Associations between childhood biomedical factors, maternal smoking, personality traits, Body and Mass Index, and the prevalence of asthma in adulthood

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Highlights

1. This was a longitudinal study based on over 5000 participants from a birth cohort in Britain, the National Child Development Study 1958.
2. Our interest was in the associations between adult asthma and a set of biomedical and psychological factors in childhood and adulthood.
3. Childhood asthma and respiratory symptoms, maternal smoking, BMI, traits neuroticism and conscientiousness were all significantly associated with adult asthma.
4. The study shows that both biomedical and psychological factors are associated with the prevalence of asthma in adulthood.

Abstract

The study set out to investigate socio-economic, biomedical, health and behavioural, and psychological factors in childhood and adulthood associated with the prevalence of asthma in adulthood, drawing data from The National Child Development Studies (NCDS), a birth cohort in the UK. The National Child Development Study, a nationally representative sample of 17,415 babies born in Great Britain in 1958 and followed up at 7, 11, 33, and 50 years was used. The prevalence of asthma at aged 50 was the outcome measure. The analytic sample consists of 5,118 participants with complete data on a set of measures at birth, at ages 7, 11, 33, and 50 years. Using logistic regression analyses, results showed that childhood asthma (OR=6.77: 4.38-10.48, $p<.001$) and respiratory symptoms (OR=1.83: 1.18-2.86, $p<.01$), maternal smoking during pregnancy (OR=1.26: 1.00-1.59, $p<.05$), Body and Mass Index (BMI) (OR=1.03: 1.02-1.05, $p<.001$), traits neuroticism (OR=1.13: 1.01-1.21, $p<.05$) and conscientiousness (OR=0.76: 0.76-0.96, $p<.01$), as well as sex (OR=1.49: 1.15-1.94, $p<.001$) were all significantly associated with the prevalence of asthma in adulthood. The study shows that both childhood and adulthood factors are significantly associated with the prevalence of asthma in adulthood.

Declaration of interests

None.

Keywords: Asthma; Respiratory Symptoms; Maternal Smoking; BMI; Traits Conscientiousness and Neuroticism; Cross-Sectional and Longitudinal

Introduction

Various studies have looked at personality correlates of health outcomes [1-3]. A number of studies have examined the associations between personality and asthma. However, the literature on this is scarce and inconsistent. In a clinical sample of 187 patients with asthma (67 adults with severe prednisone-dependent, 47 with severe non-prednisone dependent and 73 patients with mild-moderate asthma) using the NEO Five-Factor Inventory (NEO-FFI), Amelink and colleagues [4] found, with respect to personality traits, differences in patients with severe prednisone-dependent asthma and the other groups; severity and prednisone-dependency were not related to personality constructs or traits [5]. In another study with a sample of 193 adults, it was found that asthma is linked to higher impulsivity (a component of extroversion) scores on the Karolinska Scales of Personality (KSP) [6]. Yet, in a population-based sample of 5114 middle-aged adults using a German version of the Eysenck Personality Inventory, Loerbroks and colleagues [7] showed that trait neuroticism increased the risk of asthma, but extraversion did not. In regards to the initial onset of adult asthma, based on a large dataset (n=11000) with the abbreviated Eysenck Personality Inventory (EPI), Huovinen and colleagues found no significant associations between neuroticism and the onset of asthma for either males or females [8] but for females, a high extroversion score is a significant predictor of onset of asthma.

Whilst it is unclear whether a direct link exists between personality traits and asthma, there is evidence for personality traits as a mediator for asthma severity. For example, using a sample of 405 12 to 16-year-olds with asthma, a study [9] showed that increased quality of life within asthmatics is mediated by personality traits such as lower neuroticism and higher extraversion.

Bogg and Brent [10] conducted a meta-analysis of conscientiousness-related traits and the leading behavioural contributors to mortality in the United States (tobacco use, diet and

activity patterns, excessive alcohol use, violence, risky sexual behaviour, risky driving, suicide, and drug use). Based on 194 studies that were quantitatively synthesized results showed that conscientiousness-related traits were negatively related to all risky health-related behaviours (which were significantly associated with various disease outcomes) and positively related to all beneficial health-related behaviours (which tend to promote health and well-being). An indirect cause of increased severity of symptoms is a lack of medical adherence; poor compliance has been found to cause morbidity and mortality in asthma [11]. Conscientiousness has been marked as a predictor of adherence, with increased levels of the trait indicating a greater propensity for adhering to medication routines in asthmatics [12-13].

The links between social class and health and diseases outcomes have well been demonstrated in the literature [14-15], and there is evidence showing the link between childhood intelligence and mortality [16].

Among the possible confounders, previous studies have demonstrated the links between maternal smoking during pregnancy and childhood asthma [17-19], between respiratory infection in the first year after birth and subsequent asthma risk after age 5 years [20], and between smoking and asthma in adulthood [21-22]. For example, Piipari and colleagues [22] found that the risk of developing asthma was significantly higher among current smokers and among ex-smokers compared with never-smokers. There is also evidence of the association between low birthweight and subsequent childhood asthma [23]. A number of studies have shown that body and mass index (BMI) is linked with the occurrence of Asthma [24-28].

The current study set out to explore biomedical, social and psychological correlates of asthma in adulthood. With the focus on the associations between psychological factors (personality and intelligence) and the outcome variable, it takes into account a set of possible confounders assessed in childhood and adulthood such as maternal smoking, childhood asthma

and respiratory symptoms, BMI, smoking status, education and occupation examining to what extent each factor is associated with the outcome variable.

The current study has three strengths. a) It uses a large, nationally representative sample with relevant data in both childhood and adulthood; b) It looks at the associations between the two main components of individual differences, personality and intelligence, and the prevalence of asthma in adulthood while taking account the effects of a set of biomedical, social and behavioural factors; c) It uses a well devised personality measure with high reliability and validity, which contains all five personality factors named the "Big-Five personality factors".

Hypotheses

It was hypothesised childhood asthma (H1) and respiratory symptoms (H2) would be significantly associated with asthma in adulthood; maternal smoking would be significantly associated with reported asthma in adulthood (H3); current and past smoking would be significantly associated with adult asthma (H4); BMI would be positively associated with the prevalence of asthma (H5); traits emotional stability and conscientiousness would be significantly and negatively associated with adult asthma (H6, H7); childhood cognitive ability would be significantly and negatively associated with the outcome variable (H8); parental social class, education, and occupation would be significantly and negatively associated with the outcome variable (H9, H10, H11).

Method

Sample

The National Child Development Study 1958 is a large-scale longitudinal study of the 17,415 individuals who were born in Great Britain in a week in March 1958 [29]. Information was collected on the family background of the mother, her pregnancy and labour, and about her

baby at birth and during its first week of life [29]. Since then there have been nine major follow-ups. The following analysis is based on data collected when the study participants were at birth, at ages 7, 11, 33, and at 50 years. Parental social class and rate of maternal smoking during pregnancy, gestational age and birth weight, and birth order of cohort members at birth, asthma (response = 93%) and respiratory symptoms (response = 90%) by age 7 years, cognitive ability tests scores (response = 87%) at age 11 years, educational qualifications (response = 72%) at age 33 years, personality traits (response = 69%), current occupational levels (response = 67%), cohort members' tobacco use status (response = 79%) and BMI (response = 71%), and the prevalence of asthma (response = 79%), all measured at age 50 years, were included in the study. The analytic sample comprises 5,118 cohort members (50 per cent females) 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 gender), despite a slight under-representation of the most disadvantaged groups [30].

Measures

1. *Parental social class at birth* was measured by the Registrar General's measure of social class (RGSC). Data were collected through interview and questionnaire completed by health visitors, head teachers and class teachers. RGSC is defined according to occupational status and the associated education, prestige or lifestyle [31] 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 [32].

2. *Maternal smoking* At birth mothers were interviewed and provided information on whether they were tobacco users during pregnancy with Yes/No response ("Yes" was coded as 1 and "No" was coded as 0). Data were collected through interview and questionnaire completed by health visitors, head teachers and class teachers.
3. *Childhood Biomedical factors* Mothers were interviewed again when cohort members were at 7 years, and provided information on whether participants ever had asthma and respiratory symptoms by the age of 7 years diagnosed by physicians with Yes/No response. For both measures "Yes" was coded as 1 and "No" was coded as 0. Data were collected through Computer Aided Personal Interviewing.
4. *Childhood cognitive ability tests* [33] were accessed when cohort members were at age 11 consisting of 40 verbal and 40 non-verbal items and were administered at school. Children were tested individually by teachers, who recorded the answers for the tests.
5. *Educational qualifications* At age 33, participants were asked about their highest academic or vocational qualifications. Data were collected through Computer Aided Personal Interviewing. 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.
6. *Occupational levels* Current or last occupation held by cohort members at age 50 were coded according to the Registrar General's Classification of Occupations (RGSC), described above, using a 6-point classification. Data were collected through Computer Aided Personal Interviewing.
7. *Personality factors* Personality traits were assessed by the 50 questions from the International Personality Item Pool (IPIP) [34]. Responses (5-point, from "Strongly Agree" to "Strongly Disagree") are summed to provide scores on the 'Big-Five' personality traits: Extraversion, Emotionality/Neuroticism, Conscientiousness,

Agreeableness, and Intellect/Openness. Data were collected through self-completion questionnaire.

8. *Smoking status* At age 50 cohort members provided information on smoking status. It was coded as 0="never smoked cigarettes"; 1="used to smoke cigarettes but do not smoke at all now"; and 2="smoke cigarettes now". Data were collected through Computer Aided Personal Interviewing.
9. BMI: At age 50 cohort members provide information on their weight (without clothes) and height (without shoes). BMI was computed using the standard formulae kg/m^2 (the weight in kilograms divided by the square of the height in meters), a formula developed in 1869 by Lambert Adolphe Jacques Quetelet (1796-1874), a Belgian scientist. BMI is an internationally used measure of level of fat or obesity [35]. Data were collected through Computer Aided Personal Interviewing.
10. Asthma was assessed by a question "Are you currently suffering from asthma?" with Yes/No response ("Yes" coded as 1 and "No" coded as 0). Data were collected through Computer Aided Personal Interviewing.

Statistical Analyses

To investigate the prevalence of asthma in adulthood, we first examined the characteristics of the study population using *T*-test and ANOVA. Second, correlation analysis was conducted on the measures used in the study and results were presented in S1 Appendix. Following this a series of logistic regression analyses were carried out using STATA version 12. Three models were designed. Model 1 examined socio-demographic variables and childhood factors; Model 2 examined the associations between adult social factors and the outcome variable, together with factors in Model 1; Model 3 examined the associations between personality factors, smoking behaviour and BMI, and the outcome variable, taking into account the factors in

Models 1 and 2. Gestational age and birthweight, and birth order were controlled in all three models.

Results

Descriptive Analysis

Table 1 shows the characteristics of the study population according to the prevalence of asthma at 50 years.

Insert Table 1 about here

There were significant sex differences in the prevalence of asthma. It appears that the prevalence of asthma was greater for males than for females in childhood (3.3% for boys and 2.2% for girls) whereas in adulthood, the prevalence of asthma was greater for females than for males (7.2% for men and 9.7 for women). ANOVA showed that the differences were statistically significant between boys and girls at age 7 years ($F(1,5116) = 6.14$ $p< .05$), and between men and women at age 50 years ($F(1,5116) = 10.58$, $p< .001$).

The correlation matrix of the variables used in the study is shown in Appendix 1. Parental social class, childhood cognitive ability, maternal smoking, childhood asthma and respiratory symptoms, sex, education and occupation were all significantly associated with asthma in adulthood ($p<.05$ to $p<.001$). Among the personality, behavioural and health factors, low neuroticism and high conscientiousness were significantly associated with the outcome variable, and BMI was significantly and positively associated with asthma in adulthood. Thus nine of the eleven hypotheses were supported. H4 and H8 were refuted, as smoking status and childhood cognitive ability were not significantly associated with the outcome variable.

Regression Analyses

Table 2 shows the results of three models using the logistic regression while birth order, gestational age and birth weight were controlled.

Insert Table 2 about here

Model 1 shows that maternal smoking, childhood asthma and respiratory symptoms were significant and positive predictors of the prevalence of asthma in adulthood. Females tended to have a greater prevalence of asthma in adulthood than males. The strongest predictor of asthma in adulthood was asthma in childhood. Model 2 shows that after entering adult social factors into the equation the results were about the same as from Model 1. Model 3 shows that after entering health, behavioural, and personality factors into the equation six factors, sex, maternal smoking, childhood asthma and respiratory symptoms, BMI, traits conscientiousness and neuroticism were all significantly and independently associated with the prevalence of asthma in adulthood. Thus six of the eleven hypotheses were further supported. Whereas parental social class, education and occupation, childhood intelligence and smoking status were not significantly and independently associated with the outcome variable.

Discussion

The current study is among the first to investigate the associations between a set of inter-correlated biomedical, behavioural, social and psychological measures accessed in childhood and adulthood and the prevalence of asthma in adulthood using a large, nationally representative sample in the UK. The study confirmed and extended previous research in the area. Logistic regression analyses suggest that seven factors significantly and independently

associated with the reporting of adult asthma. High neuroticism, low conscientious, females, those who had asthma and respiratory symptoms in childhood and whose mothers had smoking during pregnancy, and those who had high BMI are more likely to report asthma at 50-years. The findings show that biomedical, health, and personality factors in both childhood and adulthood are correlates of adult asthma, each explains a unique variance of the outcome variable.

The significant associations between asthma and respiratory symptoms in childhood and asthma in adulthood may indicate the etiological and genetic factors of this condition; Family and twin studies have indicated that genetics plays an important role in the development of asthma and allergy [36-37]. A recent genome-wide association study shows multiple markers on chromosome 17q21 to be strongly and reproducibly associated with childhood onset asthma, indicating that genetic variants regulating ORMDL3 expression are determinants of susceptibility to childhood asthma [38].

This study also demonstrates the importance of traits conscientiousness and neuroticism, the two health related personality factors. In their review of personality and health Friedman and Kern [2] suggest various mechanisms to explain the well-established finding concerning the relationship between various health/illness outcomes and conscientiousness. The data suggest that this personality variable often shows an effect size equal or even greater than that of many well established biomedical risk factors. People who scores higher on trait conscientiousness might be more cautious than risk-taking in their daily life with their health by showing more self-control, regulate and direct their impulses better [10]. Neuroticism has been found a significant predictor of health outcomes, especially stress related health problems. Neuroticism may not cause asthma condition but high on this trait with the tendency to experience negative emotions, such as anxiety and depression, and low tolerance for stress or aversive stimuli [39-41] may worsen the symptoms.

Previous studies have shown the significant negative associations between socioeconomic status (family socioeconomic conditions, education and occupation) and a number of diseases and poor health outcomes [14-15] and between childhood intelligence and longevity [16]. The current study also shows such associations in the expected direction (see S1 Appendix). However, these associations ceased to be significant after entering a set of inter-correlated confounders in childhood and adulthood (see Table 2), whilst personality traits remained significantly associated with the outcome variable. For example, in Table 2 model 1, further analysis shows that if we take out maternal smoking, childhood intelligence is a significant predictor of asthma in adulthood (OR=0.88: 0.79-0.99, $p<.05$). This indicates first, that the effect of each of the biomedical, social and psychological variables on the outcome variable can be better understood when these inter-correlated measures are examined together; second, personality traits neuroticism and conscientiousness appear to show stronger links to adult asthma than socioeconomic factors such as family social class, education and occupation. Interventions and treatment may achieve better results when personality factors are taken into account, e.g. by providing psychotherapy to those who have high scores on neuroticism and to calm the patients, help them to reduce their negativity; and to help patients who have low scores on conscientiousness to be more prudent, and have more medical adherence.

Nevertheless, the significant associations between personality traits and asthma are cross-sectional, thus the influences might be bi-directional: traits conscientiousness and neuroticism may affect the prevalence of asthma; and asthma may affect the change of personality traits. A recent study using a 16-year longitudinal sample [40] shows the mutual reinforcement between neuroticism and negative life experiences.

Like all other studies, the current study had limitation. The outcome variable of the study is based on self-report, not medical/physiological data of asthma symptoms or attacks on the participants, though research in self-reported heath has found to be linked to mortality [42,

43]. Further, personality traits were measured once, at the same time as the outcome variable. Only longitudinal data with biomedical outcome measure that it may be possible to offer a robust explanation for the above findings. Future studies with longitudinal personality data may ascertain the effects of personality traits on asthma and vice versa.

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Table 1. Social and demographic characteristics of the study population and prevalence of asthma at age 50.

	n	%	Prevalence of asthma %
Gender			
Male	2539	49.6	7.2
Female	2579	50.4	9.7
Parental social class at birth			
Unskilled (V)	362	7.1	8.8
Partly skilled (IV)	606	11.8	14.8
Skilled manual (III)	2511	49.1	8.5
Skilled non-manual (III)	577	11.3	8.7
Managerial/tech (II)	799	15.6	7.3
Professional (I)	263	5.1	5.7
Educational qualifications at age 33			
No qualifications	355	6.9	10.7
CSE 2-5/equivalent NVQ1	562	11.0	10.0
O Level/equivalent NVQ2	1749	34.2	8.5
A level/equivalent NVQ 3	828	16.2	8.1
Higher qualification/equivalent NVQ4	853	16.7	8.4
University Degree/equivalent NVQ 5, 6	771	15.1	6.5
Own current social class at age 50			
Unskilled (V)	105	2.1	11.4
Partly skilled (IV)	531	10.4	10.2
Skilled manual (III)	894	17.5	8.3
Skilled non-manual (III)	1076	21.0	9.3
Managerial/tech (II)	2193	42.8	7.8
Professional (I)	319	6.2	6.9

Table 2. Odds ratios (95% CI) for asthma at age 50, according to maternal smoking, childhood asthma and respiratory symptoms, childhood cognitive ability, educational qualifications, current occupational levels, BMI and smoking status, and personality traits.

	Model 1	**Model 2**	**Model 3**	
	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)	#*p*-value
Childhood factors				
Sex	1.50 (1.22, 1.84)***	1.52 (1.19, 1.92)***	1.49 (1.15, 1.94)***	0.003
Parental social class at birth (*unskilled as reference group*)				
Partly skilled	1.24 (0.78, 1.95)	1.36 (0.83, 2.21)	1.37 (0.83, 2.25)	0.222
Skilled manual	0.99 (0.66, 1.47)	1.08 (0.70, 1.66)	1.08 (0.69, 1.68)	0.744
Skilled non-manual	1.01 (0.62, 1.63)	1.15 (0.68, 1.93)	1.10 (0.65, 1.87)	0.727
Managerial/tech	0.89 (0.56, 1.43)	1.05 (0.63, 1.74)	1.07 (0.64, 1.79)	0.804
Professional	0.65 (0.34, 1.26)	0.64 (0.30, 1.36)	0.57 (0.26, 1.25)	0.158
Maternal smoking	1.34 (1.08, 1.66)**	1.29 (1.03, 1.61)*	1.26 (1.00, 1.59)*	0.047
Childhood asthma	6.54 (4.36, 9.81)***	6.67 (4.36 10.22)***	6.77 (4.38, 10.48)***	<0.000
Childhood respiratory symptoms	1.80 (1.19, 2.73)**	1.83 (1.19, 2.83)**	1.83 (1.18, 2.86)**	0.007
Childhood cognitive ability	0.90 (0.80, 1.01)	0.95 (0.82, 1.09)	0.94 (0.82, 1.09)	0.436
Adult social factors				
Educational qualifications (*no qualification as reference group*)				
CSE 2-5/equivalent NVQ1		1.02 (0.63, 1.64)	1.14 (0.69, 1.88)	0.607
O Level/equivalent NVQ2		0.88 (0.57, 1.36)	1.00 (0.63, 1.58)	0.986
A level/equivalent NVQ 3		1.01 (0.61, 1.66)	1.15 (0.68, 1.94)	0.606
Higher qualification/equivalent NVQ4		0.94 (0.56, 1.55)	1.07 (0.63, 1.82)	0.801
University Degree/equivalent NVQ 5, 6		0.85 (0.47, 1.52)	0.98 (0.53, 1.79)	0.943
Own social class (*unskilled as reference group*)				
Partly skilled		0.97 (0.46, 2.02)	1.00 (0.47, 2.10)	0.995
Skilled manual		0.89 (0.43, 1.83)	0.87 (0.42, 1.80)	0.698
Skilled non-manual		0.94 (0.46, 1.94)	0.95 (0.46, 1.96)	0.893
Managerial/tech		0.81 (0.40, 1.66)	0.83 (0.41, 1.72)	0.637

Professional		0.86 (0.37, 2.02)	0.90 (0.38, 2.13)	0.813
Adult health and behavioural factors				
BMI			1.03 (1.02, 1.05)***	<0.000
Smoking status (never smoked cigarette as reference group)				
Used to smoke but do not smoke now			1.12 (0.87, 1.44)	0.377
Smokers			1.21 (0.89, 1.63)	0.223
Adult personality factors				
Extraversion			1.09 (0.96, 1.24)	0.201
Neuroticism			1.13 (1.01, 1.21)*	0.038
Agreeableness			0.97 (0.85, 1.11)	0.658
Conscientiousness			0.85 (0.76, 0.96)**	0.008
Openness			1.00 (0.88, 1.11)	0.998

Note: *p<.05; **p<.01;***p<.001. Adjusted for gestational age and birthweight, and birth order in all three models. [#] p values of the final model.

Appendix 1. Pearson product-moment correlations of variables in the study.

	Variables	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Asthma at 50 years	.50 (.50)	_														
2.	Sex	.08 (.28)	**.045****	_													
3.	Maternal smoking	1.00 (2.02)	**.056****	-.001	_												
4.	Parental social class at birth	3.32 (1.22)	**-.032***	-.021	-.086**	_											
5.	Childhood asthma	.04 (.16)	**.174****	-.036*	.010	.029	_										
6.	Childhood respiratory symptoms	.04 (.20)	**.086****	-.034*	-.011	-.008	.255**	_									
7.	Childhood cognitive ability	104.2 (12.8)	**-.033***	.078**	-.091**	.262**	-.007	.001	_								
8.	Educational qualifications	2.70 (1.44)	**-.035***	-.082**	-.091**	.313**	.019	-.004	.484**	_							
9.	Current occupational levels	4.11 (1.20)	**-.030***	-.014	-.039*	.205**	.008	.011	.326**	.446**	_						
10.	Smoking status	.69 (.77)	**.022**	-.025	.013	-.072**	-.049**	-.028**	-.138**	-.213**	-.139**	_					
11.	BMI	27.27 (5.41)	**.068****	-.101**	.104**	-.096**	.007	.004	-.073**	-.087**	-.025	.023	_				
12.	Extraversion	29.43 (6.60)	**.009**	.074**	.009	.028	.016	-.020	.021	.069**	.120**	.073**	.031*	_			
13.	Neuroticism	28.93 (7.03)	**.043****	.133**	-.013	-.024	-.014	.005	-.090**	-.087**	-.081**	.053**	.025	-.208**	_		
14.	Agreeableness	36.85 (5.28)	**-.001**	.401**	.002	.043**	.023	-.015	.118**	.081**	.106**	-.037*	-.069**	.363**	-.056**	_	
15.	Conscientiousness	34.01 (5.29)	**-.050****	.106**	-.031*	.016	-.006	-.019	.043**	.066**	.095**	-.067**	-.118**	.143**	-.193**	.275**	_
16.	Openness	32.57 (5.16)	**-.023**	-.018	-.004	.130**	.021	-.031**	.274**	.315**	.238**	.002	.009	.400**	-.102**	.336**	.223**

Note: **p*<.05; ***p*<.01. Variables were scored such that a higher score indicated being female, evidence of respiratory symptoms in childhood, prevalence of asthma in childhood or adulthood, maternal smoking, a more professional occupation for parents or cohort members, higher scores on childhood cognitive ability, highest educational qualifications, smokers, higher scores on BMI, higher scores on traits extraversion, neuroticism, agreeableness, conscientiousness, and openness. Alphas for personality factors ranged from .77 to .88.