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Fatigue in Women with Type 2 Diabetes

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Fatigue is a widespread clinical complaint among adults with type 2 diabetes (T2DM),[1–3] has been directly related to poor self-reported health,[4] and is likely a key barrier to successful self-management of diabetes.[5] Despite this, there are few data describing the magnitude, severity, or etiology of diabetes-related fatigue. This lack of research is surprising due to the number of physiological, psychological, and lifestyle factors that could predispose patients with T2DM to high levels of fatigue. It is perhaps easy to assume that fatigue in patients with T2DM is simply due to elevated blood glucose; however, this has not been substantiated in prior research. Furthermore, other contributing factors to fatigue in diabetes may warrant exploration. Physiological factors that could affect fatigue in T2DM include alterations in blood glucose levels or symptoms related to acute and/or chronic diabetes complications. Psychological factors include emotional distress stemming from diabetes self-management regimens or depression. Lifestyle factors may include increased body mass index (BMI) and reduced physical activity.

For the purposes of the study, fatigue was defined as a subjective perception of a decreased capacity to perform physical and/or mental tasks due to one or a combination of physiological, psychological, or lifestyle phenomena, including altered glucose control, diabetes symptoms, diabetes emotional distress, depression, physical inactivity, and BMI.[6] The purpose of this study was to explore the relationship between fatigue and physiological, psychological, and lifestyle phenomena in women with type 2 diabetes (T2DM), in order to establish the magnitude and correlates of fatigue in women with T2DM and explore the interrelationships between fatigue and specific diabetes-related factors that may be associated with increased levels of fatigue. These factors included: physiological factors (glucose control, diabetes symptoms), psychological factors (diabetes emotional distress, depressive symptoms in general), and lifestyle factors (BMI, physical activity). Additionally, in a subset of the participants, the relationship between glucose variability (fluctuations) and fatigue was examined.

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Type 2 diabetes is a metabolic disorder characterized by a decrease in insulin secretion and an increase in insulin resistance, resulting in alterations in carbohydrate, lipid, and protein metabolism. Diabetes manifests as elevated blood glucose levels, with blood glucose control the primary goal of therapy. Poor blood glucose control has been presumed anecdotally to be the primary source of fatigue in patients with diabetes. However, the relationship between fatigue and blood glucose levels is not well understood and is limited by the dearth of research in this area.[6] Acute episodes of hyperglycemia have been associated with fatigue symptoms in insulin-treated type 1 and type 2 diabetes,[7] and they have been associated with heightened fatigue in adults with T2DM.[8] In general, few data support a relationship between chronic hyperglycemia and fatigue. Nielsen and colleagues found no relationship between fatigue and A1C[4]; while Van der Does reported slight but statistically significant correlations between A1C and fatigue in patients with T2DM,[9] suggesting that further data are needed to support the relationship between poor glucose control and fatigue.

Glucose variability (fluctuations in glucose levels) may also contribute to fatigue. There is growing evidence that individuals with T2DM experience high postprandial glucose excursions, even in subjects with hemoglobin A1C values in the satisfactory range (< 7.0%).[10, 11] Postprandial glucose fluctuations may stimulate proinflammatory cytokines and oxidative stress, both of which have been associated with fatigue symptoms.[1, 12] In a study of symptoms and blood glucose levels, adults with T2DM reported the highest levels of physical symptoms (including fatigue) during the first hour after eating, suggesting a relationship between symptoms and the rate of glucose change.[13] Findings from these studies suggest that there is a relationship between fluctuations in blood glucose levels and fatigue.

Besides physiologic factors, psychological disturbances (including stress and depression) have been found to be predictive of fatigue in the general population,[14] and are common comorbid conditions in people with diabetes. Diabetes emotional distress related to the daily work of self-managing and living with diabetes has been associated with both energy depletion and fatigue in adults with diabetes.[15] In adults with T2DM, the added burden of initiating insulin injection therapy was associated with increased self-reported fatigue.[16]

Individuals with diabetes are twice as likely to suffer from depression as their counterparts without diabetes,[17] While the relationship has not been examined, the above studies suggest that the presence of depression or depressive symptoms greatly impacts fatigue in individuals with diabetes.

Overweight and low levels of habitual physical activity have also been strongly associated with fatigue in the general population and have special clinical relevance for women with T2DM. Most people with T2DM are overweight or obese,[18] and obesity and overweight have been associated with higher levels of fatigue in the general population[19, 20] and in women specifically.[21] Fatigue in turn has been strongly and negatively associated with physical activity levels in healthy adults[19] and adults with T2DM.[22, 23] Individuals with diabetes engage in low levels of physical activity.[24–28] Common barriers to physical activity in T2DM include health status and physical functioning,[25, 26, 29–31] obesity,[25, 29, 31, 32] and

high symptom/fatigue complaints.[22, 23, 30] Therefore, better understanding of those factors related to fatigue in diabetes is vital.

Methods

Research Design

A cross-sectional, descriptive design was used to explore the relationships among physiological, psychological, lifestyle variables, and fatigue among women with T2DM.

Sample and Setting

Inclusion criteria were: female gender, aged 40–65 years, and a history of T2DM for at least six months. This study was limited to women because women have consistently reported higher levels of fatigue than men. Exclusion criteria included: pregnancy or any self-reported condition known to cause fatigue (such as fibromyalgia, sleep apnea, or any cancer diagnosis). Subjects were recruited from outpatient endocrinology clinics associated with urban medical centers in a large Midwestern city in the U.S., through flyer distribution and Internet recruiting notices. Data were collected within the Biobehavioral Research Laboratory in a private room within the College of Nursing by two of the study's authors. All study activities were approved by the institutional review board.

Data Collection Procedures and Methods

Eligible subjects reported for a single, morning visit in the fasted state. Capillary blood samples were collected for fasting blood glucose (FBG) measurement, using an Ascensia® Contour blood glucose meter, and A1C using the DCA 2000® + Analyzer (Siemens Diagnostics, Tarrytown, NY). Both the Ascensia® Contour meter and the DCA 2000 have demonstrated accuracy in prior studies when compared with standard laboratory methods.[33–35] BMI was calculated as weight (kg)/height (meters^2).[36] After a light breakfast, subjects completed measures of the main study variables, including fatigue, diabetes symptoms, depressive symptoms, diabetes emotional distress, and physical activity. Additional health and sociodemographic factors were also assessed upon entry into the study.

In addition to FBG and A1C values, 39 of the subjects agreed also to wear a continuous glucose monitor (MiniMed Gold Continuous Glucose Monitoring [CGM] System, Northridge, CA) for three days for measurement of glucose variability. Glucose variability refers to fluctuations in blood glucose levels, which may occur rapidly (within hours) or over longer periods of time, and cannot be detected through routine clinical tests, such as a random blood glucose level or A1C analyses. Accuracy of the CGM sensor has been confirmed in several large trials.[37, 38] A decision was made to use a CGM system that blinded subjects to their glucose readings. This helped to prevent subjects from making aggressive changes in their diabetes management during the three days that the monitor was worn.

Distinguishing between fatigue as a symptom of non-psychological disease, and fatigue as a separate psychological phenomenon is challenging. Fatigue was measured using the four-

item General Fatigue subscale of the Multidimensional Fatigue Inventory-20 (MFI-20).[39] The Multidimensional Fatigue Inventory is a 20-item multidimensional tool that incorporates both pure measures of fatigue with fatigue effects, such as activity and motivation. The MFI uses a Likert-type scale from 1 to 5, with total scores from 4 to 20, and contains 5 subscales: General Fatigue, Physical Fatigue, Reduced Motivation, Reduced Activity, and Mental Fatigue. Some items are reverse-scored, and higher scores indicate higher levels of fatigue. The General Fatigue scale was used as a composite measure of the overall subjective fatigue experience in the study participants, and fit best with the definition of fatigue used to guide the study. The MFI demonstrated adequate internal consistency reliability (Cronbach's alpha = 0.831).

Diabetes symptoms were measured using the Diabetes Symptom Checklist-Revised (DSC-R).[40] The DSC-R contains 34 items that measure both the *occurrence* and *perceived burden* of physical and psychological symptoms related specifically to T2DM, including hyperglycemic, hypoglycemic, cardiovascular, polyneuropathic sensory, polyneuropathic pain, psychological fatigue, psychological cognitive, and ophthalmologic symptoms. Each item could be scored from 0 (*the symptom did not occur*) to 5 (*the symptom occurred and was extremely troublesome*). For this study, a mean total symptom score was calculated from 26 of the 34 the symptoms. The eight symptom questions in the Psychological Fatigue and Psychological Cognitive subscales were omitted to avoid item overlap with the fatigue instrument. Internal consistency reliability of the 26-item revised symptom scale was supported (Cronbach's alpha = 0.933).

Diabetes emotional distress refers to the emotional stress related to diabetes self-management, relationships with health care providers, and intrapersonal relationships. The Diabetes Distress Scale (DDS)[41] is comprised of 17 items that measure four domains of diabetes-related emotional distress: Emotional Burden, Physician-Related Distress, Regimen-Related Distress, and Diabetes-Related Intrapersonal Distress. The DDS demonstrated adequate internal consistency reliability (Cronbach's alpha = 0.913).

Depressive symptoms were measured using the Depression subscale of the Profile of Moods States (POMS-D).[42] The POMS-D did not incorporate somatic symptoms such as "tiredness" or "fatigue" that are normally included in depression measures but would confound study findings. The POMS, including a shortened Dutch version, have been used in several studies of patients with type 1 and type 2 diabetes.[9, 16, 43] Internal consistency reliability was supported for the 15 items that comprised the POMS-D scale for the total sample (Cronbach's alpha = 0.93).

Lifestyle phenomena variables included BMI and physical activity. Physical activity was measured using the 7-Day Physical Activity Recall (PAR),[44] which assesses the intensity and duration of leisure-time and occupational physical activities (including planned exercise bouts) recalled from the previous seven days. Average daily hours of all activity, including light, moderate, hard, and very hard activity, and sleep were calculated; these data were transformed into metabolic expenditure (METs) for use in the statistical analyses.

Glucose Variability Calculation

Glucose variability in the 39 participants who participated in this aspect of the study was determined from the CGM sensor readings using the Continuous Overall Net Glycemic Action (CONGA) method.[45] CONGA is defined as the standard deviation of the differences between time points. Higher CONGA values indicate more glucose variability. Use of CONGA analysis enabled the quantification of intraday fluctuations in glucose levels where continuous data points were available. For each observation (glucose value) after a specified number of hours (*n*), the difference between the current observation and the observation *n* hours previous was calculated. CONGA was calculated using one-, two-, four-, and six-hour time periods in order to maximize the likelihood of uncovering glucose fluctuations in subjects with T2DM. Blood glucose fluctuations in patients with T2DM may result from the rise in blood glucose levels following meals and snacks. The CGM substudy was designed to allow the subjects free choice about the timing and frequency and amount of meals. Thus, the choice to use four different time periods offered the most promise for detecting excursions relative to the pre- and postprandial times, when blood glucose levels are likely to be lowest and highest.

Statistical Analysis

SPSS 15.0 software (Chicago, IL) was used for all statistical analyses. Data were summarized using descriptive statistics (i.e., means and standard deviation for continuous variables; count and frequency for categorical variables). Pearson correlation analyses were run with all proposed variables to test for significant bivariate relationships with fatigue. Any physiologic, psychological, or lifestyle variables showing significant association with fatigue in the bivariate analysis were further selected for multivariate analysis, with fatigue as the dependent variable. Finally, a second model was developed, using those health and demographic factors that were correlated to fatigue. The independent variables age, education, and hemoglobin were thus included in a second multivariate regression to control for confounding effects. Throughout the paper, statistical significance was set at $p < 0.05$ using two-sided tests for all analyses.

Results

The sample included 83 women, 39 (47%) of whom also participated in a three-day continuous glucose monitoring (CGM) assessment in addition to the main study. Recruitment efforts resulted in 152 women being screened for eligibility by telephone. Of those, 23 refused to participate or did not schedule study appointments, and 10 did not show up for their scheduled appointments. Thirty-two women were ineligible due to known obstructive sleep apnea ($n = 11$), age ($n = 5$), heart failure ($n = 5$), pulmonary disease ($n = 4$), fibromyalgia ($n = 3$), current hospitalization/acute illness ($n = 3$), or hepatitis ($n = 1$). Four women did not meet the inclusion criteria after providing informed consent and were subsequently withdrawn from the study. Two women were chronic opiate users; one woman had a history of cardiac disease, including acute coronary syndrome and heart failure, and one woman was found to have a severely low capillary blood hemoglobin level and was referred to her physician for further testing. A total of 83 women completed the study.

Demographic and health characteristics of the 83 participants are shown in Table 1. The mean scores from the dependent and independent variables are presented in Table 2. Only racial make-up differed between the groups that did or did not undergo CGM (χ^2 3 df = 1.669, $p < 0.01$).

Pearson correlation analyses were run with all proposed variables to test for significant relationships with fatigue (Table 3). Of the physiologic variables, only diabetes symptoms were moderately associated with fatigue ($r = 0.54$, $p < 0.001$). Neither fasting blood glucose nor A1C was related to fatigue. Additionally, glucose variability as measured by any CONGA (1-, 2-, 4- or 6-hour) was not significantly associated with fatigue in this study. The psychological variables diabetes emotional distress ($r = 0.45$, $p < 0.001$) and depressive symptoms ($r = 0.51$, $p < 0.001$) were both moderately related to fatigue. Of the lifestyle variables, BMI was positively associated with fatigue ($r = 0.30$, $p < 0.01$), while average daily physical activity was negatively associated with fatigue ($r = -0.28$, $p < .05$).

Correlation analyses were also conducted between fatigue and several covariates that could hypothetically affect fatigue levels. Age ($r = -0.26$), years of education ($r = -0.23$) and blood hemoglobin levels ($r = -0.28$) were inversely and significantly related to fatigue (all $p < 0.05$). Other potential covariates were not related to fatigue (data not shown).

A standard multiple regression analysis was performed (Table 4), using fatigue as the dependent variable. The five significant independent variables (diabetes symptoms, diabetes emotional distress, depressive symptoms, BMI, and physical activity) were chosen from the correlation analysis and entered into the regression model. Diabetes symptoms, depressive symptoms, and higher BMI remained significant predictors of fatigue in women with T2DM. The model accounted for 48% of the variance in fatigue scores.

A second model was created that included the three covariates (age [years], education [years], and hemoglobin [grams/dl]) that were found to be significantly associated with fatigue (Table 5). Although the R^2 significantly increased from 0.48 to 0.58, none of these covariates were found significantly associated with fatigue in the multivariate model. Diabetes symptoms, depressive symptoms, and BMI remained significant predictors of fatigue in the covariate-controlled regression model.

Discussion

Findings from correlation analyses revealed that fatigue was significantly related to diabetes symptoms, diabetes emotional distress, depressive symptoms, BMI, and reduced physical activity. There was no relationship between fatigue and measures of FBG or A1C. Regression analyses revealed that the strongest explanatory factors for fatigue were diabetes symptoms, depressive symptoms, and BMI, which accounted for 48% of the variance in fatigue scores. Glucose variability was not significantly associated with fatigue in these women.

Fatigue among the women with diabetes in this study was markedly higher (12.4 ± 7.9) than previously reported population-based age-matched healthy norms that also used the same measure (the MFI-20 General Fatigue subscale) (8.7 ± 3.5 & 8.4 ± 3.6).[46, 47] Moreover, the

fatigue scores from the women in the study reported herein were similar to fatigue scores among patients who had been chronically unwell for > six months, also measured using the MFI-20 General Fatigue subscale,[47] suggesting that fatigue is a severe problem in the population in this study. The findings that low physical activity, depression, and BMI were all significant predictors of fatigue are consistent with the literature in various populations; however, findings from this study establish that this is also true in women with T2DM. Epidemiological studies have shown that individuals who are physically active are less likely to report feelings of low energy or fatigue than their sedentary peers.[48] The significant correlation between low physical activity and higher fatigue ($r = -0.283$, $p < 0.05$) was thus consistent with this, but again establishes this in women with T2DM. When entered into the regression equation, physical activity did not explain any of the variance in fatigue; however, physical activity expenditure was low in most subjects. Greater than 80% of the women reported getting less than one hour of moderate physical activity (such as walking or gardening) per day. The protocol used for scoring the PAR assigned equal MET values to walking bouts, regardless of the intensity, speed, or terrain.[49] This may have led to overestimation of the actual amount of metabolic expenditure used in moderate-intensity activity because, for most women in the study reported herein, walking accounted for the majority of moderate-intensity activity. Thus, it is likely that the metabolic energy usage reported for many of the women was falsely high. The average amount of physical activity reported by the subjects is too low to confer health benefits, such as improved aerobic capacity or muscle strength, which could potentially affect fatigue levels.

Though an association was expected between fatigue and blood glucose levels, none was found. These findings are by no means conclusive. The glucose levels found in the subjects in this study were lower than those of subjects in prior studies that did indicate a significant relationship between acute blood glucose levels and fatigue.[7, 8, 50, 51] Warren et al. reported that patients identified the onset of symptoms (including fatigue) at a blood glucose threshold of 274 mg/dl,[7] while Sommerfield reported that subjects complained of heightened fatigue when their blood glucose levels were elevated to 300 mg/dl.[8] Drivsholm[51] and Bulpitt[50] both reported that common diabetes symptoms (including fatigue) were associated with elevated blood glucose levels in women who were newly diagnosed with T2DM; average fasting plasma glucose levels reported in their studies were 247 mg/dl and 175 mg/dl, respectively.[50, 51] The average acute blood glucose level in this study was 142.9 ± 59.8 mg/dl--far lower than the glucose levels at which subjects in the prior studies reported symptoms of fatigue. In fact, only three subjects from the current study had fasting blood glucose levels over 274 mg/dl, and 81% of the subjects had blood glucose levels under 175 mg/dl. These findings suggest that a relationship between acute blood glucose levels and fatigue may exist, but only when blood glucose levels are extremely high or when fatigue is measured using consistent construct definitions and measurement instruments.

Blood glucose control (as measured by A1C) was not associated with fatigue in the study reported herein. These findings are consistent with other reports in which only minor[7, 9, 15] or no[50] associations between A1C and fatigue were found in studies of patients with T2DM.

In the current study, the amount and severity of diabetes symptoms was strongly related to fatigue. Physiological pathways, such as inflammation, may explain this relationship, but

there may also be psychological explanations. Diabetes symptoms in the women were also significantly related to depression and diabetes emotional distress (Table 3). Patients who experience more diabetes symptoms may feel more distress and depression. Weijman et al. measured diabetes symptoms using the DSC-R in a study of fatigue among Dutch employees with diabetes; as in the current study, those authors reported that fatigue was strongly associated with the burden of diabetes, including diabetes symptoms.[2]

The choice of measuring self-reported physical activity rather than exercise capacity (maximal oxygen consumption or VO_{2max}) may not have captured physiological phenomena that could potentially affect fatigue levels. Subjects with uncomplicated T2DM have been found to have lower maximal exercise performance (VO_{2max}) than age- and activity-matched controls, and had to work harder for similar increases in oxygen consumption.[52]

The relationship between physical activity and fatigue may have been masked or weakened by only measuring self-reported physical activity data. A comprehensive measure of physical activity including measures of self-reported physical activity habits and maximal exercise capacity (VO_{2max}) may better have elucidated the relationship between physical activity and fatigue in patients with T2DM.

Finally, no significant relationship was found between glucose variability and fatigue in women with T2DM. The literature search found no prior studies examining the relationship between glucose variability and symptom experiences in adults with diabetes. Perhaps wide swings in glucose might affect fatigue levels through physiological paths and/or psychological paths. Correlation analyses revealed no statistically significant relationships between measures of glucose variability and fatigue: CONGA1 $r = 0.14$, CONGA2 $r = 0.168$, CONGA4 $r = 0.101$, and CONGA6 $r = 0.058$ (all $p > 0.05$).

The lack of a significant relationship could be due to several factors. The sample size used in the glucose monitoring substudy was small ($n = 39$), which increases the possibility of missing a significant relationship and thereby committing a type II error. The glucose fluctuations in the sample were observed primarily after meals, when blood glucose levels would normally rise in response to carbohydrate intake. When the raw CGM data were reviewed, the glucose excursions were not as pronounced as those which might be seen in patients with type 1 diabetes. The subjects in this study had peaks of lower magnitude which were sustained over a longer period of time. In addition, the lowest point (nadir) was seldom in the hypoglycemic area. Therefore, it would be difficult to evaluate variability. Another issue is whether CONGA is the best choice for analysis of glucose variability in subjects with T2DM. The subjects in this study were in relatively good blood glucose control (mean A1C 7.37% ± 1.8). Perhaps if they had sustained hyperglycemia (as induced in the previous studies using clamps), they may have felt fatigued.

Patients with diabetes who monitor their blood glucose levels have expressed feelings of psychological distress when their blood glucose levels do not remain in their target range.[53] The subjects in the CGM substudy were blinded to the real-time glucose readings, so they did not see their blood glucose results and thus did not experience the emotions that accompany seeing blood glucose values rise and fall within short time periods. The subjects

were asked to calibrate their CGM monitors by performing fingerstick home blood glucose checks four times daily. The fingerstick tests were done before meals and may not have reflected the rises in blood glucose levels following meals.

Implications/Relevance for Diabetes Educators

Fatigue is common in women with T2DM and is likely affected by a combination of physiological, psychological, and lifestyle-related phenomena, especially the presence and severity of diabetes symptoms, depressive symptoms, and high BMI. Fatigue in this population is similar in magnitude to chronically ill populations. This population has a significant correlation between low physical activity and higher fatigue. Also, in this population, diabetes symptoms, depression, and BMI were all significant predictors of fatigue. Findings from the current study revealed no relationship between any measure of blood glucose control and fatigue.

A large portion of the variance in diabetes related to fatigue remains unexplained. Future studies could use path analysis to help elucidate these relationships and should include men with T2DM and individuals with type 1 diabetes, to expand on these findings in women with T2DM. The use of real-time or ecological methods of data gathering in combination with multilevel statistical models will uncover temporal relationships between fatigue and associated factors.

Findings from this study support the need for inclusion of symptom assessment in diabetes self-management education. Diabetes health care providers should use complaints of fatigue as a starting point for further evaluation of comorbid conditions, including diabetes complications and clinical or subclinical psychological illness. Health care providers should thoroughly assess their fatigued patients' diabetes self-care practices.

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TABLE 1

DEMOGRAPHIC AND HEALTH CHARACTERISTICS

	Total sample (*n* = 83)	**Glucose monitoring substudy subjects (*n* = 39)**
Age: (years)		
Mean (SD)	52.96 (6.46)	52.35 (6.67)
Range	40–65	40–64
Race: N (%)		
Non-Hispanic White	28 (33.7)	20 (51.3)
Non-Hispanic Black	35 (42.2)	12 (30.8)
Hispanic	12 (14.5)	7 (17.9)
Other	8 (9.6)	0
Education: (years)		
Mean (SD)	14.8 (2.8)	15.47 (2.81)
Range	8–24	9–22
Duration of DM: (years)		
Mean (SD)	5.8 (5.6)	5.7 (5.7)
Range	0.5–31	0.5–20
Diabetes therapy: N (%)		
Diet only	8 (9.6)	5 (12.8)
Oral medication	63 (75.9)	30 (76.9)
Insulin injections	4 (4.8)	2 (5.1)
Oral + insulin	8 (9.6)	2 (5.1)

Table 2

DESCRIPTIVE (MEAN & SD) OF OUTCOME AND INDEPENDENT VARIABLES

Variable	Total subjects (*n* = 83)	Glucose monitoring substudy subjects (*n* = 39)
Fatigue		
(possible score 4–20)	12.75 (4.6)	12.9 (5.1)
Range	4–20	4–20
Fasting Blood Glucose		
(mg/dl)	143 (59.8)	133.3 (41.0)
Range	65–437	74–235
Hemoglobin A1c (%)	7.42 (1.87)	7.4 (1.8)
Range	4.8–14.0	4.8–14
Diabetes		
Symptoms		
(possible score 0–5)	1.1 (0.91)	1.2 (1.0)
Range	0–4.23	0.08–4.23
Emotional		
Distress		
(possible score 1–5.76)	2.5 (1.0)	2.6 (0.9)
Range	1–5.29	1.06–4.29
Depression		
Symptoms		
(possible score 0–60)	10.7 (10.9)	10.2 (11.4)
Range	0–59	0–59
Body Mass Index (kg/m^2)	33.7 (7.8)	32.6 (7.7)
Range	17.9–53.7	19.5–53.6
Physical Activity		
(mean METS/day)	34.7 (2.7)	34.6 (2.2)
Range	31.11–44.48	31.11–40.82

BIVARIATE CORRELATIONS BETWEEN FATIGUE AND INDEPENDENT VARIABLES

Outcome Variable	**Fasting Blood Glucose**	**A1C**	**Diabetes Symptoms**	**Emotional Distress**	**Depression Symptoms**	**Body Mass Index**	**Physical Activity (METS/day)**
Fatigue	0.065	0.211	0.537**	0.445**	0.514**	0.302**	−0.283*
Independent Variable							
Fasting Blood Glucose		0.638**	0.201	0.110	0.005	0.172	0.006
A1C			0.404**	0.251*	0.192	0.054	0.181
Diabetes Symptoms				0.429**	0.445**	0.131	−0.213
Emotional Distress					0.461**	0.283**	−0.212
Depression Symptoms						0.043	−0.155
Body Mass Index							−0.199

* $p < 0.05$.

** $p < 0.01$.

TABLE 4

REGRESSION ANALYSIS SUMMARY FOR EXPLANATORY VARIABLES OF FATIGUE IN WOMEN WITH TYPE 2 DIABETES

Variable	B	SE B	beta	t	*p*
Diabetes symptoms	1.546	0.483	0.313	3.2	0.002
Diabetes emotional distress	0.551	0.449	0.126	1.23	0.224
Depressive symptoms	0.122	0.041	0.297	2.97	0.004
Body mass index	0.119	0.051	0.208	2.34	0.022
Physical activity	− 0.179	0.146	− 0.108	−1.22	0.226

$F(5, 74) = 13.47$, $p < 0.001$

$R^2 = 0.477$, adjusted $R^2 = 0.441$

TABLE 5

REGRESSION ANALYSIS SUMMARY INCLUDING COVARIATES

Variable	B	SE B	beta	t	*p*
Diabetes symptoms	1.766	0.471	0.358	3.75	0.000
Diabetes emotional distress	0.569	0.423	0.133	1.35	0.183
Depressive symptoms	0.083	0.039	0.205	2.11	0.038
Body mass index	0.100	0.048	0.179	2.09	0.041
Physical activity	− 0.203	0.133	− 0.125	−1.52	0.132
Age	− 0.068	0.055	− 0.100	−1.23	0.221
Education (years)	− 0.179	0.139	− 0.112	−1.29	0.202
Hemoglobin	− 0.267	0.227	− 0.096	−1.78	0.243

F (8, 70) = 11.83, $p < 0.001$

$R^2 = 0.575$, adjusted $R^2 = 0.562$