ORIGINAL ARTICLE

Does Personality and Anxiety Symptomatology Matter in the Diabetes Mellitus Treatment Adherence? A Cross -Sectional Study Among Women with Diabetes Mellitus.

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ABSTRACT

INTRODUCTION: Anxiety is prevalent among women with diabetes mellitus (DM). Women also tend to have a higher level of neuroticism. Both underlying neuroticism trait and anxiety symptoms can have an impact on social functioning and diabetes care. This study aimed to determine the relationships between neuroticism and anxiety symptoms, and other clinical and psychosocial variables, among females with DM. **MATERIALS AND METHODS**: This was a cross-sectional study conducted among women with DM in a Malaysian university hospital. Sociodemographic and clinical variables were acquired, including perceptions on religious practice, social support, and diabetic self-care. Study subjects completed the Generalized Anxiety Disorder 7-item (GAD-7) and the Big-Five Inventory (BFI). The neuroticism subscale of the BFI was used for analysis. **RESULTS**: There were 141 subjects (Median age: 64.0 years, IQR: 52.5–71.0 years) with a median duration of DM of 12.0 years (IQR: 6.0–20.0 years). Neuroticism scores correlated positively with the GAD-7 scores (Spearman's rho: 0.406; p<0.001). In bivariate analyses, neuroticism also had significant associations with employment status (p=0.023), religious practice (p=0.006), perceived social support (p=0.001), and perceived ability of diabetic self-management (p<0.001). In the regression analysis, after controlling for employment, religious practice, and social support, neuroticism remained associated with anxiety (p<0.001) and diabetic self-management (p=0.001). **CONCLUSION**: Neuroticism was related to a poorer subjective sense of diabetic management and a greater level of anxiety among women with DM. Improving self-efficacy in managing diabetes may help patients coping with anxiety symptoms among those with neuroticism traits, contributing to better treatment among women with DM.

Keywords
anxiety; diabetes mellitus; female; neuroticism; personality; self-care

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INTRODUCTION

Diabetes mellitus (DM) is one of the most common debilitating chronic conditions leading to decreased quality of life, increasing care cost, and reduction in life expectancy. Worldwide, it was estimated that in 2017, there were 451 million (age 18-99 years) people suffering from DM and it was expected to increase to 693 million by 2045.[1] DM is also a key public health concern in Malaysia and is known to increase premature and preventable mortality.

Anxiety is among the highly prevalent mental health conditions, estimated to be affecting 284 million people globally in 2017.[2] According to the World Health Organization (WHO), up to 20% of healthcare attending women in developing countries suffer from anxiety disorders.[3] DM is associated with an increased risk of psychological disorders with anxiety being considered as the commonest comorbidity. A large international study involving more than 3000 individuals with type DM from 15 countries reported an overall prevalence of anxiety disorders of 18%.[4] Past meta-analysis indicated that patients with DM face a greater likelihood of experiencing anxiety compared to the general population.[5,6]

Numerous studies concluded that anxiety symptoms are significantly more prevalent in females compared to males. [4,7,8] Based on a recent study of 48 reviews, it was revealed that females were almost twice as likely to be affected as males with female: male ratio of 1.9:1.[9] Anxious individuals were found to have significantly higher mean fasting blood-glucose level comparatively, associated with greater diabetic complications, poorer quality of life with poor treatment adherence,[10] and higher mortality risk.[11]

Neuroticism, one of the domains of the Five-Factor Model of personality, refers to an enduring tendency to experience negative emotions with emotional instability.[12,13] Individuals scoring high on neuroticism are more susceptible to experience feelings of anxiety, anger, guilt, and depression. It is also well-known that the prevalence of the neuroticism trait is higher in women compared to men. [14,15]

The present work is a part of another study, the Anxiety, Depression, And Personality Traits in Diabetes Mellitus (ADAPT-DM) study carried out at the Universiti Kebangsaan Malaysia Medical Centre, UKMMC.[16] The main objectives of the present study were: (a) to measure neuroticism trait among female patients with DM; (b) to determine the level of anxiety symptoms; (c) to investigate the relationship between levels of neuroticism with anxiety symptoms, sociodemographic factors, and diabetes-related factors. Based on the available literature, we hypothesized that neuroticism trait is significantly associated with anxiety symptoms, social functioning, and diabetes care.

MATERIALS AND METHODS

Study Design and Participants

This was a cross-sectional study conducted at Universiti Kebangsaan Malaysia Medical Centre (UKMMC), a tertiary referral centre in Kuala Lumpur, Malaysia. Approval was obtained from the Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM FPR.SPI 800-2/28/166/FF-2019-342). Patients who attended medical outpatient clinics at UKMMC were recruited via convenience sampling. Interested patients were provided with information about the study. Eligible patients had given their informed consent prior to participation in the study. The inclusion criteria for this study were: (1) being 18 years and above, (2) female, and (3) having a confirmed diagnosis of type 1 or type 2 DM. Patients with impaired mental capacity, such as those with active psychosis and dementia, were excluded from the study. As the BFI neuroticism score was the main outcome measurement, the sample size was estimated based on it. Using the standard deviation of 0.6 for the BFI neuroticism score,[14] with a precision of 0.1 and a confidence interval of 95%, a sample size of 139 was required.[17]

Measuring Instruments

Study participants were asked to complete a series of questionnaires. Data collected via clinical interview and/or from patient records included: (1): Demographic data (age, race, marital status, employment status, household income, and religion); (2) Social history (practice of religion, perceived level of social support, smoking, and alcohol use); (3) Medical history; (4) DM history (duration, type, and insulin therapy); (5) Body mass index (BMI), classified according to the WHO recommendations for BMI categories in Asian populations; (6) HbA1c levels; and (7) Perceived good self-management of DM (Five-point Likert scale, from 'strongly agree' to 'strongly disagree').

Additional information was collected using validated questionnaires completed by patients at the time of the interview. The following validated instruments in the Malay language were employed: *Seven-item Generalised Anxiety Disorder scale (GAD-7)*: It is a self-reported questionnaire with good reliability, having a sensitivity for diagnosing anxiety (cut point ≥8) of 92% and specificity of 76%.[18] The GAD-7 has been found to be a good case-finding instrument for GAD, panic disorder, social anxiety disorder, and post-traumatic stress disorder (PTSD). The Malay version of the GAD-7 was found to be valid and reliable in case-finding for anxiety with good sensitivity of 76% (95% CI 61%–87%) and specificity of 94% (88%–97%).[19] Participants with scores ≥ 8 were classified as having anxiety disorders.

Big Five Inventory (BFI): This is a short instrument to measure the five-factor structure of personality. The BFI includes 44 items divided into five subscales: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness. Participants were asked to select the most relevant response on a 5-point scale: 0-Strongly Agree, 1-Agree, 2-Neutral, 3-Disagree, 4-Strongly Disagree.[20] It has been successfully translated into Malay. The Malay version of the BFI showed good internal consistency as well as good convergent and discriminant validity.[21]Subscal e's scores were calculated based on the answers for analyses.

Data Analysis

Statistical analysis was carried out using the Statistical Package for Social Science (SPSS), version 20 (IBM Corp., Armonk, NY, USA) software programme. Both GAD-7 and BFI neuroticism scores were not normally distributed (Kolmogorov-Smirnov test: $p<0.001$ for GAD-7 scores and $p=0.006$ for neuroticism scores). Correlation analyses were conducted between BFI neuroticism scores and other continuous variables, including GAD-7 scores, using the Spearman correlation coefficients. BFI neuroticism scores across categorical and ranked variables were analysed using the Mann-Whitney U test (2 categories), Kruskal-Wallis test (>2 categories), and Jonckheere-Terpstra test (ranked

variables). Multivariate linear regression analysis, including significant variables from univariate analyses, was conducted to determine variables associated with BFI neuroticism scores. Missing values were handled using the listwise deletion method in the regression model.[22] All tests were two-tailed. The significance level (α) was set at 0.05.

RESULTS

The total number of study participants was 141, with a median age of 64.0 years (IQR: 52.2-71.0 years). Other sociodemographic characteristics of the participants are shown in Table 1. The majority of the participants agreed or strongly agreed that they practised their religion frequently (84.4%) and had good social support (82.2%). With regards to DM, 87.2% were diagnosed with type 2 DM. The median duration of illness was 12.0 years (IQR: 6.0 - 20.0 years). For the objective measure of diabetic control, the median HbA1c level was 7.5% (IQR: 6.6%-9.3%). Subjectively, 74.5% of the participants agreed or strongly agreed to the statement, 'I am able to manage my diabetes well'. The rates of other medical conditions are given in Table 2.

The BFI neuroticism scores (Median 2.5, IQR: 2.1 – 2.9) showed a significant correlation with GAD-7 scores (Median 0.0, IQR: 0.0 – 3.0), but not with other continuous variables (Table 3). When BFI scores were compared across categorical and ranked variables, significant differences were found across categories of employment status (p=0.023), levels of religious practice frequency (p=0.006), levels of social support (p=0.001), and levels of perceived ability for diabetic self-management (p<0.001).

The GAD-7 scores, employment, practice of religion, social support, and perceived ability for diabetic self-management were entered into a multivariate linear regression model for the BFI neuroticism scores (Table 4). While employment, the practice of religion, and social support became statistically insignificant, neuroticism remained associated with the GAD-7 scores (p<0.001) and perceived diabetic self-management (p=0.001).

Table 1. Demographic and social variables of the study participants.

Variables	N	%
Race		
Malay	99	70.2
Chinese	23	16.3
Indian	17	12.1
Others	2	1.4
Marital status		
Married	89	63.1
Single	17	12.1
Divorced/separated	4	2.8
Widowed	30	21.3
Missing	1	0.7
Employment		
Employed	59	41.8
Unemployed	35	24.8
Retired	45	31.9
Missing	2	1.4
Household income		
<RM3,000	92	65.2
RM3,000-6,000	27	19.1
>RM6,000	16	11.3
Missing	6	4.3
Religion		
Islam	101	71.6
Buddhism	17	12.1
Hinduism	15	10.6
Christianity	6	4.3
Others	1	.7
Missing	1	0.7
Frequently practise religion		
Strongly disagree	3	2.1
Disagree	4	2.8
Neutral	15	10.6
Agree	66	46.8
Strongly agree	53	37.6
Have good social support		
Strongly disagree	0	0
Disagree	5	3.5
Neutral	20	14.2
Agree	90	63.8
Strongly agree	26	18.4
Smoking		
Never	137	97.2
Ex-smoker	3	2.1
Current smoker	1	.7
Alcohol use		
Yes	2	1.4
No	139	98.6

Table 2. Diabetes-related and other clinical variables.

Variables	N	%
DM type		
Type 1	10	7.1
Type 2	123	87.2
Gestational	6	4.3
Missing	2	1.4
Insulin therapy		
Yes	72	51.1
No	53	37.6
Missing	16	11.3
'I am able to manage my diabetes well'		
Strongly disagree	1	0.7
Disagree	5	3.5
Neutral	29	20.6
Agree	55	39.0
Strongly agree	50	35.5
Missing	1	0.7
Obesity		
BMI <23.0 kg/m^2	21	14.9
BMI 23.0-27.5 kg/m^2	27	19.1
BMI >27.5 kg/m^2	53	37.6
Missing	40	28.4
Hypertension		
Yes	106	75.2
No	35	24.8
Dyslipidaemia		
Yes	76	53.9
No	65	46.1
Ischaemic heart disease		
Yes	26	18.4
No	115	81.6
Stroke		
Yes	10	7.1
No	131	92.9
Renal disease		
Yes	22	15.6
No	119	84.4

As the study included participants with various subtypes of DM, additional subgroup analyses were conducted for subjects with type 2 DM only (N=123) to check the validity of the findings. The results of these bivariate analyses and multivariate linear regression analysis are presented in the Supplementary Tables (Tables S1 – S3). The findings were largely similar to the main analyses, with the linear regression model producing the same significant associations between neuroticism and GAD-7 scores as well as perceived diabetic self-management (Table S3).

Table 3. BFI neuroticism scores across sociodemographic and clinical variables.

Variables		BFI neuroticism score		*p*-value
		Median	IQR	
Race[a]				0.069
	Malay	2.38	0.8	
	Chinese	2.75	0.88	
	Indian	2.75	0.75	
	Others	2.26	NA	
Marital status[a]				0.849
	Married	2.5	0.87	
	Single	2.57	1.07	
	Divorced/separated	2.13	NA	
	Widowed	2.5	0.6	
Employment[a]				0.023*
	Employed	2.75	0.88	
	Unemployed	2.5	0.6	
	Retired	2.25	0.71	
Household income[b]				0.128
	<RM3,000	2.62	0.67	
	RM3,000-6,000	2.38	1	
	>RM6,000	2.38	0.94	
Religion[a]				0.051
	Islam	2.38	0.73	
	Buddhism	2.82	0.69	
	Hindusim	2.75	0.91	
	Christianity	2.88	1.41	
	Others	0	NA	
Frequently practise religion[b]				0.006*
	Strongly disagree	3	NA	
	Agree	2.69	0.32	
	Neutral	2.69	0.75	
	Agree	2.38	0.84	
	Strongly agree	2.4	0.92	
Have good social support[b]				0.001*
	Strongly disagree	NA	NA	
	Agree	2.5	0.34	
	Neutral	2.8	0.75	
	Agree	2.5	0.87	
	Strongly agree	2.13	0.88	
Smoking[a]				0.967
	Never	2.5	0.78	
	Ex-smoker	2.5	NA	
	Current smoker	0	NA	
Alcohol use[c]				0.843
	Yes	0	NA	
	No	2.5	0.75	
Insulin therapy[c]				0.885
	Yes	2.44	0.88	
	No	2.45	0.76	
'I am able to manage my diabetes well'[b]				<0.001*
	Strongly disagree	NA	NA	
	Disagree	3	NA	
	Neutral	2.63	0.72	
	Agree	2.5	0.78	
	Strongly agree	2.25	1	
Obesity[b]				
	BMI <23.0 kg/m^2	2.25	1.25	0.395
	BMI 23.0-27.5 kg/m^2	2.38	0.87	
	BMI >27.5 kg/m^2	2.63	0.65	
Hypertension[c]				0.384
	Yes	2.44	0.82	
	No	2.45	0.95	
Dyslipidaemia[c]				0.952
	Yes	2.25	0.76	
	No	2.5	0.75	
Ischaemic heart disease[c]				0.054
	Yes	2.44	0.73	
	No	2.45	0.75	
Stroke[c]				0.684
	Yes	2.13	0.75	
	No	2.5	0.88	
Renal disease[c]				0.966
	Yes	2.63	0.56	
	No	2.4	0.88	

Variable	Spearman's correlation coefficient	*p*-value
Age	0.084	0.324
Duration of DM	0.073	0.418
HbA1c	-0.012	0.894
G A D - 7 scores	0.406	<0.001*

[a]Kruskal-Wallis test; [b]Jonckheere-Terpstra test; [c]Mann-Whitney U test

*Statistically significant

Table 4. Multivariate linear regression for variables associated with BFI neuroticism scores.

Variable	Coefficient	95% CI		*p*-value
		Lower	Upper	
GAD-7 scores	0.052	0.030	0.075	<0.001 *
Employment	-0.058	-0.151	0.035	0.221
Practice of religion	-0.084	-0.185	0.017	0.104
Social support	-0.066	-0.197	0.064	0.317
'I am able to manage my diabetes well'	-0.167	-0.259	-0.074	0.001*

$F(5, 132) = 11.951$, $p < 0.001$, $R^2 = 0.312$
* Statistically significant

DISCUSSION

The present study revealed no association between neuroticism and objective measures of diabetic control. However, neuroticism was related to a poorer subjective sense of diabetic management and a greater level of anxiety among females with DM.

In this study, the presence of neuroticism trait was found to correlate with anxiety symptoms. Most studies show strong association between neuroticism and anxiety suggesting that the neuroticism trait itself predisposes to the emergence of anxiety symptoms.[6,23]. High neuroticism trait leads to negative emotions such as worry, fear, depression, etc., predisposing to anxiety. In certain conditions, an individual with neuroticism trait tends to experience such intense negative emotions especially when stressors are not well managed, eventually leading to poorer outcome.[24,25]

Compared to other personality traits, neuroticism was shown to be a strong predictor of psychopathology. It is evident that anxiety is closely associated with neuroticism traits [7,26] emerging as a vulnerability factor for the development of anxiety. [27,28] According to Aldinger *et al.* (2004), nervous and emotionally unstable individuals were at a 7-fold increased risk of developing anxiety disorders comparatively.[27]

Out of the five dimensions of the Five-Factor Model, neuroticism being the factor of interest in this study was due to its strong and thoroughly researched association with anxiety.[26] Neuroticism is linked to many different psychopathologies where anxiety may play a role. The synergistic relationship between neuroticism trait and internalizing psychopathologies especially anxiety disorders are well known.[29] Similarly, another study indicated that anxiety had a strong, positive association with neuroticism whereby women reported higher levels of anxiety and neuroticism compared to men.[30] Women were known to be more prevalently anxious in view of their different coping skills used to overcome stressors, predicting the presence of high anxiety traits.[31]

One of the possible mechanisms includes the mediating effects of rumination and worry. Rumination, which is described as unproductive, repetitive negative thoughts, is considered as a psychological vulnerability to anxiety.[32-34] In their study of 405 elderly adults from China, Chen *et al.* found that neuroticism was found to be significantly linked to symptoms of anxiety. Furthermore, mediation analysis demonstrated that this relationship was partially mediated by rumination.[33] Hence, patients with a greater degree of neuroticism may be more likely to be ruminative. As they are prone to be preoccupied with negative life events, they may experience more severe anxiety.

Our study findings conform with the stress-diathesis model, which proposes that for individuals with high levels of neuroticism, exposure to difficult life events contributes to the emergence of anxiety symptoms.[35] As for the current study, females with higher neuroticism traits when diagnosed with DM are more likely to experience ruminative thoughts and worries concerning their illness. And when these thoughts are manifested intensely it may result in heightened anxiety and a poor subjective sense of illness management.

Genetic studies have postulated that higher neuroticism score causes anxiety and other psychological disorders.[36-39] Hettema *et al.* performed the largest population-based twin study on this topic to date. They gauged data from over 9000 male and female twins, discovered 40-50% genetic correlations between neuroticism and anxiety disorders with low environmental correlations, concluding that the association between neuroticism and anxiety disorder is essentially caused by their mutual genetic factors.[40]

Numerous studies have reported the link between personality domains and physical health.[13,41,42] Among the personality traits, neuroticism appears to be robustly associated with a broader range of physical health problems, including DM.[43-45] In a study by Wheeler *et al.* in 2012, high neuroticism was significantly related to lesser adherence to their diabetes regimen, including diet, exercise, and glycaemic control.[44] On the contrary, another large prospective study by Cukić and Weiss found that higher levels of neuroticism were associated with reduced risk of type 2 DM, after controlling for confounders such as age, race, BMI, and depressive symptoms. This is attributed to the association between neuroticism and greater vigilance and perceived susceptibility to health risks, leading to early help-seeking behaviour.[43] Such contradictory findings suggest that there might be unknown

variables affecting the relationship between neuroticism traits and diabetes care-related behaviours, which warrant further investigation.

Self-efficacy is concerned with the judgments on how well one can execute courses of action required to deal with prospective situations.[46] When a self-efficacious person is faced with difficulties, they tend to exert greater effort to master the challenges compared to those who have serious doubts about their capabilities who tend to exert lesser effort leading to giving up altogether.[46] Evidence has shown a strong significant negative relationship between self-efficacy and neuroticism.[47,48] A recent meta-analysis of 53 studies reported that neuroticism was strongly and consistently correlated negatively with self-efficacy, in contrast to all other Big Five Traits that demonstrated positive correlations. [49]

The present study reveals the inverse relationship between neuroticism trait and self-efficacious behaviour in diabetic care. Individuals with neuroticism trait displayed a lower level of self-efficacy when it comes to managing their illness. Self-care in DM is crucial when it comes to the management of their illness. Though this study is parallel to other studies in having a lack of any relationship between the objective outcome of diabetes,[50] it appears that subjectively the neuroticism trait does play a role. Individuals with higher neuroticism scores are least confident in carrying out healthy behaviours in alleviating their symptoms, such as adhering to healthy dietary habits and regular exercise behaviours.[44,51] Besides that, these individuals also showed a pessimistic attitude when it came to engaging in positive behaviour in managing their own health.[51]

Another vital factor includes non-adherence to the treatment, which is described as taking <80% of the prescribed treatment.[52] The prevalence of non-adherence to DM medications was noted to be 30%.[52] Neuroticism was significantly related to adherence. The more neurotic the individual was, the less their adherence to the treatment, supporting that personality factors in chronically ill individuals may affect their illness care and outcome.[44] Our study highlights that neuroticism is an important variable to consider in the context of the patient's diabetes adherence. These findings could influence diabetes intervention and care in several ways such as treatment adherence, diet control, and exercise.[44]

This study had few limitations. Firstly, this study being cross-sectional in nature was not able to establish causal relationships. As both exposure and outcome are simultaneously assessed, there is no evidence of a temporal relationship between neuroticism and anxiety. Hence, without a longitudinal data, it is not feasible to determine a true cause-and-effect relationship in the absence of follow-up care. Another limitation of this study is about the small sample size, which was carried out conveniently in a tertiary care centre. However, it is believed that the findings can be generalised in the Malaysian context in view of similarity of participants' socio-demographic characteristics with the general population of Malaysia. The use of single-question assessments in this study might also have contributed to a possible limitation as validated scales were not employed to evaluate social support, diabetic self-management, and religious practice.

Despite these limitations, this present study contributes to the understanding of the relationship between neuroticism and anxiety among female patients with DM, as studies in Malaysia are scant and only reported the magnitude of the psychopathology in DM.[52] Further longitudinal studies with follow-up care and assessment is suggested to investigate the true causal relationship between the variables. Besides that, a multi-site study with stratified random sampling is proposed as it provides better coverage of the population to strengthen the representation of the data.

CONCLUSIONS

Our study showed that neuroticism traits were associated with a poorer subjective sense of DM management. A greater level of intervention is pivotal to increase the self-efficacy in managing patients with DM by modifying the neuroticism traits which may help in reducing their anxiety symptoms. Eventually, this may improve the sense well-being and better treatment outcomes.

Data Availability

The data used to support the findings of this study is available upon request from the corresponding author.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors' Contributions

Gurpreet Kaur Autar Singh wrote the main manuscript text. Luke Sy-Cherng Woon and Hatta Sidi conceived and designed the study. Luke Sy-Cherng Woon analyzed the data. Luke Sy-Cherng Woon and Hatta Sidi reviewed and interpreted the results and assisted in the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Supplementary Materials

The Supplementary Tables (S1 – S3) contain results of subgroup analyses for study subjects with type 2 DM only.

Table S1. Correlations between BFI neuroticism scores and other continuous variables.

Variable	Spearman's correlation coefficient	*p*-value
Age	0.012	0.898
Duration of DM	0.112	0.239
HbA1c	0.048	0.610
GAD-7 scores	0.401	<0.001*

* Statistically significant

Table S2. BFI neuroticism scores across categorical and ranked variables.

Variables	*p*-value
Race[a]	0.058
Marital status[a]	0.633
Employment[a]	0.024*
Household income[b]	0.778
Religion[a]	0.038*
Frequently practise religion[b]	0.013*
Have good social support[b]	0.003*
Smoking[a]	0.751
Alcohol use[c]	0.894
Insulin therapy[c]	0.418
'I am able to manage my diabetes well'	0.004*
Obesity[b]	
Hypertension[c]	0.680
Dyslipidaemia[c]	0.821
Ischaemic heart disease[c]	0.080
Stroke[c]	0.819
Renal disease[c]	0.729

Table S3. Multivariate linear regression for variables associated with BFI neuroticism scores.

Variable	Coefficient	95% CI		*p*-value
		Lower	Upper	
GAD-7 scores	0.334	0.026	0.076	<0.001*
Employment	-0.105	-0.164	0.035	0.200
Religion	0.109	-0.040	0.175	0.215
Practice of religion	-0.073	-0.171	0.079	0.465
Social support	-0.112	-0.225	0.055	0.232
'I am able to manage my diabetes well'	-0.218	-0.238	-0.034	0.009*

$F(6, 119) = 8.286$, $p < 0.001$, $R^2 = 0.307$
* Statistically significant

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