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Personality as a predictor of HbA1c level in patients with type 2 diabetes mellitus

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Abstract

Type 2 diabetes mellitus (T2DM) is the most common type of diabetes, accounting for around 90% of all cases worldwide. One means to strengthen the prevention and treatment of diabetes is via changes in self-management and lifestyle behaviors. However, lifestyle and personal health behaviors are strongly influenced by personality traits, and thus personality may play a significant role in such aspects as medication compliance, exercise habits, blood glucose monitoring, diet control, and maintenance of an ideal body weight.

In this study, we examined whether certain personality traits of patients with T2DM are correlated with higher glycohemoglobin (HbA1c) levels.

A total of 214 participants with T2DM were recruited from an outpatient setting. χ^2 test and logistic regression analyses with 5 models were employed.

The OR for the "neuroticism" trait was 3.199 (95% CI = 1.228–8.331, $P = .017$), and those with this trait were 3.199 times more likely to have higher HbA1c levels than those with the "openness-extraversion" personality trait. This strong relationship between neuroticism and a higher HbA1c level was also evident in models 2, 3, 4, and 5. One-way ANOVA also indicated that the group with the neuroticism personality trait had significantly different mean fasting glucose, HbA1c, triglyceride, and high-density lipoprotein cholesterol levels.

We found that a personality characterized by neuroticism is an independent predictor of higher HbA1c level in this study. We also found that people in the pre-contemplation and contemplation stages of exercise have higher HbA1c levels.

Abbreviations: BF = body fat, HbA1c = glycohemoglobin, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, OR = odds ratio, QB4 = quick big-4, T2DM = type 2 diabetes mellitus, TC = total cholesterol, TG = triglyceride, WC = waist circumference, WHR = waist-hip ratio.

Keywords: diabetes, glycemic control, medication adherence, personality

1. Introduction

Diabetes is an enormous chronic disease burden on the general population. The World Health Organization noted that there were 80 million diabetes patients in 1990. This number rose to 170 million in 2000, and by 2016, 422 million adults worldwide were believed to have the disease.[1] An estimated 3.7 million people die annually from consequences of high blood sugar, and there are also 1.5 million deaths attributed to diabetes.[1] More than 80% of diabetes deaths occur in low- and middle-income countries, and World Health Organization projects that diabetes will be the seventh leading cause of death in 2030.[1]

Type 2 diabetes mellitus (T2DM) is the most common type of diabetes, accounting for around 90% of all cases worldwide.[2] One goal of treatment is to enhance self-management strategies such as medication adherence,[3,4] physical activity, exercise,[5] and proper diet. Obesity, smoking, and alcohol consumption are all related to an increased risk of T2DM.[6,7]

Lifestyle and personal health behaviors are influenced by personality traits, which determine characteristic patterns of thinking, feeling, and behaving.[7,8] Personality may thus play a significant role in health-related behaviors such as exercise and diet.[8]

Recently, accumulating evidence has suggested that different personality traits may influence health behaviors and outcomes, especially in diabetes patients.[3,9–11] For example, personality traits that are characterized by dysphoria, worry, tension, and negative emotions ("Type D" personality) are more commonly associated with poor self-efficacy, poor social support, poor medication adherence, unhealthy behaviors, and poor glycemic control.[3,9,10] Results from cross-sectional and longitudinal surveys showed that the "Type A" personality is associated with

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The data that support the findings of this study are available from a third party, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are available from the authors upon reasonable request and with permission of the third party.

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good glycemic control due to a strong conscientious nature and a drive for goal-oriented behavior.[11] These personal characteristics possibly lead to positive behavior strategies such as eating healthy food, getting a regular medical examination, and being compliant with medication.

Some researchers have noted an association between an increased risk for high glycohemoglobin (HbA1c) level and specific traits, such as anxiety and "neuroticism,"[4,12,13] whereas "agreeableness," "conscientiousness," and emotional stability are associated with high levels of self-control, healthy diet, and improved adherence to medication and exercise regimens.[14] By contrast, in the Estonian Biobank cohort study, "openness to experience" was associated with a high risk of developing diabetes.

There is also evidence that certain personality traits are more associated with traits or behaviors that are correlated with diabetes, such as poor physical activity, unhealthy dietary choices, and increased alcohol intake.[12] People with greater "extraversion" are more likely to have metabolic syndrome.[15]

Bagnjuk et al[16] investigated the relationship between personality traits and obesity. They found that the extraversion trait had a positive relationship with obesity in a cross-sectional study, but a negative one in a longitudinal setting.

In a population-based cohort study, people with T2DM were found to be less extraverted, less conscientious, less agreeable, and less emotionally stable than those without T2DM.[17] However, these personality traits were not found to predict the incidence of diabetes or HbA1c levels.

The current work seeks to explore the association between personality and the development of diabetes. To our knowledge, the relationship between personality traits and HbA1c level has never been studied in patients with T2DM in Taiwan.

2. Methods

2.1. Participants

The participants were recruited from among patients who were diagnosed with T2DM in a Taiwan teaching hospital between August 2012 and July 2013. The study enrolment criteria were as follows: over 30 and under 65 years old; clear consciousness; and ability to communicate orally. We excluded from our study any patient who reported a physician-diagnosed mental illness, stroke, hemiplegia, acute angina, Alzheimer disease, severe cognitive impairment, active drug or alcohol addiction, need for insulin injections, or liver or renal function tests greater than 1.5 times the normal levels.

This study was approved by the Institutional Review Board of Taipei Medical University (TMU-JIRB: approval No. 201205036). The participants were informed about the study's purpose and the confidentiality of their individual data and also advised of their right to withdraw from the research study by simply failing to complete the questionnaire. A total of 214 valid questionnaires were obtained and the questionnaire availability was 97.7%.

2.2. Measures

The outcome variable was HbA1c level, which represented a dichotomous variable that set ≥ 7 as a high average blood glucose control over about 3 months.[18]

Personality traits were measured using a reliable and validated Chinese version of the Quick Big-4 (QB4).[19] The QB4 comprises 4 domains as follows: openness-extraversion (13-item), neuroticism (7-item), agreeableness (6-item), and conscientiousness (7-item). The extraversion trait was combined with the openness to experience trait in Wang's study as they found that Chinese people tended to consider these 2 traits as being the same thing.[19] The QB4 contains 33 items, rated on a 5-point scale, from 1 = "strongly disagree" to 5 = metabolic syndrome strongly agree."[19] We used the z-score of the total score for each personality trait because each personality trait has different item numbers.[20] In this study, high scores reflect a strong personality on each domain and associated behaviors.

All participants answered the questions regarding age, gender, marital status, education, socioeconomic status, lifestyle behaviors (e.g., smoking and alcohol use), and chronic diseases. A registered nurse assessed physical measurements, namely, waist circumference (WC), body fat percentage (BF), and waist–hip ratio (WHR). The fasting glucose, HbA1c, TG, total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) levels were assessed by standardized laboratory measurements.

The patients self-reported their own exercise behavior using the 5-point transtheoretical model scale.[21,22] The scale lists 5 stages of exercise behavior: 1 point for precontemplation (people do not intend to take action in the foreseeable future, usually measured as the next 6 months), 2 points for contemplation (people intend to change in the next 6 months), 3 points for preparation (people intend to take action in the immediate future, usually measured as the next month), 4 points for action (people have made specific overt modifications in their lifestyles within the past 6 months), and 5 points for maintenance (people are working to prevent relapse but they do not apply change processes as frequently as do people in action).[21,22]

2.3. Statistical analyses

Descriptive and χ^2 analyses were used to examine all predictor variables: age (as a continuous variable), gender, marital status (single, married, others), education (less than primary, secondary, university, and above), socioeconomic status (high, medium, low), smoking and alcohol use (never, former, current), and chronic disease (no, yes). Other measured variables were body composition, namely, WC (<90 cm in men; <80 cm in women), BF (normal $<25\%$ in men and $<30\%$ in women vs high), and WHR (normal <0.9 in men and <0.85 in women vs high). Clinical indicators were fasting glucose (<100 mg/dL vs high), HbA1c (normal <7 vs high), TC (<160 mg/dL vs high), LDL-C (normal <100 mg/dL vs high), HDL-C (normal >40 mg/dL vs low), and TG (normal <150 mg/dL vs high) levels.

Logistic regression analyses were carried out to examine the selected significant variables from χ^2 tests to determine which variables were significant in the analyses of 5 models. The first model included participants' characteristics; the second added personality traits controlling for age and gender; the third model in addition adjusted for exercise stage; the fourth model included body composition; and the fifth model additionally adjusted clinical indicators.

We also compared the 4 personality trait groups in terms of the dependent variables (namely, WC, BF, and WHR, and fasting glucose, HbA1c, TG, TC, LDL-C, and HDL-C levels) using one-way ANOVA. The assumptions under which ANOVA is reliable are the same as for all parametric tests based on the normal distribution. Thus, we performed the Levene test for all

Table 1

Multivariate association of measured variables with HbA1c (N = 214).

Variables	Total (%)	Mean (SD)	HbA1c <7 (%)	HbA1c ≥7 (%)	χ^2	*P*
Age (y)	214	55.64 (9.11)				
Gender					9.614	.002†
Male	92 (43.0)		63.0	37.5		
Female	122 (57.0)		37.0	62.5		
Marital status					5.477	.065
Single	26 (12.1)		10.9	12.5		
Married	166 (77.6)		69.9	79.8		
Others	22 (10.3)		19.6	7.7		
Education					1.14	.566
≤ Primary	49 (22.9)		17.4	24.4		
Secondary	78 (36.4)		37.0	36.3		
≥University	87 (40.7)		45.7	39.3		
Socioeconomic status					3.101	.212
High	46 (21.5)		21.7	21.4		
Medium	50 (23.4)		32.6	20.8		
Low	118 (55.1)		45.7	57.7		
Personality trait					15.852	.001†
Openness-extraversion	66 (30.8)		41.3	28.0		
Neuroticism	75 (35.0)		17.4	39.9		
Agreeableness	39 (18.2)		32.6	14.3		
Conscientiousness	34 (16.0)		8.7	17.9		
Smoking status					2.282	.320
Never	153 (71.5)		73.9	70.8		
Former	24 (11.2)		15.2	10.1		
Current	37 (17.3)		10.9	19.0		
Alcohol use					0.515	.773
Never	162 (75.7)		76.1	75.6		
Former	19 (8.9)		6.5	9.5		
Current	33 (15.4)		17.4	14.9		
Exercise Stage					21.694	<.000‡
Precontemplation	38 (17.8)		4.3	21.4		
Contemplation	100 (46.7)		34.8	50.0		
Preparation	19 (8.9)		10.9	8.3		
Action	37 (17.3)		28.3	14.3		
Maintenance	20 (9.3)		21.7	6.0		
Diabetes duration (y)	8.86 (5.95)				1.306	.728
<5	74 (34.6)		41.3	32.7		
6–10	67 (31.3)		28.3	32.1		
11–15	49 (22.9)		21.7	23.2		
≥16	24 (11.2)		8.7	12.0		
Chronic diseases					2.127	.145
No	44 (20.56)		28.3	18.5		
Yes	170 (79.44)		71.7	81.5		
Body fat	29.76 (8.50)				10.428	.001†
Normal (<25% in men; <30% in women)	86 (40.2)		60.9	34.5		
High	128 (59.8)		39.1	65.5		
Waist Circumference	91.7 (11.04)				2.797	.094
Normal (<90 cm in men; <80 cm in women)	50 (23.4)		32.6	20.8		
High	164 (76.6)		67.5	79.2		
Waist-hip ratio	0.91 (0.06)				4.698	.030*
Normal (<0.9 in men; <0.85 in women)	91 (42.5)		56.5	38.7		
High	123 (57.5)		43.5	61.3		
Triglyceride	147.47 (85.30)				19.308	<.000‡
Normal (<150 mg/dL)	142 (66.4)		93.5	58.9		
High	72 (33.6)		6.5	41.1		
Fasting Glucose	166.05 (55.67)				0.093	.761
<100 mg/dL	12 (5.6)		6.5	5.4		
>100 mg/dL	202 (94.4)		93.5	94.6		
Total Cholesterol	175.59 (38.11)				0.232	.298
<160 mg/dL	77 (36)		43.5	33.9		
>160 mg/dL	137 (64)		56.5	66.1		
LDL-C	103.83 (23.45)				0.455	.500

(*continued*)

Table 1

(continued).

Variables	Total (%)	Mean (SD)	HbA1c <7 (%)	HbA1c ≥7 (%)	χ^2	*P*
Normal (<100 mg/dL)	93 (43.5)		47.8	42.3		
High	121 (56.5)		52.2	57.7		
HDL-C	39.08 (13.49)				17.12	<.000‡
Normal (<40 mg/dL)	109 (50.9)		76.1	41.7		
High	105 (49.1)		23.9	58.3		
HbA1c	8.29 (1.63)					
Normal (<7%)	46 (21.5)					
High	168 (78.5)					

* $P < .05$.
† $P < .01$.
‡ $P < .001$.

dependent variables to determine the homogeneity of the data, and then we used the Tukey HSD test if the result of the Levene test was not significant. Likewise, we used the Games–Howell test if the assumption of equal variances could not be justified.[23]

An effect size measure for ANOVA is eta squared, written as η^2, which is used to evaluate the magnitude of observed differences. It is interpreted as follows: < 0.2 (small), > 0.2 and < 0.8 (moderate), and > 0.8 (large).[24] Data were analyzed using SPSS v18.[25] All *P* values were 2-tailed, and values less than.05 were taken to indicate statistical significance.

3. Results

The participants ranged in age from 30 to 65 years, with a mean age of 55.64 years (SD = 9.11) and included 92 (43%) males and 122 females (57%). The sample was more likely to be female and married, had university education and low socioeconomic status, possessed the neuroticism trait, never smoked, never used alcohol, had diabetes for less than 5 years, and had other chronic diseases (Table 1).

We used the χ^2 test to determine whether related variables differed on HbA1c. One group ("low HbA1c") had HbA1c levels less than 7; the other group had HbA1c levels of 7 and above. As shown in Table 1, the Pearson χ^2 indicated that gender ($\chi^2 = 9.614$, $P = .002$), personality traits ($\chi^2 = 15.852$, $P = .001$), exercise stage ($\chi^2 = 21.694$, $P < .001$), BF ($\chi^2 = 10.428$, $P = .001$), WHR ($\chi^2 = 4.698$, $P = .03$), TG level ($\chi^2 = 19.308$, $P < .001$), and HDL-C level ($\chi^2 = 17.12$, $P < .001$) all differed significantly between the 2 groups that were differentiated by HbA1c level. The group with high (>7) HbA1c levels were more closely associated with the following variables: female, neuroticism trait, contemplation exercise stage, high BF, high WHR, normal TG level, and high HDL-C level.

The 5-model Cox and Snell R^2 indicated that the proportions of variance explained by the predictors were approximately 8.6%, 14.6%, 19.7%, 20.4%, and 26.3% (Table 2). The Cox and Snell R^2 is usually an underestimation however, the Nagelkerke R^2 showed that 13.3%, 22.6%, 30.5%, 31.5%, and 40.6% of the variance can be predicted from the linear combination of the independent variables in each model (Table 2).

Table 2 shows the independent variables that predicted <7 HbA1c versus ≥7 HbA1c by logistic regression analyses. In the baseline model, the odds ratio (OR) for age was 0.935 (95% confidence interval [CI] = 0.892–0.979, $P = .005$) and that for gender was 3.985 (95% CI = 1.927–8.239, $P < .001$). In other words, older age was less likely to be associated with a high HbA1c level, whereas females were 3.985 times more likely than males to have a be in the high HbA1c group. Both younger age and female subjects were more likely to be in the high HbA1c groups in models 2, 3, and 4. However, in the model 5, only gender still had a significant relationship with the high HbA1c group; age did not show a significant relationship with HbA1c level in the model 5.

Model 2 was controlled for age and gender. Gender was found to be significantly related to the high HbA1c group. The OR for the neuroticism trait was 3.199 (95% CI = 1.228–8.331, $P = .017$), and those with this trait were 3.199 times more likely to be in the high HbA1c group than those with the openness-extraversion trait. This strong relationship between the neuroticism trait and a high HbA1c level was also reflected in models 3, 4, and 5.

Model 3 incorporated the exercise stage. The results for this model were as follows: OR for the preparation stage was 0.142 (95% CI = 0.022–0.920, $P = .041$), that for action stage was 0.127 (95% CI = 0.025–0.658, $P = .014$), and that for maintenance stage was 0.079 (95% CI = 0.013–0.472, $P = .005$). The preparation, action, and maintenance stages were less likely than the precontemplation stage to be associated with high HbA1c levels. This was also seen in model 4. No other variables were noted to be related to high HbA1c levels in model 5.

We added WHR and BF to model 4, and the OR for WHR was 1.388 (95% CI = 0.573–3.362, $P = .468$) and that for BF was 1.657 (95% CI = 0.735–3.734, $P = .223$). These 2 predictors did not add enough to reach significance.

In model 5, the OR for TG level was 0.136 (95% CI = 0.034–0.542, $P = .005$) and that for HDL-C level was 0.434 (95% CI = 0.170–1.107, $P = .08$). Those in the high HbA1c group were more likely to have a high TG level, whereas HDL-C level did not show a relationship with high or low HbA1c levels (Table 2).

Table 3 shows that those with the agreeableness personality trait had low mean WC (88.36), WHR (0.88), and fasting glucose (148.36), HbA1c (7.71), and TG (128.79) levels. They also had high mean HDL-C levels (42.67). Those with the extraversion personality trait had low mean BF (28.07) and TC (167.91) levels, whereas those with the neuroticism personality trait had low mean LDL-C (101.03) levels. The Levene test showed significant results for WC, BF, and HbA1c and TG levels, and this meant that these variables' sample sizes were not equal, so we used the Games–Howell test to analyze these variables.

Table 2

Five models of significant correlates of low-high HbA1c from binary logistic regression (N = 214).

		Model 1		Model 2		Model 3		Model 4		Model 5	
Variable (reference)	**Category**	**OR (CI 95%)**	***P***	**OR (CI 95%)**	***P***	**OR (CI 95%)**	***P***	**OR (CI 95%)**	***P***	**OR (CI 95%)**	***P***
Age		0.935 (0.892–0.979)	.005[¶]	0.940 (0.896–0.986)	.012[‖]	0.950 (0.904–0.998)	.042[‖]	0.949 (0.902–0.998)	.043[‖]	0.964 (0.916–1.016)	.170
Gender (male)	Female	3.985 (1.927–8.239)	<.000[#]	4.055 (1.861–8.835)	<.000[#]	3.273 (1.441–7.433)	.005[¶]	3.172 (1.239–8.121)	.016[‖]	4.902 (1.673–14.362)	.004[¶]
Personality (openness-extraversion)				0.004[¶]		0.007[¶]		0.007[¶]		0.019[‖]	
	Neuroticism			3.199 (1.228–8.331)	.017[‖]	3.409 (1.247–9.316)	.017[‖]	3.432 (1.238–9.513)	.018[‖]	3.202 (1.103–9.293)	.032[‖]
	Agreeableness			0.566 (0.215–1.489)	.249	0.725 (0.252–2.079)	.549	0.713 (0.243–2.090)	.537	0.547 (0.169–1.772)	.314
	Conscientiousness			2.698 (0.801–9.091)	.109	3.496 (0.969–12.608)	.056	3.390 (0.936–12.278)	.063	1.615 (0.400–6.521)	.501
Exercise (precontemplation)						0.029[‖]		0.041[‖]		0.561	
	Contemplation					0.285 (0.058–1.397)	.122	0.240 (0.045–1.278)	.095	0.522 (0.089–3.060)	.471
	Preparation					0.142 (0.022–0.920)	.041[‖]	0.135 (0.020–0.912)	.040[‖]	0.431 (0.058–3.200)	.410
	Action					0.127 (0.025–0.658)	.014[‖]	0.119 (0.022–0.656)	.014[‖]	0.361 (0.058–2.265)	.277
	Maintenance					0.079 (0.013–0.472)	.005[¶]	0.074 (0.012–0.464)	.005[¶]	0.209 (0.029–1.522)	.122
Waist–hip ratio (high)[*]	Normal							1.388 (0.573–3.362)	.468	2.096 (0.756–5.811)	.155
Body fat (normal)[†]	High							1.657 (0.735–3.734)	.223	1.634 (0.675–3.958)	.276
Triglyceride (high)[‡]	Normal									0.136 (0.034–0.542)	.005[¶]
HDL-C (low)[§]	Normal									0.434 (0.170–1.107)	.080
Constant		84.721	.001[¶]	42.784	.006[¶]	108.898	.004[¶]	85.147	.007[¶]	95.465	.008[¶]
-2 Log likelihood		203.518		188.861		175.799		174.008		157.551	
Cox and Snell R Square		0.086		0.146		0.197		0.204		0.263	
Nagelkerke R Square		0.133		0.226		0.305		0.315		0.406	

[*] Waist–hip ratio (<0.9 in men; <0.85 in women).
[†] Body fat (<25% in men; <30% in women).
[‡] Triglyceride (<150 mg/dL).
[§] High-density lipoprotein cholesterol (<40 mg/dL).
[‖] $P < .05$.
[¶] $P < .01$.
[#] $P < .001$.

Table 3

Means, SD, and Levene statistic comparing 4 personality trait groups.

	Extraversion (n = 66)		Neuroticism (n = 34)		Agreeableness (n = 39)		Conscientiousness (n = 75)			
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Levene statistic**	***P***
Waist circumference	92.86	11.29	92.35	7.921	88.36	9.816	92.16	12.413	2.677	.048*
Waist–hip ratio	0.91	0.07	0.91	0.04	0.88	0.07	0.92	0.07	2.295	.079
Body fat (%)	28.07	6.851	30.84	8.462	29.70	9.22	30.79	9.32	2.814	.040*
Fasting glucose	168.53	55.81	193.06	69.18	148.36	42.76	160.81	50.77	1.463	.226
HbA1c (%)	8.16	1.64	9.10	1.89	7.71	1.64	8.33	1.37	4.280	.006*
Triglyceride	137.85	62.55	188.32	103.25	128.79	64.21	147.13	97.98	3.347	.020*
Total Cholesterol	167.91	28.26	177.03	63.57	180.92	38.23	178.93	29.08	2.444	.065
HDL-C	39.85	14.29	31.82	12.61	42.67	14.07	39.84	11.84	0.610	.609
LDL-C	102.09	25.06	101.03	18.12	102.23	24.54	107.47	23.54	0.596	.618

* $P < .05$.

A statistically significant difference was found among the 4 personality trait groups in terms of WHR ($F_{3,210} = 4.244$, $P = .006$, $\eta^2 = 0.006$, small) and fasting glucose ($F_{3,210} = 4.452$, $P = .005$, $\eta^2 = 0.006$, small), HbA1c ($F_{3,210} = 4.244$, $P = .006$, $\eta^2 = 0.006$, small), TG ($F_{3,210} = 4.244$, $P = .006$, $\eta^2 = 0.006$, small), and HDL-C ($F_{3,210} = 4.244$, $P = .006$, $\eta^2 = 0.006$, small) levels (Table 4).

Table 4

One-way ANOVA summary table comparing personality trait groups on all dependent variables.

Variables	***df***	**SS**	***MS***	***F***	***P***	**Effect size η^2**
Waist circumference§						
Between groups	3	553.874	184.625	1.525	.209	0.02
Within groups	210	25418.202	121.039			
Total	213	25972.076				
Waist–hip ratio‡						
Between groups	3	0.049	0.016	4.244	0.006†	0.06
Within groups	210	0.812	0.004			
Total	213	0.861				
Body fat (%)§						
Between groups	3	307.764	102.588	1.429	0.235	0.02
Within groups	210	15076.221	71.792			
Total	213	15383.984				
Fasting glucose‡						
Between groups	3	39470.850	13156.950	4.452	.005†	0.06
Within groups	210	620624.683	2955.356			
Total	213	660095.533				
HbA1c (%)§						
Between groups	3	36.618	12.206	4.822	.003†	0.06
Within groups	210	531.540	2.531			
Total	213	568.158				
triglyceride§						
Between groups	3	76466.380	25488.793	3.633	.014*	0.05
Within groups	210	1473154.952	7015.024			
Total	213	1549621.332				
Total cholesterol‡						
Betweven groups	3	5911.770	1970.590	1.364	.255	0.02
Within groups	210	303401.861	1444.771			
Total	213	309313.631				
HDL-C‡						
Between groups	3	2374.313	791.438	4.564	.004†	0.06
Within groups	210	36412.173	173.391			
Total	213	38786.486				
LDL-C‡						
Between groups	3	1557.929	519.310	0.944	.420	0.01
Within groups	210	115548.015	550.229			
Total	213	117105.944				

* $P < .05$.

† $P < .01$.

‡ We used the Tukey HSD because variances can be assumed to be equal (i.e., the Levene test is not significant).

§ We used the Games-Howell because the assumption of equal variances cannot be justified (i.e., the Levene test is significant).

For WHR, the conscientiousness personality trait was compared with the openness-extraversion and neuroticism personality traits, and the difference was not significant, but when compared with the agreeableness personality trait, there was a significant mean difference (0.04, $P = .003$).

For the fasting glucose level, neuroticism was compared with openness-extraversion, and the difference was not significant, but when compared with conscientiousness (32.25, $P = .023$) and agreeableness (44.70, $P = .003$), there was a significant mean difference.

For the HbA1c level, neuroticism was compared with the openness-extraversion and conscientiousness traits, and the difference was not significant. When neuroticism was compared with agreeableness, the group means differed significantly (1.39, $P = .007$).

For the TG level, there was no significant mean difference among neuroticism, openness-extraversion, and conscientiousness traits. When neuroticism was compared with agreeableness, group means differed by 59.53 ($P = .026$), which was significant.

For the HDL-C level, neuroticism was compared with openness-extraversion, conscientiousness, and agreeableness. Group means differed by −8.03 ($P = .022$), −8.02 ($P = .019$), and 10.84 ($P = .003$), respectively which were significant.

4. Discussion

In this study, our data suggest that certain personality traits are predictive of HbA1c level in χ^2 tests. Other predictive factors are gender, exercise stage, BF, WHR, and TG and HDL-C levels. This finding is consistent with previous research as well as growing evidence based on the interplay between diabetes and lifestyle, stress, diet, chronic disease, and healthy behavior.[16,17]

Our logistic regression analyses found that a personality characterized by the neuroticism trait was an independent predictor of HbA1c level; specifically, those with the neuroticism personality trait were 3.199 times more likely than those with the openness-extraversion personality trait to have higher levels of HbA1c, after controlling for demographics.[4,12,13] After we added exercise stage to the model with personality trait groups, our findings confirmed previous work that showed that people in the precontemplation and contemplation stages of exercise had high HbA1c levels.[5] When exercise stages as well as neuroticism were examined, the significant statistical correlation with high HbA1c levels was consistent with a previous study that showed that neuroticism is related to exercise adherence.[13] The one-way ANOVA also indicated that those with neuroticism had significantly different fasting glucose, HbA1c, TG, and HDL-C mean levels. These are all relevant to both metabolic syndrome and T2DM. Our findings suggest that neuroticism confers a propensity to the development of diabetes.

Conscientiousness and self-control have been shown to have protective functions in relation to weight gain. Neuroticism, impulsivity, and sensitivity to reward appear as risk factors. Conscientiousness measures regulation of internal urges and self-discipline, and thus may provide a possible source of control over impulsive reward-oriented behavior.[16] Low conscientiousness, a cognitive behavioral disposition reflecting careless behavior, and a lack of self-control and planning are associated with an elevated risk of diabetes and diabetes-related mortality.[17] The underlying mechanisms likely involve health behaviors such as poor weight management, physical inactivity, and poor adherence to medical management recommendations.[12,13]

Personality is formed by family, peers, social environment, and other factors. The neuroticism trait tends to be associated with anxiety, depression, irritability, feelings of weakness or helplessness, and unstable emotions.[8,13] People with neuroticism often have low levels of self-control and self-efficacy, along with poor medical adherence and weight control. However, a study showed that patients with the openness personality trait are also associated with a high risk of developing diabetes.[12] It is possible that these patients with T2DM do not worry about their disease, which reflects on their degree of curiosity or imagination.

This study has several limitations. First, the patients in this study were recruited from only 1 hospital, and they are unlikely to represent all adults with T2DM in Taiwan. Second, our analyses and conclusions are largely based on self-administered questionnaires, although all biological parameters were assessed at a teaching hospital. Third, questionnaires were completed by participants without intervention from the interviewer, and the data likely include recall bias (and others). Further studies need to have stronger study designs to investigate the relationship between personality traits and HbA1c level.

5. Conclusions

On the basis of this study, we suggest that a direct relationship exists between personality traits and HbA1c level. This indicates that much attention should be directed to the impact of personality on chronic illness as another way to help predict (and control) the progression of diseases such as diabetes. This information can help health professionals provide appropriate and targeted health guidance, as well as predict and prioritize which patient populations may have considerable difficulty embracing healthy lifestyles. This will allow improvements not only in the quality of patient care but also in how appropriate support and social resources are provided.

Author contributions

Conceptualization: Shu-Fen Lee.
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