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Personality Correlates of Type 1 Diabetes in a National Representative Sample

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Abstract

We examined cross-sectional relationships between personality traits and type 1 diabetes. The sample (n=8490) was taken from the 1982-84 wave of the National Health and Nutrition Examination Survey Epidemiological Follow-up Study. We fit three logistic regression models to test whether neuroticism, extraversion, openness, or the Type A behavior pattern were associated with type 1 diabetes. Model 1 included sex, age, race/ethnicity and all four personality traits. Model 2 added depressive symptoms. Model 3 added body mass index, hypertension, and cigarette smoking status. Results regarding personality traits were consistent across all three models: higher neuroticism was associated with 39% higher chance of having type 1 diabetes per standard deviation increase and openness was associated with 26% decrease in that chance per standard deviation increase. Extraversion, and Type A personality were not associated with type 1 diabetes in our models.

Keywords: personality traits, type 1 diabetes, neuroticism, openness, insulin

Introduction

Diabetes is a major risk factor for health complications, including heart disease and stroke, blindness, kidney and nervous system disease, limb amputations, and early death (Centers for Disease Control and Prevention - CDC, 2011). Type 1 diabetes is a progressive autoimmune disease in which pancreatic beta cells are destroyed and exogenous insulin is needed for survival (Bach, 1994). Genetic factors play a major role in type 1 diabetes etiology, primarily through the

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human leukocyte antigen complex (Barrett et al., 2009; Lambert et al., 2004; Redondo, Fain, & Eisenbarth, 2000). Studies of monozygotic twins have shown that concordance rates range from 30 to 50%, which suggest that non-genetic risk factors also play a role (Todd, 1990).

One factor that triggers the expression of the genetic influences is stress. Evidence for this comes both from animal models and studies on human populations. For example, chronic stress significantly increases the incidence of the phenotypic expression of the type 1 diabetes gene in the bio-breeding rat (Carter, Herrman, Stokes, & Cox, 1987; Lehman, Rodin, McEwen, & Brinton, 1991). Similarly, stressful events such as family-related losses are associated with type 1 diabetes onset in 5-9 year old children (Hägglöf, Blom, Dahlquist, Lönnberg, & Sahlin, 1991). Moreover, children with type 1 diabetes are reported by caregivers/parents to experience a higher number of stressful events in the first two years of life compared to matched healthy controls (Thernlund et al., 1995).

Personality traits, such as those described by the Five-Factor Model (Digman, 1990), influence the degree to which stress is experienced, how it is perceived, and how individuals cope with the threatening and challenging life situations that bring on stress. In particular, neuroticism, or negative affectivity, may be an important risk factor as it plays a role in the perception of stress (McCrae, 1990; Watson & Pennebaker, 1989). Higher neuroticism also generates further stressful life events and maladaptive coping strategies (Suls & Martin, 2005) and thus neuroticism, via its impact on stress, could be a risk factor for type 1 diabetes onset.

Several cross-sectional studies examined the association of personality traits with diabetes. One study found that people with diabetes had lower levels of conscientiousness, openness, and higher levels of agreeableness than those without diabetes (Goodwin & Friedman, 2006). Another study found that higher neuroticism was associated with having a diabetes diagnosis (Goodwin, Cox, & Clara, 2006). Furthermore, some studies identified that the observed relationships may be driven by specific personality facets, rather than domains, namely the extraversion facet E4: Activity, and the conscientiousness facet C2: Order (Čukić, Mõttus, Realo, & Allik, 2016). Finally, there is some evidence that high conscientiousness and high agreeableness may lower the expression of diabetes genetic risk (Čukić et al., 2015). However, none of these studies differentiated between type 1 and type 2 diabetes. There have been several longitudinal studies focusing on personality contributions to type 2 diabetes development (Čukić & Weiss, 2014; Jokela et al., 2014), but again none focused exclusively on type 1 diabetes.

However, a recent case-control study that focused on type 1 diabetes (Rassart, Luyckx, Moons, & Weets, 2014) found that cases had lower extraversion and higher neuroticism than controls. This study also found that young adult females with type 1 diabetes had, on average, lower levels of extraversion than female controls, and that males with type 1 diabetes had higher levels of neuroticism than

matched controls. However, the authors did not control for potential confounds related to personality and type 1 diabetes risk, such as body mass index (BMI) (Brummett et al., 2006; Hyppönen, Virtanen, Kenward, Knip, & Akerblom, 2000) or depressive symptoms (Anderson, Freedland, Clouse, & Lustman, 2001; Bienvenu et al., 2004).

The present cross-sectional study thus focused on the associations between the personality traits neuroticism, extraversion, openness, and type A behavior and type 1 diabetes. In our models we controlled for the effects of sex, age, race/ethnicity, depressive symptoms, BMI, hypertension, and smoking history.

Method

Participants

The sample was drawn from the 1982-1984 wave of the National Health and Nutrition Examination Survey I Epidemiological Follow-up Study (NHEFS) (Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), 2012). Of the initial 12 220 participants, 3284 were excluded because of missing data on personality measures, depressive symptoms, diabetes, demographics or medical covariates. An additional 446 participants were excluded because they had type 2 diabetes. The final sample thus comprised 8490 participants (M_{age}=55.38, SD_{age}=14.36) with full data on the study variables. It consisted of 3171 men (M_{age}=57.0, SD_{age}=14.51) and 5319 women (M_{age}=54.40, SD_{age}=14.18) who self-reported their ethnicity as "white" (n=7387), "black" (n=1016), or "other" (n=87). The category "other" included Aleut, Eskimo, American Indian, Asian/Pacific islander, Hispanic, Japanese, Chinese, Korean, or Hindu.

Measures

Diabetes

Participants were classified as having type 1 diabetes based on their answers to the questions "Did a doctor ever tell you that you had diabetes or sugar diabetes?" and "Are you *now* taking medications for this condition: Insulins (includes NPH U-100, Lente U-100, Lente Reg.)". Participants answering "yes" to both questions were classified as having type 1 diabetes. Participants answering "yes" to the first question and "no" (n=446) to the second question were classified as having type 2 diabetes and excluded from the analyses. Participants answering "no" to both questions were classified as not having diabetes.

While, today, insulin is prescribed to treat some cases of type 2 diabetes, and especially the later stages of the disease (Hamaty, 2011), this is a recent

phenomenon (Holden, Gale, Jenkins-Jones, & Currie, 2014) and at the time of the sample collection in 1982, and up until the late 1990's, the distinction between type 1 and type 2 diabetes was based on whether patients were taking insulin (Andersen, Christiansen, Andersen, Kreiner, & Deckert, 1983; Barker et al., 1993; Tisch & McDevitt, 1996).

In total, 137 (1.6%) participants were classified as having type 1 diabetes. The remaining 8353 (98.4%) participants were classified as being free of diabetes.

Personality Traits

Short scales were used to assess neuroticism, extraversion, and openness (Costa & McCrae, 1986; Costa, McCrae, & Locke, 1990; Costa et al., 1986). The neuroticism short scale consisted of five items chosen on theoretical grounds from the NHANES General Well-Being Schedule (Dupuy, 1984; Fazio, 1977). The eight-item extraversion scale and the six-item openness scale were selected from the NEO Inventory using multiple regression (Costa & McCrae, 1986). The scales had following internal consistencies: .76 for neuroticism, .51 for extraversion, and .42 for openness, which is satisfactory for the present combination of breadth and brevity of the scales (Costa et al., 1986). Importantly, they showed good convergent and discriminant validity against self-reports and spouse ratings on the NEO Inventory, self-reports on the Eysenck Personality Inventory, and on peer ratings on the NEO Inventory (Costa & McCrae, 1986).

The six-item Framingham Type A scale (Haynes, Levine, Scotch, Feinleib, & Kannel, 1978) was used to assess the Type A behavioral pattern. The scale has been related to the low pole of the agreeableness domain of the Five-Factor Model (Costa, Stone, McCrae, Dembroski, & Williams, 1987; Dembroski & Costa, 1987; Dembroski, MacDougall, Costa, & Grandits, 1989). Chronbach's alpha of the scale in the current sample was .58.

Demographics

Age was treated as a continuous variable. Gender was coded 0 for females and 1 for males. Race/ethnicity was entered as two dummy-coded variables, which compared participants who self-identified as "black" and "other" to those who identified as "white", respectively.

Depressive Symptoms

The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) was used to assess depressive symptomatology. It consists of twenty items designed to assess symptoms of depression in general population. The scale is a reliable measure of the construct (Chronbach's alpha = .85). Depressive symptoms were treated as a continuous variable.

Health

While weight data were available in the NHEFS cohort, height data were only available for the NHANES I. We thus used height data from the NHANES I and weight data from the NHEFS to compute BMI, which we treated as a continuous variable.

Hypertension status was based on participants' answer to the question "Has a doctor ever prescribed medication for you for hypertension or high blood pressure?" Responses were coded 0 for "no" and 1 for "yes".

Smoking status was based on answers to the questions "Have you ever smoked more than 100 cigarettes?" and "Are you a smoker now?" Participants answering "yes" to both questions were classified as current smokers. Participants answering "yes" to the former and "no" to the latter were classified as former smokers. Participants answering "no" to both questions were classified as non-smokers. Smoking status was entered as two dummy coded variables: the first compared former smokers to non-smokers and the second compared current smokers to non-smokers.

Analyses

Logistic Regression Models

To test whether personality factors are associated with type 1 diabetes, we conducted logistic regressions by fitting generalized linear models using the glm function in R version 3.0.3 (R Core Team, 2013). The first model tested if there are associations between neuroticism, extraversion, openness, and type A and type 1 diabetes, controlling for sex, age, and ethnicity. The second model added the effects of depressive symptoms. The third model tested whether the effects of personality traits, controlling for demographics, would be attenuated by associated risk factors like smoking, hypertension, and BMI. For the proportion of participants with type 1 diabetes in our sample (0.02), the sample size to detect an effect size commonly reported in the literature on personality and health (OR=1.5) with 80% power of is n=8107. Our sample (n=8490) is thus well suited for the planned analyses. Power analysis was conducted using G*Power version 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009).

Results

Descriptive Statistics

Means and frequencies for the sample based on diabetes status in 1982-1984 are presented in Table 1. Participants with type 1 diabetes were significantly older ($t(8488)=-4.75$, $p<.001$), had higher BMIs ($t(8488)=-7.35$, $p<.001$), were more often diagnosed with hypertension ($X^2=1$, $N=8490)=75.85$, $p<.01$), and had higher neuroticism ($t(8488)=-3.21$, $p=.001$) and higher CES-D scores ($t(8488)=-3.14$, $p=002$) than participants with no diagnosis of diabetes.

Table 1. *Descriptive Statistics of the Sample by Diabetes Status*

	No diabetes (*n*=8353)		Type 1 (*n*=137)		Total (*n*=8490)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Neuroticism	9.74	6.60	11.57	7.33	9.77	6.61
Extraversion	18.17	3.57	17.58	3.63	18.16	3.58
Openness	11.84	3.01	10.71	2.63	11.82	3.01
Type A	14.00	3.55	13.66	3.94	14.00	3.56
Depressive Symptoms	8.14	8.16	10.35	8.63	8.18	8.17
BMI (kg/m2)	26.10	4.85	29.19	5.89	26.15	4.89
Age	55.28	14.37	61.15	12.19	55.38	14.36
	n	*%*	*n*	*%*	*n*	*%*
Gender						
Males	3116	37.3	55	40.1	3171	37.3
Females	5237	62.7	82	59.9	5319	62.7
Ethnicity						
White	7296	87.3	91	66.4	7387	87.0
Black	973	11.7	43	31.4	1016	12.0
Other	84	1.0	3	2.2	87	1.0
Hypertension						
Yes	2371	28.4	86	62.8	2457	28.9
No	5982	71.6	51	37.2	6033	71.1
Smoking Status						
Non-Smoker	3732	44.7	75	54.7	3807	44.8
Former Smoker	2229	26.7	37	27.0	2266	26.7
Current Smoker	2392	28.6	25	18.3	2417	28.5

Note. Personality and depressive symptoms scores are in raw units.

Logistic Regression Models

Results of the logistic regression models are presented in Table 2. In the basic model, including only demographic predictors and personality traits, age was significantly related to type 1diabetes prevalence, with a 3% increase in chance of reporting diabetes associated with every year of age. In addition, participants who self-identified as "black" or "other" were 3.6 and 3.7 times more likely to report having type 1 diabetes than participants who self-identified "white". Of the personality traits, every standard deviation of neuroticism was associated with a 37% increase in risk of type 1 diabetes and every standard deviation of openness was associated with a 28% decrease in risk of being classified as having type 1 diabetes. Neither gender nor extraversion was significantly related to risk of type 1 diabetes. In the second model, depressive symptoms were not significantly related to risk of type 1 diabetes; all other results were similar to those in the first model. In the third model, which added BMI, hypertension status, and smoking behavior, each unit of BMI was associated with an 8% increase in risk of being classified as having type 1 diabetes, hypertension was associated with a two and a half fold increase in risk of being classified as having type 1 diabetes, and the two smoking status variables were not significantly associated with risk. The effects of age, neuroticism, openness, and ethnicity were still significant.

Table 2. *Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Associations Between Personality Traits and Type 1 Diabetes*

	Model 1			Model 2			Model 3		
	OR (95% *CI*)		*p*	*OR* (95% *CI*)		*p*	*OR* (95% *CI*)		*p*
Age	1.03	(1.02-1.04)	<.001	1.03	(1.02-1.04)	<.001	1.02	(1.01-1.04)	.005
Gender									
Female vs. Male	1.12	(0.78-1.62)	.52	1.12	(0.78-1.61)	.53	1.39	(0.94-2.06)	.10
Ethnicity									
White vs. Black	3.60	(2.48-5.23)	<.001	3.63	(2.49-5.28)	<.001	2.59	(1.75-3.84)	<.001
White vs. Other	3.73	(1.14-12.16)	.029	3.73	(1.14-12.17)	.029	3.71	(1.12-12.31)	.032
Neuroticism	1.37	(1.17-1.61)	<.001	1.41	(1.13-1.74)	.002	1.39	(1.12-1.72)	.003
Extraversion	0.98	(0.82-1.18)	.84	0.98	(0.82-1.17)	.82	0.99	(0.82-1.18)	.88
Openness	0.72	(0.60-0.87)	<.001	0.72	(0.60-0.87)	<.001	0.74	(0.61-0.89)	.001
Type A	1.04	(0.87-1.25)	.68	1.04	(0.87-1.25)	.68	1.01	(0.84-1.21)	.92
Depressive Symptoms				0.97	(0.79-1.19)	.75	0.94	(0.77-1.16)	.57
BMI							1.08	(1.05-1.12)	<.001
Hypertension									
Present vs. Absent							2.45	(1.68-3.59)	<.001
Smoking Status									
Non vs. Former							0.85	(0.55-1.31)	.46
Non vs. Current							0.67	(0.41-1.09)	.11

Note. BMI=Body Mass Index. Personality scores, BMI and depressive symptoms are in raw units.

Discussion

Participants higher in neuroticism or lower in openness were more likely to report having insulin dependent or type 1 diabetes after controlling for age, sex, race/ethnicity, depressive symptoms, BMI, hypertension, and smoking status. The finding that higher neuroticism is related to higher risk of type 1 diabetes corresponds to previous cross-sectional studies of personality and diabetes (Čukić et al., 2016; Goodwin et al., 2006; Goodwin & Friedman, 2006). The finding that lower openness is related to higher risk of type 1 diabetes is also consistent with previous reports (Čukić et al., 2015; Goodwin & Friedman, 2006).

Given the cross-sectional design of our study, we are limited in the interpretation of the associations. However, the results raise three hypotheses. Firstly, type 1 diabetes could lead to changes in personality trait levels. Being a challenging and potentially life threatening disease (Diabetes Control and Complications Trial Research Group, 1997), type 1 diabetes could lead to an increased experience of anxiety and distress associated with neuroticism. Similarly, adapting to the demands of living with the disease may lower one's openness as the nature of the disease has a significant impact on lifestyle. One openness item stated: "I often try new and foreign foods". Given the special dietary requirements of diabetes management, we conducted supplementary analyses in which we scored openness without this item. This did not alter the results: in the fully adjusted model the modified version of openness was associated with a 26% decrease in likelihood of having type 1 diabetes per standard deviation increase (OR=0.74, 95% CI [0.62, 0.89], p=.002). Thus, it is not likely that the altered dietary habits of individuals with type 1 diabetes explain the association between diabetes and lower openness. The second hypothesis is that higher neuroticism and lower openness are contributing factors that could trigger the disease. Given that people with higher levels of neuroticism experience stressful events more strongly (McCrae, 1990; Watson & Pennebaker, 1989), it could be that higher neuroticism is in fact one of the factors that cause type 1 diabetes onset. Similarly, higher openness is related to more adaptive coping strategies (Carver & Connor-Smith, 2010), and thus lower openness could contribute to type 1 diabetes onset through chronic maladaptive reactions to stress. Finally, a third possibility is that a common genetic factor could underlie type 1 diabetes, high neuroticism and lower openness.

Despite its inverse correlation with agreeableness (Costa et al., 1987) and previously reports of associations between agreeableness and diabetes (Goodwin & Friedman, 2006), we did not find an association between type A behavior and type 1 diabetes. There are two possible reasons for this discrepancy. First, low agreeableness/high type A behavior could be related to type 2 diabetes, due to behavioral risk factors such as higher involvement in drinking (Malouff, Thorsteinsson, Rooke, & Schutte, 2007) and cigarette smoking (Terracciano & Costa, 2004), but not to the more genetically determined and stress-related type 1

diabetes. Another possibility is, speculatively, that type A behavior does not reflect aspects or facets of agreeableness related to type 1 diabetes risk.

Extraversion was not related to type 1 diabetes, which is in line with previous studies that show no difference in extraversion between those with and without diabetes (Goodwin & Friedman, 2006). However, another study found lower extraversion in women with type 1 diabetes compared to female controls, but the effect was not present in men (Rassart et al., 2014). We thus conducted a supplementary analysis, splitting our sample by gender and re-running the fully adjusted model. This did not change our results: extraversion was not related to type 1 diabetes in males (p=.39) or females (p=.56).

Our study had some limitations. First, as noted earlier, it was cross-sectional. Future studies should aim to address the question of associations between personality and type 1 diabetes using multiple waves of data. Second, there was no measure of conscientiousness in the NHEFS data. Given that conscientiousness is an important predictor of various health behaviors and outcomes (Bogg & Roberts, 2004; Chapman, Roberts, & Duberstein, 2011; Deary, Weiss, & Batty, 2010), future studies should aim to include all five personality domains. Furthermore, variables used to determine diabetes status were both based on self-reports. However, prior studies indicate that self-reports are a reliable assessment of medical conditions and actual disease diagnoses (Simpson et al., 2004). Future studies should, however, be based on physician diagnosis, or include measures of blood glucose levels and glycated haemoglobin. This would also allow for greater accuracy in distinguishing between type 1 and type 2 diabetes. Another limitation of our study is that the effect sizes we found are slightly lower than expected and our study thus may be slightly underpowered. Being drawn from a national representative sample, only 137 participants were classified as having type 1 diabetes. Future studies should use sampling methods that specifically target the type 1 diabetes population. Finally, despite the strong genetic component of type 1 diabetes (Barrett et al., 2009; Lambert et al., 2004; Redondo et al., 2000), we did not have data on family history or diabetes genetic risk. Future studies should examine possible genetic links between personality traits and type 1 diabetes.

The present study also had strengths. First, the detailed questions enabled us to differentiate between likely cases of type 1 and type 2 diabetes. Second, the study included several health and psychological covariates related to diabetes.

In conclusion, higher neuroticism and lower openness were related to type 1 diabetes risk in a cross-sectional study. More research is needed, particularly using longitudinal designs in younger participants, before the nature of these relationships is fully understood.

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Correlatos de personalidad y de diabetes tipo 1 en la muestra representativa nacional

Resumen

Examinamos relaciones transversales entre los rasgos de personalidad y la diabetes tipo 1. Se tomó la muestra (*n*=8490) de la ola 1982-84 de la Encuesta Nacional de Examen de Salud y Nutrición (Encuesta de Seguimiento Epidemiológico). Usamos tres modelos de regresión logística para examinar si el neuroticismo, extraversión, franqueza o patrón de conducta tipo A estaban relacionados con la diabetes tipo 1. Modelo 1 incluía sexo, edad, raza/etnicidad y los cuatro rasgos de personalidad. Modelo 2 añadió síntomas de depresión. Modelo 3 añadió índice de masa corporal, hipertensión y hábito de fumar. Los resultados respecto a los rasgos de personalidad eran consistentes en todos los tres modelos: el neuroticismo más alto se relacionaba con la posibilidad 39% más alta por incremento de la desviación estándar de tener la diabetes tipo 1 y la franqueza se relacionaba con la disminución de 26% por incremento de la desviación estándar en esta ocasión. La extraversión y personalidad tipo A no se relacionaban con la diabetes en nuestros modelos.

Palabras claves: rasgos de personalidad, diabetes tipo 1, neuroticismo, franqueza, insulina

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