthood in a British cohort. Comparing with previous studies in the area there are two advantages of the data used for the present study: It is a large, nationally representative birth cohort with both childhood and adulthood measures, and all covariates, except the current occupation, were measured from 4 years to 54 years earlier; and it contains intelligence and personality, the two main components

of individual differences, together with a set of sociodemographic variables in childhood and adulthood. As intelligence and personality traits are inter-correlated (Furnham, 2008), this study is able to ascertain whether each of the components of individual differences is independently associated with adult heart conditions.

Hypotheses

Based on the literature reviewed above, it was hypothesised that parental social class would be significant and negatively associated with heart conditions in adulthood (H1); childhood heart problems would be significantly associated with heart conditions in adulthood (H2); childhood cognitive ability would be significantly and negatively associated with heart conditions in adulthood (H3); adulthood trait emotional stability would be significantly and negatively associated with heart conditions in adulthood (H4) and adulthood trait conscientiousness would be significantly and negatively associated with the outcome variable (H5).

Method

Sample

The National Child Development Study (the 1958 British birth cohort) is a large-scale longitudinal study of the 17,415 individuals who were born in Great Britain in a week in March 1958 (Ferri, Bynner, & Wadsworth, 2003; Butler & Bonham, 1963). The following analysis is based on data collected at birth, at ages 7, 11, 33 and 54 years. Information of heart problems in childhood was provided at age 7 years. Children at age 11 years completed tests of cognitive ability. At the age 33 years respondents provided information on educational qualifications. At age 50 years, participants completed a questionnaire on personality traits. At the age of 54 years, cohort members provided information on the prevalence of heart conditions. Participants

also provided information on their current occupational levels. The analytic sample comprises 5,697 cohort members (50.7% males) with complete data. Analysis of response bias in the cohort data showed that the achieved adult samples did not differ from their target sample across a number of critical variables (social class, parental education and sex), despite a slight under-representation of the most disadvantaged groups. Bias due to attrition of the sample during childhood has been shown to be minimal (Plewis, Calderwood, Hawkes, Nathan, 2004).

Measures

1. *Parental Social Class at Birth* was measured by the Registrar General's measure of social class (RGSC). RGSC is defined according to occupational status and the associated education, prestige or lifestyle (Marsh, 1986) and is assessed by the current or last held job. Where the father was absent, the social class (RGSC) of the mother was used. RGSC was coded on a six-point scale: I professional; II managerial/tech; IIIN skilled non-manual; IIIM skilled manual; IV semi-skilled; and V unskilled occupations (Leete & Fox, 1977);
2. *Childhood Heart Problems* At birth mothers were interviewed and provided information on gestational age and birth weight (used as the control variables in the study), and mothers were interviewed again when participants were at age 7 years on whether cohort members ever had heart problems diagnosed by physicians by the time of interview;
3. *Childhood Cognitive Ability* Childhood cognitive ability was assessed at age 11 years in school using a general ability test (Douglas, 1964) consisting of 40 verbal and 40 non-verbal items. For the verbal items, children were presented with an example set of four words that were linked either logically, semantically, or phonologically. For the non-verbal tasks, shapes or symbols were used. The children were then given another

set of three words or shapes or symbols with a blank. Participants were required to select the missing item from a list of five alternatives. Scores from these two set of tests correlate strongly with scores on an IQ-type test used for secondary school selection ($r=0.93$, Douglas, 1964) suggesting a high degree of validity.

4. *Educational Qualifications* At age 33 years, participants were asked about their highest academic or vocational qualifications. Responses are coded to the six-point scale of National Vocational Qualifications levels (NVQ) which ranges from 'none' to 'university degree/higher/equivalent NVQ 5 or 6;
5. *Adulthood Personality Traits* were assessed at age 50 years by the 50 questions from the International Personality Item Pool (IPIP) (Goldberg, 1999). Responses (5-point, from "Strongly Agree" to "Strongly Disagree") are summed to provide scores on the 'Big-Five' personality traits: Extraversion, Emotional Stability/Neuroticism, Conscientiousness, Agreeableness, and Intellect/Openness. Alphas for the Big-Five factors ranged from .73 to .88. A preliminary test shows Extraversion, Emotional Stability/Neuroticism, Conscientiousness are significantly associated with the outcome variable. Therefore only these three personality traits are included in the following analyses;
6. *Own Current Social Class* At age 54 years, data on current or last occupation held by cohort members were coded according to the Registrar General's Classification of Occupations (RGSC), using a 6-point classification described above;
7. *Adulthood Self-reported Heart Conditions* At age 54 years, participants answered the question about whether they suffered heart conditions (heart attack/coronary heart disease/angina/congestive heart failure etc.) with Yes/No response. In addition, 4.1% of the total cohort members who answered "Yes" to the previous question also answered a question on the specific heart problems they suffered: That they had heart

attack (17.7%); coronary heart disease (16.6%); angina (18.2%); congestive heart failure (3.1%); and other heart problems (63.4%). The response of general (non-specific) heart conditions was used as the outcome variable.

Statistical Analysis

To investigate the set of psychological, biomedical, and socio-demographic factors associated with the prevalence of self-reported heart conditions in adulthood, first, the characteristics of the study population and sex differences in self-reported heart conditions in adulthood were examined using Chi-square Test. Second, correlation matrix were prepared examining the bivariate associations between the measures used in the study. Third, the hierarchical logistic regression analyses was conducted using STATA version 14 with heart conditions at age 54 as the dependent variable. Model 1 examined the effects of childhood factors on heart conditions at age 54 years; Model 2 examined the associations between adult social and psychological factors and the outcome variable, together with the childhood factors. Gestational age and birth weight were controlled in both Models, as findings show the link between these conditions and health outcomes (Boyle, Poulsen, Field, Kurinczuk, Wolke, Alfirevic, & Quigley, 2012; Vohr, Wright, Dusick, Mele, Verter, Steichen, . . . Kaplan, 2000).

Results

Descriptive Analysis

The prevalence of heart conditions at age 54 was 4.1% (5.4% for men and 2.7% for women). The chi-square test showed that there were sex differences in the prevalence of heart conditions in adulthood ($\chi^2 (1, N=5697) = 26.20, p < .001$). The prevalence of childhood heart problems by

the age 7 years was 1.0% for boys and 0.8% for girls. There were no statistical significant differences on the rate of heart problems between boys and girls by the age of 7 years.

Table 1 shows the characteristics of the study population according to prevalence of heart conditions at age 54 years. It shows that compared with cohort members from managerial or professional family background, cohort members from unskilled or partly skilled family background appeared to have greater prevalence of heart conditions in adulthood. But there seemed to have no clear pattern on the associations between educational qualifications or occupational levels and the outcome variable.

Correlation Analysis

Pearson correlation coefficients of the variables in the study are shown in Supplement 1. Heart conditions measured at age 54 was significantly and negatively associated with parental social class, childhood cognitive ability, and sex, and was positively associated with heart problems by the age of 7 years diagnosed by physicians. Personality traits extraversion, emotional stability, and conscientiousness in adulthood were also significantly and negatively associated with the outcome variable ($p < .05$ to $p < .001$).

Regression Analysis

Table 2 shows the results of hierarchical logistic regression analyses using heart conditions at age 54 years as the dependent variable.

Model 1 shows that among childhood factors, childhood heart problems diagnosed by physicians by age 7 years (OR=3.47: 1.74-6.92, $p < .001$) and childhood cognitive ability accessed at age 11 years (OR=0.88: 0.80-0.99, $p < .05$), and sex (OR=0.53: 0.42-0.63, $p < .001$) were significantly associated with self-reported heart conditions at age 54 years.

Model 2 shows that after entering adult social and personality variables into the equation, childhood heart problems and sex remained the significant predictors, but childhood cognitive ability ceased to be a significant predictor. And among all adulthood factors, emotional stability was the only significant predictor of the outcome variable in adulthood (OR=0.83: 0.75-0.93, $p < .001$). Thus hypotheses 2 and 4 were supported but hypotheses 1, 3 and 5 were partially supported (in the correlation matrices) as they were not the significant predictors of the outcome variable in the final regression model. Regression analysis has the advantage over correlation for controlling for other factors.

Discussion

This study investigated biomedical, social, and psychological factors associated with self-reported heart conditions in adulthood in a British birth cohort. Among all factors measured in childhood and adulthood, three factors childhood heart problems diagnosed by physicians, adulthood emotional stability as well as sex were significantly associated with self-reported heart conditions in adulthood. The results of the study confirm and extend the previous findings in the area, showing that both a biomedical factor and a psychological factor are associated with heart conditions in adulthood.

First, cohort members who suffered heart problems are more than three times likely to report heart problems in adulthood. This shows the long term effect of biomedical conditions on health outcomes, which is not unexpected.

Second, emotionally more stable individuals have better strategy coping with stress whereas emotionally less stable individuals, with the features of negative affect and pessimism, tend to have greater prevalence of mental and physical health problems (Chapman, Roberts, & Duberstein, 2011), and various heart diseases (McCann, 2014; Jokela, et al., 2014; Almas, et al., 2017; Čukić & Bates, 2015). Although heart problems in adulthood may not be caused by

adulthood emotional instability, higher scores on this trait may make those who have such conditions suffer more and delay the recovering process. On the other hand, cardiovascular disease can result, for example, in depression. Therefore, there could be influences in both directions.

Third, childhood cognitive ability has a protective effect on adult heart conditions when only look at childhood factors. The effect is no longer significant after taking adult social and personality factors into account. This in part, might be due to the inter-correlations between childhood intelligence and education and occupation and between childhood intelligence and adult personality. One of the explanations could be that the associations between the dependent variable and the independent variables were rather modest and as a result, when more variables were entered into the model, the minor effect of each independent variable on the outcome variable was further weakened. Future studies in clinical samples (with diagnosed and more acute CVD patients) are required to confirm or refute the findings in the current study.

Fourth, there appears to have sex differences of the prevalence of heart conditions in adulthood. Men tend to have a greater rate of heart conditions compared with women (Bhatnagar, Wickramasinghe, Williams, Rayner, & Townsend, 2015). This is in line with the results of a recent study which suggest that men are inherently more susceptible to heart disease than women (Beltrán-Sánchez, Finch, & Crimmins, 2015). The reason for this finding, however, is not clear. There is some evidence showing that cardiovascular disease develops 7 to 10 years later in women than in men and is still the major cause of death in women (Maas, & Appelman, 2010). One of the explanations is that estrogen offers women some protection from heart disease until after menopause, when estrogen levels drop. Hence, the rates of heart conditions may alter for men and women in later follow-ups (Maas, & Appelman, 2010). Future studies are required to clarify these sex differences.

Although enhancing emotional stability through, for example, cognitive therapy (Beck, 1979; Miller, 1991; van Montfort, Denollet, Widdershoven, & Kupper, 2016; Zinbarg, Uliaszek, Adler, 2008) may not cure heart diseases, it may help prevent the worsening of heart conditions by reducing negativity and pessimism that associated with trait neuroticism. The therapeutic interventions and treatment might be more effective for individuals who suffer from heart conditions when taken personality into account.

Limitation and suggestions for future research

Although our study is based on a birth cohort with representative sample, the attrition of respondents over time was greater among the socioeconomically disadvantaged groups. Our results may thus be a conservative estimate of the long term influence of social inequalities experienced during childhood. Moreover, the outcome variable of the current study is by self-report rather than by medical professionals, though research in self-reported health has found to be linked to mortality (Heistaro, Jousilahti, Lahelma, Puska, 2001; Kaplan & Camacho, 1983). Furthermore, it would be very desirable to have had personality traits and intelligence measured more than once, so that the stability and change of these factors in relation to the outcome variable could be investigated, though there is considerable evidence of the stability of personality and intelligence over time. This study is based on a British cohort, and may not be representative in other countries.

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Table 1. Characteristics of the study population according to the prevalence of heart conditions at age 54 years.

			Heart conditions
	n	%	%
Sex			
Male	2889	50.7	5.4
Female	2808	49.3	2.7
<i>Parental social class at birth</i>			
Unskilled (V)	413	7.2	5.3
Partly skilled (IV)	665	11.7	4.5
Skilled manual (III)	2772	48.7	3.9
Skilled non-manual (III)	638	11.2	5.0
Managerial\tech (II)	884	15.5	3.2
Professional (I)	325	5.7	4.0
<i>Educational qualifications at age 33</i>			
No qualifications	402	7.1	4.0
CSE 2-5/equivalent NVQ1	640	11.2	3.0
O Level/equivalent NVQ2	2001	35.1	4.1
A level/equivalent NVQ 3	868	15.2	4.7
Higher qualification/equivalent NVQ4	903	15.9	5.0
University degree/equivalent NVQ 5, 6	883	15.5	3.5
<i>Own current social class</i>			
Unskilled (V)	120	2.1	4.2
Partly skilled (IV)	668	11.7	3.9
Skilled manual (III)	1009	17.7	5.6
Skilled non-manual (III)	1037	10.0	2.8
Managerial\tech (II)	2373	41.7	4.1
Professional (I)	390	6.8	4.4

Table 2. Odds ratios (95% CI) for heart conditions at age 54, according to parental social class, childhood heart problems, childhood cognitive ability, educational qualifications and occupation levels, personality traits extraversion, conscientiousness and emotional stability.

<i>Measures</i>	Model 1		Model 2	
	Odds ratio (95% CI)	<i>p</i>-value	Odds ratio (95% CI)	<i>p</i>-value
Sex	0.62 (0.50, 0.77)***	<.001	0.53 (0.42, 0.68)***	<.001
<i>Parental social class at birth (unskilled as reference group)</i>				
Partly skilled	0.94 (0.61, 1.44)	0.763	0.95 (0.61, 1.46)	0.800
Skilled manual	0.71 (0.50, 1.03)	0.067	0.71 (0.49, 1.03)	0.069
Skilled non-manual	0.85 (0.53, 1.33)	0.447	0.86 (0.54, 1.37)	0.520
Managerial\tech	0.66 (0.42, 1.04)	0.076	0.68 (0.43, 1.07)	0.097
Professional	0.68 (0.37, 1.28)	0.199	0.70 (0.38, 1.30)	0.165
Childhood heart problems by age 7	3.59 (1.82, 7.03)***	<.001	3.47 (1.74, 6.92)***	<.001
Childhood cognitive ability at age 11	0.88 (0.80, 0.99)*	0.027	0.91 (0.81, 1.03)	0.147
<i>Educational qualifications (no qualification as reference group) at age 33</i>				
CSE 2-5/equivalent NVQ1			0.86 (0.55, 1.34)	0.499
O Level/equivalent NVQ2			0.93 (0.63, 1.36)	0.700
A level/equivalent NVQ 3			0.98 (0.62, 1.53)	0.926
Higher qualification/equivalent NVQ4			1.09 (0.69, 1.71)	0.714
University Degree/equivalent NVQ 5, 6			0.73 (0.43, 1.23)	0.236
<i>Current social class (unskilled as reference group) at age 54</i>				
Partly skilled			1.02 (0.37, 2.72)	0.973
Skilled manual			1.19 (0.46, 3.07)	0.721
Skilled non-manual			0.85 (0.32, 2.27)	0.754
Managerial\tech			1.14 (0.44, 2.93)	0.779
Professional			1.30 (0.45, 3.74)	0.624
<i>Personality factors at age 50</i>				
Extraversion			0.92 (0.82, 1.04)	0.175
Conscientiousness			0.93 (0.83, 1.05)	0.213
Emotional stability			0.87 (0.75, 0.93)***	<0.001

Note: * $p < .05$; *** $p < .001$. Adjusted for gestational age and birth weight.