Health Psychology
2014, Vol. 33, No. 12, 1618–1621

0278-6133/14/$12.00 http://dx.doi.org/10.1037/hea0000003

BRIEF REPORT

Personality and Risk of Diabetes in Adults: Pooled Analysis of 5 Cohort Studies

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Objective: Diabetes is an increasingly important public health concern, but little is known about the contribution of psychological factors on diabetes risk. We examined whether personality is associated with risk of incident diabetes and diabetes-related mortality. ***Method:*** An individual-participant meta-analysis of 34,913 adults free of diabetes at baseline (average age 53.7 years, 57% women) from 5 prospective cohort studies from the United States and United Kingdom. Personality dimensions included extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience based on the Five Factor Model. ***Results:*** During an average follow-up of 5.7 years, 1845 participants became diabetic. Of the 5 personality dimensions, only low conscientiousness was associated with an elevated diabetes risk (OR = 0.87, 95% CI = 0.82–0.91 per 1 standard deviation increment in conscientiousness). This association attenuated by 60% after adjustment for obesity and by 25% after adjustment for physical inactivity. Low conscientiousness was also associated with elevated risk of diabetes mortality (HR = 0.72, CI = 0.53–0.98 per 1 standard deviation increment in conscientiousness). Other personality traits were not consistently associated with diabetes incidence or mortality. ***Conclusions:*** Low conscientiousness—a cognitive–behavioral disposition reflecting careless behavior and a lack of self-control and planning—is associated with elevated risk of diabetes and diabetes-related mortality. The underlying mechanisms are likely to involve health behaviors, such as poor weight management, physical inactivity, and adherence to medical management recommendations.

Keywords: diabetes, personality, meta-analysis, mortality, conscientiousness

Supplemental materials: http://dx.doi.org/10.1037/hea0000003.supp

This article was published Online First August 19, 2013.

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Mika Kivimäki is an Economic and Social Research Council Professor and is supported by the Academy of Finland; Medical Research Council (Grant K013351); and the U.S. National Institutes of Health (R01HL036310; R01AG034454). Mika Kivimäki and Solja T. Nyberg are supported by the Finnish Work Environment Fund. G. David Batty is a Wellcome Trust Fellow. The Centre for Cognitive Ageing and Cognitive Epidemiology is supported by the Biotechnology and Biological Sciences Research Council, the Engineering and Physical Sciences Research Council, the Economic and Social Research Council, the Medical Research Council and the University of Edinburgh as part of the cross-council Lifelong Health and Wellbeing Initiative.

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Type 2 diabetes mellitus and its complications are among the leading causes of death and disability. Globally, 350 million people were estimated to have diabetes in 2008, and the numbers are rising in most parts of the world (Danaei et al., 2011). Approximately 2% of years of healthy life lost due to death and nonfatal illness or impairment in year 2010 was attributable to diabetes (Murray et al., 2012). Sociodemographic factors, metabolic markers, and health behaviors are known to be associated with diabetes risk (Buijsse, Simmons, Griffin, & Schulze, 2011). Given that many of these risk factors tend to cluster together, it is important to consider potential upstream factors that contribute to the overall adoption of an unhealthy lifestyle predisposing to the development of diabetes. These upstream factors may be related to people's psychological and sociodemographic characteristics.

The personality traits *conscientiousness* (a tendency to show self-discipline and planned rather than spontaneous behaviors) and *neuroticism* (a tendency to easily and frequently experience negative emotions) are associated with various physical illnesses (Deary, Weiss, & Batty, 2010; Smith & MacKenzie, 2006) and mortality risk (Deary et al., 2010; Jokela et al., in press), with low conscientiousness and high neuroticism increasing these risks. Other personality traits, such as low agreeableness and interpersonal hostility, have also been associated with morbidity (Sutin et al., 2010), although less consistently (Deary et al., 2010; Smith & MacKenzie, 2006; Sutin et al., 2010). Personality might also influence the risk of adult diabetes, via behavior-related risk factors, such as physical activity and obesity (Jokela et al., 2013). To date, however, few large-scale prospective studies are available on the relationship between personality traits and diabetes risk.

We pooled data from almost 35,000 adults participating in 5 cohort studies to examine whether personality is prospectively associated with adult-onset incident diabetes and diabetes mortality, and whether these associations are accounted for by health behaviors (smoking and physical activity), hypertension, and obesity. Based on earlier studies examining related health outcomes (Jokela et al., 2013; Sutin et al., 2010), we hypothesized that low conscientiousness, high neuroticism, and low agreeableness are associated with higher risk of incident diabetes and diabetes-related mortality.

Methods and Materials

We searched the Inter-University Consortium for Political and Social Research (http://www.icpsr.umich.edu/icpsrweb/ICPSR/) and the Economic and Social Data Service (http://www.esds.ac.uk/) databases for eligible cohort studies for which data were publicly available. Studies with $n > 1{,}000$, a longitudinal design with at least 1 follow-up, data on diabetes status (baseline and follow-up), and personality assessment at baseline (using the brief 15-item questionnaire based on the Five Factor Model or a more extensive questionnaire) were eligible. Five studies met the inclusion criteria: the British Household and Panel Survey (BHPS), the Midlife in the United States (MIDUS), the Health and Retirement Study (HRS), and the Wisconsin Longitudinal Study graduate (WLSG) and sibling (WLSS) samples (see descriptive details in the Online Supplemental Material and Supplemental Table 1). All the studies were approved by the relevant local ethics committees.

There were a total of 38,447 participants with data on personality traits at baseline and follow-up data on diabetes. Participants with diabetes at baseline were excluded from the analysis of incident diabetes (552 participants in BHPS; 2,505 in HRS; 155 in MIDUS; 192 in WLSG; 130 in WLSS), leaving 34,913 eligible participants. Information on cause-specific death was not available in BHPS and MIDUS; mortality analysis was therefore carried out based on HRS, WLSG, and WLSS, including individuals with and without diagnosed diabetes at baseline (total $n = 24{,}543$; 108 deaths with diabetes as the underlying cause).

Information on personality, diabetes, and the potential mediators/covariates was based on self-reported data in all studies. Personality was assessed using standardized questionnaire instruments of the Five Factor Model including measures of Extraversion, Neuroticism, Agreeableness, Conscientiousness, and Openness to experience (John, Naumann, & Soto, 2008). Diabetes status was requested. Incident diabetes was determined by negative response at baseline and affirmative response at follow-up, and any nonresponses were coded as missing data. Diabetes mortality was determined on the basis of death certificates. Assessment details are provided in the Online Supplemental Material.

The associations of personality traits with incident diabetes and mortality were assessed using logistic and Cox's proportional hazards regression, respectively. Personality traits were standardized into z-scores within the sample ($M = 0$, $SD = 1$) and the five personality traits were all included in the models to estimate their independent effects adjusting for the four other traits, gender, age at baseline, race/ethnicity (0 = White, 1 = non-White) and individual follow-up time (in months) between baseline and follow-up (in the analysis of incident diabetes). The results from the individual cohorts were summarized with the use of random-effect meta-analysis of STATA 12.1 statistical software (College Station, TX.).

Results

In the pooled data, average age of the participants was 53.7 years and 57% were women. During the average follow-up period of 5.7 years, 1,845 participants developed diabetes. The incidence of diabetes was six to eight cases per 1,000 person-years in four of the cohorts but 19 cases per 1,000 person-years in the HRS in which the participants were older, more likely non-White, and hypertensive than participants in the other cohorts (Supplemental Table 1).

Lower conscientiousness was associated with higher diabetes risk in all the cohorts (pooled odds ratio [OR] = 0.87, 95% confidence interval [CI] = 0.82–0.91, per 1 *SD*; Figure 1), with no heterogeneity in effect sizes ($I^2 = 0\%$, $p = .99$). The OR = 0.87 is equivalent to an effect size of $d = -0.08$ on the Cohen's *d* metric [$d = \log(OR)^{*}\text{sqrt}(3)/\pi$]. Analysis of conscientiousness divided into quintile categories revealed a linear dose-response pattern (Supplemental Figure 1): the pooled odds ratios per descending quintiles were 1.00 (highest quintile, reference group), 1.11 (0.79–1.55), 1.23 (0.89–1.70), 1.22 (0.87–1.72), and 1.58 (1.10–2.28, lowest quintile) in model adjusted for gender, age, race/ethnicity and other personality traits. Thus, individuals in the lowest quintile of conscientiousness had 58% higher odds of incident diabetes compared to individuals in the highest conscientiousness quintile. There were no statistically significant differences in this association by gender, age (below vs. above 50y), race/ethnicity (White vs. others), marital status (married vs. nonmarried), or education (primary, secondary, tertiary education), all *p* values for subgroup heterogeneity >0.30 (details not shown).

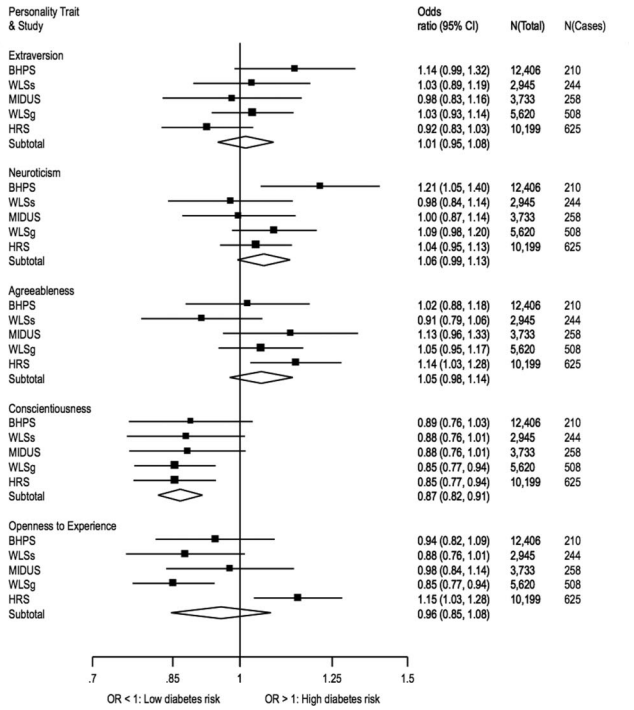

Figure 1. Associations between personality traits and risk of incident diabetes during follow-up among participants without diabetes at baseline (n = 34,913). Personality traits are mutually adjusted, and the associations are further adjusted for gender, age at baseline, race/ethnicity, and individual follow-up time in months. Studies are sorted in increasing order of diabetes incidence (cases per total participants; see Supplemental Table 1). Values are odds ratios per 1 *SD* increment in personality trait score.

In the pooled data, higher conscientiousness was associated with sociodemographic covariates and behavior-related factors that are protective of diabetes (Supplemental Table 2). Adjusting for baseline body mass index (BMI) attenuated the association between conscientiousness and diabetes risk by almost 60% (from OR = 0.88 to OR = 0.95; Table 1). The corresponding attenuation after adjustment for physical activity was 25% (from OR = 0.88 to OR = 0.91; Table 1). Other covariates had smaller effects on the association. Together BMI, smoking, physical activity, and high blood pressure accounted for approximately 75% of the inverse association between conscientiousness and diabetes risk (from OR = 0.88 to OR = 0.97). Other personality traits were not significantly associated with diabetes risk (Figure 1; Supplemental Figure 1). There was some evidence for between-study heterogeneity in the effect size of openness to experience (I^2 = 78%, p = .001) but not for extraversion (I^2 = 28%, p = .24), neuroticism (I^2 = 30%, p = .22) or agreeableness (I^2 = 41%, p = .15).

In the three cohorts with information on cause-specific mortality, there was an inverse association between conscientiousness and diabetes mortality risk (HR = 0.72, CI = 0.53–0.98; Supplemental Figure 2), although other personality traits were not associated with diabetes mortality (HR = 0.72 equals approximately an effect size of Cohen's d = −0.18). The association between conscientiousness and diabetes-related mortality was less affected by adjustment for covariates than the association with incident diabetes (Table 1). Adjustment for BMI attenuated the association by 18% and that for physical inactivity by 11%. After adjustment for self-reported diabetes status at baseline, the association was attenuated by 25%.

Discussion

Analysis of five American and British studies showed low conscientiousness to be associated with an increased risk of incident diabetes in adulthood. This association was in part explained by higher prevalence of obesity and lower physical activity among those with low conscientiousness. Low conscientiousness also predicted diabetes-related mortality. The other four personality dimensions of the Five Factor Model (extraversion, neuroticism, agreeableness, and openness to experience) were not consistently associated with incident diabetes or diabetes-related mortality across studies.

The strengths of the present study were the large sample used in the analysis, the prospective study design with an average follow-up of 5.7 years, and the assessment of personality using the Five Factor Model. The main limitation is reliance on self-reported data on diabetes, which may underestimate the prevalence of diabetes. Given that individuals with low conscientiousness tend to be less concerned with their health (Axelsson, Brink, Lundgren, & Lotvall, 2011; Hill & Roberts, 2011), self-reported data might have attenuated the association with incident diabetes because undiagnosed disease is probably more common in less conscientious individuals who tend to have medical check-ups less frequently than those with high conscientiousness. Measurement of diabetes mortality is also subject to misclassifications because diabetes may be underrecorded as the underlying cause of death in deaths caused by subsequent complications of diabetes, including coronary heart disease and stroke (Gu, Cowie, & Harris, 1998). If individuals with low conscientiousness are less likely to avoid these complications by not following treatment regimens, the association between conscientiousness and diabetes mortality might be underestimated to some degree.

People with high conscientiousness can be described as dutiful, task-oriented, orderly, and self-disciplined whereas individuals with low conscientiousness tend to be careless, unreliable, and disorganized (John et al., 2008). The association between conscientiousness and diabetes was very consistent across the five samples. This suggests that low conscientiousness is a potentially important upstream risk factor for developing diabetes across populations. Several health behaviors contribute to the risk of diabetes, and most of these risk factors are associated with conscientiousness (Bogg & Roberts, 2004). In particular, low conscientiousness is associated with higher risk of obesity (Jokela et al., 2013), one of the main drivers of metabolic changes leading to hyperglycemia. Obesity and physical inactivity partially mediated the association between conscientiousness and incident diabetes but contributed less to the association with diabetes-related mortality. This finding is consistent with the notion that obesity plays a more important role in the etiology than in the progression of diabetes (Kokkinos et al., 2012). Indeed, the progression of diagnosed diabetes to a fatal stage is often characterized by poor control of glucose levels and failure to manage cardiovascular complications. Further research is needed to examine whether conscientiousness is related to factors critical to successful diabetes treatment.

The finding that other personality traits were not consistently related to diabetes risk is also important. Many early theories of psychological medicine have emphasized the role of psychosocial

Table 1
Association of Conscientiousness With Diabetes Incidence and Mortality, Adjusted for Baseline Covariates

Adjustment	Diabetes incidence OR (95% CI)	Diabetes mortality‡ HR (95% CI)
Base model*	0.88 (0.84–0.92)	0.72 (0.53–0.99)
+ Education	0.89 (0.85–0.93)	0.73 (0.53–0.98)
+ Marital status	0.88 (0.84–0.93)	0.72 (0.54–0.95)
+ Smoking	0.89 (0.85–0.93)	0.72 (0.53–0.99)
+ Physical activity†	0.91 (0.87–0.96)[a]	0.75 (0.56–1.01)
+ Body mass index	0.95 (0.90–1.00)[a]	0.77 (0.57–1.04)
+ Blood pressure	0.89 (0.85–0.94)	0.72 (0.54–0.95)
+ Smoking, physical activity, BMI, blood pressure	0.97 (0.92–1.02)[a]	0.77 (0.59–1.02)
+ Baseline diabetes status		0.79 (0.60–1.05)[a]

Note. Base model was adjusted for gender, age at baseline, race/ethnicity, and follow-up time in months (for diabetes incidence). For diabetes incidence, n = 21,903 to 34,913 depending on covariates and cohorts included in the analysis. BMI = body mass index.
[a] Statistically significant mediation effect ($p < .05$) as determined with the mediation test for dichotomous variables (binary_mediation package of STATA 12.1).
* Odds ratio (OR) = .88 (0.84–0.93) for diabetes incidence without British Household and Panel Survey (BHPS) cohort. † BHPS cohort was not included in analyses including physical activity as a covariate. ‡ Diabetes mortality was examined in Health and Retirement Study, Wisconsin Longitudinal Study graduate and sibling cohorts (n = 108 diabetes-related deaths among 24,543 participants).

stress and sensitivity to negative emotions (related to high neuroticism), hostility (low agreeableness), and low sociability (low extraversion) in predisposing to physical illnesses (Smith & MacKenzie, 2006). The present results suggest that when all the five higher-level personality dimensions are considered together, conscientiousness is the only trait independently associated with diabetes risk. Our data therefore support conscientiousness as the most relevant personality dimension in terms of health consequences (Martin, Friedman, & Schwartz, 2007; Bogg & Roberts, 2004; Jokela et al., in press).

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Received December 29, 2012
Revision received March 18, 2013
Accepted April 24, 2013 ■