Daytime Functioning in People with Type 2 Diabetes and Insomnia Symptoms: A Comparison-Correlational Study

Mohammed M Alshehri (malshehri@kumc.com)
University of Kansas Medical Center https://orcid.org/0000-0003-0028-0957
Jason Rucker
University of Kansas Medical Center
Aqeel M Alenazi
Prince Sattam bin Abdulaziz University
Shaima Alothman
Princess Nora bint Abdulrahman University
Wafa Alahmari
Princess Nora bint Abdulrahman University
Corey Gray
University of Kansas Medical Center
Bader Alqahtani
Prince Sattam bin Abdulaziz University
Patricia Kluding
University of Kansas Medical Center

Research

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Abstract

Background Sleep disturbances showed negative impact on self-care and diabetes outcomes for people with type 2 diabetes. However, there is a need to understand to what extent insomnia symptoms impact daytime functioning in people with type 2 diabetes. This study compared common daytime functioning outcomes including fatigue, daytime sleepiness, and quality of life related to vitality and physical function in people with type 2 diabetes with and without insomnia symptoms. Methods This study was a cross-sectional comparison design which used validated instruments to assess common daytime functioning outcomes (i.e. fatigue severity scale, daytime sleepiness, and quality of life related to vitality and physical function domains) in 60 participants with type 2 diabetes with and without symptoms of insomnia. Insomnia Severity Index was used to stratify participants into an insomnia group and non-insomnia control group. Multivariate linear model and partial correlations tests were utilized to examine the relationships between outcomes in the two groups after controlling for age and depression symptoms. Results Levels of fatigue severity, and quality of life related vitality and physical function were worse in the insomnia group compared to non-insomnia group (P<.004). After controlling for age, the multivariate linear model showed that the insomnia group had greater fatigue severity (R 2 =0.15, p=.003), and lower quality of life related to vitality and physical function (R 2 =0.25, p<.001; and R 2 =0.11, p=.004, respectively). Partial correlation showed that daytime sleepiness was correlated with Insomnia Severity Index in the full sample after controlling for age (r =.35, p =.006). When added depression symptoms into the models, the differences or relationships were not observed. Conclusion Fatigue, and quality of life related vitality and physical function were worse in people with both type 2 diabetes and insomnia symptoms compared to people with type 2 diabetes only. Depression symptoms may have an independent contribution for the daytime functioning.

Introduction

Sleep disturbances have been associated with impairments such as fatigue and daytime sleepiness in people with type 2 diabetes mellitus (T2DM) [1, 2]. In addition, hypoglycemia and/or hyperglycemia may exacerbate fatigue, while poor glycemic control has been associated with daytime sleepiness [3, 4]. Sleep disturbances, particularly insomnia symptoms such as difficulty falling asleep, maintaining asleep, and/or waking up too early are associated with suboptimum self-care behavior in those with T2DM [5]. Despite the growing prevalence of insomnia symptoms in people with T2DM, it is not clear whether or to what extent these symptoms exacerbate fatigue and daytime sleepiness.

Both, insomnia and T2DM are thought to have a bidirectional relationship in which hypothalamic-pituitary-adrenal (HPA) axis hyperactivation increases cortisol level, which negatively impacts fatigue, daytime sleepiness and depression [6, 7]. Increasing the cortisol level during a poor night of sleep is associated with the risk of hyperglycemia due to liver glucose production [6, 7]. Self-reported daytime functioning has been widely used to collectively describe the constellation of psychological and physical symptoms that includes fatigue, daytime sleepiness, mood disturbance, and quality of life (QoL) [8, 9]. Hyperactivation of the HPA axis due to a poor night of sleep [6] or diabetes related distress [7] can disrupt

homeostasis throughout the body and may contribute to the common reports of fatigue, daytime sleepiness and depression observed in people with T2DM [10, 11] and with insomnia [6]. However, while the underlying mechanisms of the association of poor daytime functioning with T2DM or insomnia symptoms have yet to be tested, there is a need to investigate the additive effect of insomnia symptoms on self-reported fatigue and daytime sleepiness in people with T2DM.

Previous studies examined the additive effect of other sleep disorders such as restless leg syndrome (RLS) and obstructive sleep apnea (OSA) on daytime functioning [12, 13]. However, these studies have not considered insomnia symptoms as a contributing factor for poor daytime functioning among people with T2DM. Although people with T2DM and RLS report poor sleep quality and daytime dysfunction including fatigue and sleepiness [12], it is unclear whether RLS severity exacerbates insomnia symptoms and. contributes to worse daytime function outcomes for people with T2DM. While previous studies have argued that RLS and poor sleep quality are associated with low QoL in people with T2DM, the independent effects of insomnia and depression symptoms were not specifically controlled [14–16]. In addition, a review suggested that the association between daytime sleepiness and severe OSA in people with T2DM was such that treating OSA may minimize the symptoms of daytime sleepiness [13]. However, these studies have not assessed or controlled for insomnia or depressions symptoms which may well be considered as contributing factors to daytime functioning. In fact, recent evidence indicates that sleep quality may mediate the relationship between psychological distress and QoL in people with T2DM [17]. Therefore, it is important to consider psychological symptoms when assessing the association between insomnia symptoms and daytime functioning in people with T2DM.

Insomnia symptoms and T2DM may independently influence daytime functioning. However, their combined effects in those with both T2DM and insomnia remain unclear. Understanding how insomnia symptoms affect daytime functioning in individuals with T2DM may help facilitate the design of preventive strategies in diabetes management to optimize care in this population. Therefore, the primary purpose of this study was to compare fatigue, daytime sleepiness, vitality, and physical function in people with T2DM with and without insomnia symptoms. Our hypotheses were that people with T2DM and insomnia symptoms would have worse fatigue severity, daytime sleepiness symptoms, and QoL related to vitality and physical function compared to people with T2DM without insomnia symptoms. Our secondary aim was to investigate the relationship between insomnia symptoms and daytime functioning outcomes in people with T2DM after controlling for risk factors of insomnia and T2DM including age and depression symptoms.

Methods

Research Design

This cross-sectional study was conducted as part of a larger project investigating the consistency of sleep schedules in people with T2DM. Portions of this project have been published elsewhere [5]. This study utilized data from people with T2DM only and people with both T2DM and insomnia symptoms to

compare fatigue, daytime sleepiness, vitality, and physical function. Participants were stratified into two groups, those with insomnia (IN) and without insomnia (No-IN), using a cut-off score of >10 on the insomnia severity index (ISI) [18].

Data Collection Procedures

Participants were recruited through University Research Center's Frontiers research subject registry [19], Cray Diabetes clinic, and campus advertisements, as well as through flyers distributed to the surrounding community. The study was approved by the University Research Center's Institutional Review Board. Written informed consent was obtained from each participant during the first study visit.

Participants were enrolled in the study following telephone and in-person screening sessions. Individuals were included if they 1) had self-reported T2DM; 2) were 40-75 years old; 3) were able to understand English; and 4) were able to attend and finish the testing procedures. Individuals were excluded if they 1) were at risk of untreated OSA or RLS as determined by the Stop Bang and RLS Diagnostic Index; 2) reported being pregnant; 3) reported heavy alcohol use (i.e., ≥15 alcohol drinks per week for men and ≥8 for women; 4) had a self-reported history of neurological disease, bipolar disorder, seizure disorder, chronic fatigue syndrome, rheumatic disease, dialysis, blindness, or amputation; 5) currently performed night-shift work; 6) reported severe symptoms of pain, depression and anxiety, as evidenced by a score of ≥7 on the Brief Pain Inventory, ≥21 on the Beck Depression Scale, and ≥15 on the Generalized Anxiety Disorder–7 scale. These exclusion criteria were designed to minimize the potential effects of other comorbidities and sleep disorders on daytime functioning.

Participants were divided into either the IN group or the No-IN group based on their score on the ISI, with those scoring > 10 allocated to the IN group and those scoring ≤ 10 allocated to the No-IN group. In addition, people in the IN group reported the insomnia symptoms for at least 3 months. The ISI is a self-report measure designed to evaluate the nature, severity, and impact of insomnia [18]. Scores on the ISI range from 0 to 28, with higher scores indicating greater insomnia severity [18]. Previous research has shown this instrument to be an excellent screening tool to predict the diagnosis of insomnia [20], and a cut-off score >10 has been shown to result in high sensitivity (97.2%) and specificity (100%) for the detection of insomnia in a clinical sample [18].

Participants

A total of 60 participants with self-reported T2DM participated in the study and were included in the final analysis. The sample size was determined based on an ongoing project to study the night to night sleep variation and outcomes in people reported T2D with and without insomnia symptoms.

Measures

All measurements, including demographic and clinical variables, fatigue severity, daytime sleepiness symptoms, and QoL related vitality and physical function, were obtained during the course of a single visit.

Demographic and clinical variables*:* Information regarding age, sex, education and ethnicity was collected during the assessment visit. Body mass index was calculated via height and weight measurements. Positive Airway Pressure (PAP) machine utilization was determined through the use of a yes/no question (e.g., "Do you use a PAP machine?"). Compliance with PAP usage was assessed via a diary indicating the nights of sleep with using a PAP machine. Non-compliance was defined as non-usage on more than 2 out of 7 nights and/or < 4 hours per night in this project [21].

Daytime functioning: Each participant completed a comprehensive assessment of daytime functioning including *fatigue severity, daytime sleepiness, vitality*, *physical function, and depression symptoms.*

Fatigue severity was measured using the Fatigue Severity Scale (FSS), which is a 9-item questionnaire that has been validated in people with diabetes [22]. The FSS emphasizes the impact of daily functional fatigue accumulation during the past week on subscales of motivation, exercise, interference with work, family, or social life. These subscales are summed to yield with a score of <4 indicating no fatigue, scores between 4 and 4.9 indicating moderate fatigue, and a score ³5 indicating severe fatigue [22].

The Short Form-36 vitality (SF 36-vitality) subscale is widely used to measure energy in chronic disease groups [23]. Vitality represents the combination of fatigue and energy. The SF-36-vitality includes four questions, two related to fatigue and two related to energy over the past 4 weeks. These questions represent both positive (energetic) and negative (tired) states. Scoring criteria for SF-36-vitality was used for each item, then summed to range between zero (worse scores) to 100 (optimal scores) [24].

Physical function over the past 4 weeks was measured using the Short Form-36 physical subscale (SF 36-physical function) [24]. This subscale contains ten items rated from zero (very limited ability to perform daily physical activities) to 100 (able to perform all daily activities without limitations). SF 36 subscales were chosen based on the limitations in physical activities and symptoms related to fatiguability because of health problems

Daytime sleepiness symptoms were assessed through the Epworth Sleepiness Scale (ESS) which refers to usual lifestyle in recent times. The ESS consists of eight items rated on a 4-point Likert scale, with subjects rating how likely they would be to fall asleep in 8 different states of daily activity [25]. The ESS has demonstrated satisfactory test-retest reliability (r = .82) and internal consistency (α = .88) [25]. A cutoff score of ≥10 suggests pathological sleepiness [25].

Statistical Analysis

All data analyses were performed using SPSS 23.0 for Mac (Chicago, IL). Descriptive statistics included means and standard deviations, and frequencies were used for continuous variables and categorical variables, respectively. Skewness and kurtosis tests examined the normality of residuals during model development. Chi-square and independent sample *t*-test analyses were used to assess between-group differences in categorical and continuous variables, respectively. Pearson correlation was utilized to investigate the relationship between daytime functioning outcomes and ISI scores. A multivariate general

linear model assessed the differences between groups in daytime functioning outcomes after controlling for covariates. Partial Pearson's correlation tests were used to assess the relationship between daytime functioning outcomes and insomnia severity after controlling for demographic variables. Symptoms of depression, as assessed by the Beck Depression Inventory [26], was also included as a covariate. Cohen's guidelines were used to illustrate the direction and magnitude of correlations in which r = .1–.29 is small, r = .3–.49 is medium and r = .5–1.0 is large [27]. All tests were conducted at an alpha level of 0.05.

Results

Demographics and clinical variables

Figure 1 shows the flowsheet of the study. Demographics and clinical variables for participants in both groups are summarized in table 1. There were no differences between the No-IN and IN groups in any demographic variables with the exception of age (64.79±6.50 and 60.28±7.83, respectively, p=0.02). The average ISI score was 4.64±3.15 in the No-IN group and 16.00±3.08 in the IN group (p<0.001). Participants in the No-IN group reported less depression symptoms compared to participants in the IN group (4.79±4.77 and 11.00±5.91, p<0.001).

Measures of daytime functioning

There were significant between-group differences in FSS (p=0.003), SF 36-vitality (p<0.001) and SF 36-physical function (p=0.004) scores. People in the IN group reported higher scores on the FSS (4.29±1.40), and lower scores on the SF 36-vitality (41.77±18.86) and SF 36-physical function (58.55±23.85) compared to the No-IN group (3.15±1.44, 60.71±13.79, and 78.64±16.77, respectively) (Table 2). No significant between-group difference was observed in ESS scores (p=0.09).

Results of the multivariate linear model are provided in Table 3. After controlling for age, there were significantly higher scores for IN group in FSS (ß=1.15, p=.003), and lower scores in SF 36-vitality (ß=-18.87, p<.001) and SF 36-physical function (ß=-16.66, p=.004). However, no significant between-group differences in FSS, SF 36-vitality, and SF 36-physical function were observed when covariates of age and depression symptoms were added to the model (p=.19, p=.07, p=.70, respectively). No significant between-group differences in ESS were noted in any of the models (p>.05).

Relationships between insomnia severity and daytime functioning outcomes

In table 4, Pearson's correlation showed moderate positive correlations between ISI scores and FSS (r=.34, p=.008) and ESS (r=.35, p=.006), and moderate negative correlation with vitality-SF 36 (r=-.48, p<.001) and physical function-SF 36 (r=-.35, p=.006) after controlling for age. However, no significant correlations between these variables were observed after controlling for symptoms of depression.

Discussion

This project is the first to compare measures of daytime functioning such as fatigue, daytime sleepiness, vitality related QoL, and physical function related QoL in people with T2DM to people with both T2DM and insomnia symptoms. Consistent with our hypothesis, we found that people with T2DM and insomnia symptoms reported higher fatigue severity, and poor vitality and physical function related to QoL than people with T2DM without insomnia symptoms. We also observed moderate correlations between insomnia severity and fatigue severity, daytime sleepiness, and vitality and physical function related QoL across both groups. Depression, rather than age, seemed to mediate these relationships.

High fatigue severity and low QoL are common health complains in people with T2DM as well as in people with insomnia. We observed significantly higher fatigue scores in those with T2DM and insomnia symptoms than those without insomnia symptoms. This suggests that the combination of T2DM and insomnia might aggravate the severity of fatigue or the perception of poorer daytime function in general. Consistent with our findings, a large cohort study of 13,171 adults with T2DM, aged 30–75 years, reported that 24.6% of the sample complained of fatigue and 24.2% reported insomnia symptoms [28]. Likewise, worse scores in QoL related to vitality and physical function were observed in people with T2DM and poor sleep quality compared with people with T2DM and good sleep quality. Furthermore, there was a moderate negative correlation between sleep quality and QoL related to vitality and physical function. In a different study of 116 participants with T2DM, lower physical function related QoL was significantly associated with poor sleep quality [29]. However, these previous studies did not account for depression symptoms as a confounding factor in the relationship between insomnia and daytime functioning in people with T2DM.

Although we excluded individuals with severe symptoms of depression from our study, we found that symptoms of depression influenced the relationship between insomnia symptoms and daytime functioning in people with T2DM. This is in agreement with a previous study of 2024 patients with insomnia which observed that the association between insomnia severity and fatigue was mediated by depression symptoms [30]. Moreover, it has been shown that people with chronic insomnia are often diagnosed with major depression, which might be associated with fatigue symptoms [31]. This data suggests that treating depression symptoms might be beneficial in reducing fatigue in people with insomnia [30]. However, a cross-sectional study of people with T2DM showed that depression symptoms were not a predictor of fatigue severity in this population. Rather, sleep quality was found to be the strongest explanatory factor for fatigue [32]. One possible explanation for this inconsistency may be the use of a validated survey for insomnia in the former studies versus screening for sleep disturbances using a subjective sleep quality questionnaire in the latter. Our study employed the ISI, an instrument that is well-validated for insomnia screening, and our data are in agreement with previous studies that utilized ISI to confirm insomnia symptoms. Nevertheless, other methods of diagnosing insomnia, such as comprehensive interviews, might yield different findings. Future studies are still needed to investigate the complex associations between insomnia, fatigue, and depression in people with T2DM.

Previous studies have provided conflicting results related to the association between insomnia and daytime sleepiness. It has been suggested that daytime sleepiness is associated with insomnia only in

people with T2DM with short sleep duration [33]. This is possibly because some people with insomnia symptoms may actually spend long periods of time in bed sleeping, thus reducing the need to nap during the daytime. Similarly, some studies have reported increased daytime sleepiness in people with T2DM [34, 35]. Although our findings suggest a moderate correlation between daytime sleepiness and insomnia severity in this group of individuals with T2DM, there were no between-group differences in ESS score and both groups fell below the cut-off score of 10 that has been suggested to reflect excessive daytime sleepiness. Neither did we observe between-group differences in sleep apnea status or BMI, both of which have been associated with daytime sleepiness [36]. This may be due to the fact that we relied on a relatively simple screening to determine the presence of sleep apnea. Use of a more objective measure, such as polysomnography, to identify untreated sleep apnea may help better characterize these relationships in future studies.

Daytime dysfunction is associated with psychological distress in both people with T2DM and those with insomnia [1, 37]. When account for depression symptoms in the model, we did not observe significant relationships between daytime functioning and symptoms of depression. A review study challenged the assumption of daytime functioning impairments due to insomnia [8]. The review showed that daytime sleepiness was not increased in people with insomnia; however, impairments in fatigue, mood, and QoL were associated with insomnia. Our data suggest the effects of insomnia, depression, or the combination of both may explain the deterioration of fatigue, and QoL related to vitality and physical function in people with T2DM. Indeed, depression symptoms could worsen daytime functioning in people with T2DM and insomnia symptoms. Therefore, there is a need to understand the complex relationship between insomnia and depression in people with T2DM.

Although this study has identified a potential impact of insomnia symptoms on daytime functioning in people with T2DM, there are several limitations that must be considered. Despite the presence of a comparison group, it is not possible to determine causal relationships due to the cross-sectional nature of the study. Future investigations should consider longitudinal designs to examine causal relationship between insomnia symptoms and poor daytime functioning outcomes in people with T2DM. Objective measurements are needed in order to assess physical activity, OSA status, and glycemic control. These measures will help improve understanding of the influences of extraneous factors on the association between insomnia symptoms and daytime functioning in people with T2DM. In addition, medications such as antidepressants and hypnotics have a negative effect on fatigue and daytime sleepiness [38], while stimulants have a positive impact on daytime sleepiness [39]. Our work did not account for the use of these medications. However, we did not find any significant difference in the number of medications between groups. Although, our participants visited our lab independently, other comorbidities may influence activity level. Future studies may consider including the number of comorbidities as a covariate in the analysis. Finally, comprehensive functional assessments, including variables such as cognition, self-care, and activities of daily living may help in identifying other associations with insomnia and poor daytime symptoms.

The results of this project provide insight into the negative impact of insomnia symptoms on daytime functioning in people with T2DM. Evaluation of insomnia symptoms using a feasible and sensitive tool such as the ISI may improve the standard of diabetes care. For instance, diabetes self-care behavior requires many daytime activities that could be affected by insomnia symptoms [5]. Therefore, ruling out negative factors that could be barriers to optimizing daytime functioning outcomes may support diabetes health outcomes. In addition, diabetes educators may consider providing sleep hygiene to those who present with high scores on ISI and FSS, and refer those with high risk of sleep disorders to sleep specialties. Providing sleep hygiene in diabetes education may offer beneficial suggestions to improve daytime functioning outcomes such as ensuring enough sleep at night, developing routine sleep schedule, avoiding excessive awake time on the bed, and avoiding caffeine for 6 hours before bedtime. In addition, suggestions specific for those with diabetes may include encouraging patients with sleep apnea to adhere to the PAP throughout the night. Finally, preliminary data have shown that cognitive behavioral therapy for insomnia may be a feasible and effective in performing activities for optimum self-care for people with T2DM [40]. These promising results may encourage diabetes educators and other health care professionals to consider sleep promotion programs in order to optimize daytime functioning for their clients.

Conclusions

This study suggested a negative impact of insomnia symptoms on fatigue and QoL related to vitality and physical function in people with T2DM. Depression symptoms may have an independent contribution to the daytime functioning in people with T2DM with insomnia symptoms. Diabetes educators may consider including sleep hygiene or cognitive behavioral therapy for insomnia with diabetes education to promote daytime functioning in people with insomnia symptoms. Future longitudinal research is needed to investigate the complex relationship between depression, insomnia symptoms and daytime functioning in people with T2DM.

Abbreviations

T2DM
Type 2 diabetes mellitus
HPA
Hypothalamic-pituitary-adrenal
QoL
Quality of Life
RLS
Restless leg syndrome
OSA
Obstructive sleep apnea
IN

Insomnia group without insomnia
No-IN
Without insomnia group
ISI
Insomnia Severity Index
PAP
Positive Airway Pressure
FSS
Fatigue Severity Scale
SF 36
Short Form-36
ESS
Epworth Sleepiness Scale

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board and the Human Subjects Committee of the University of Kansas Medical Center (IRB # STUDY00142985). All participants signed a written informed consent before the assessment visit.

Consent to publish

Not applicable

Availability of data and materials

The datasets analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors whose names are listed in this manuscript have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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Author contributions

all Authors read and approved the manuscript. MMA conceptualized the study, researched and analyses the data, wrote the manuscript; JR, AMA, SA, WA, CG, BA and PK contributed in reviewing and writing the manuscript; AMA help in the planning the data analysis. JR and PK conceptualized the study.

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Tables

Table 1. Comparison of demographic and clinical variables between participants with T2DM with and without insomnia symptoms.

	No-IN group (mean±SD) (n=28)	IN group (mean±SD) (n=32)	*p* value
Age	64.79±6.50	60.28±7.83	.02**
Gender, Female, n (%)	13 (46.42)	19 (59.37)	.44*
BMI	35.57±7.90	32.54±5.26	.08**
Education, n (%)			.42**
8 grades or less	0 (0)	1 (3.12)	
High school	5 (17.85)	6 (18.75)	
Some college	11 (39.28)	6 (18.75)	
College graduate	7 (25)	11 (34.37)	
Graduate degree	5 (17.85)	8 (25)	
Ethnicity, n (%)			.28**
White	21 (75)	23 (71.87)	
Black	5 (17.85)	3 (9.37)	
Other (Asian or multiracial)	2 (7.14)	6 (18.74)	
ISI	4.64±3.15	16.00±3.08	<.001*
Beck Depression Inventory	4.79±4.77	11.00±5.91	<.001*
Using Passive Airway Pressure, n (%)			.74**
Never	18 (64.28)	20 (62.5)	
Current	9 (32.14)	12 (37.5)	

**Chi-square test*

***Independent two sample t test*

Table 2. Comparison of daytime functioning outcomes between T2DM with and without insomnia symptoms.

	No-IN Group (mean±SD) (n=28)	IN Group (mean±SD) (n=32)	*p* value	Effect Size (d)	95% Confidence Interval
FSS	3.15±1.44	4.29±1.40	.003*	D=0.80	(-1.87 to -.40)
ESS	7.36±5.00	9.75±5.68	.09*	D=0.44	(-5.17 to .39)
SF 36-Vitality	60.71±13.79	41.77±18.86	<.001*	D=2.10	(10.24 to 27.63)
SF 36-Physical function	78.64±16.77	58.55±23.85	.004*	D=0.96	(5.23 to 26.95)

T2DM: Type 2 diabetes; FSS: Fatigue Severity Scale; ESS: Epworth Sleepiness Scale

**Independent two sample t-test*

Table 3. Multivariable general linear model to assess between-group differences after controlling for covariates

	Model	ß	Observed Power	*p*-value	95% Confidence Interval
FSS	1	1.15	.86	.003	(.40 to 1.89)
	2	.53	.25	.19	(-.28 to 1.35)
ESS	1	1.78	.23	.22	(-1.12 to 4.68)
	2	-.70	.07	.71	(-.44 to -.07)
SF 36-Vitality	1	-18.87	.98	<.001	(-27.76 to -9.98))
	2	-8.1	.40	.07	(-1.74 to -.40)
SF 36-Physical function	1	-16.66	.84	.004	(-27.81 to -5.50)
	2	-2.09	.06	.70	(-12.80 to 8.62)

T2DM: Type 2 diabetes; FSS: Fatigue Severity Scale; ESS: Epworth Sleepiness Scale; group variable included two categories: Insomnia and no insomnia (reference category)

Model 1: Age was controlled

Model 2: Age and depression symptoms were controlled

Table 4. Correlations between daytime functioning outcomes and insomnia symptoms after controlling for covariates.

Outcomes (n=60)	ISI					
	Model 1		Model 2		Model 3	
	r	*p*-value	Partial r	*p*-value	Partial r	*p*-value
FSS	.34	.008	.35	.007	.10	.44
ESS	.35	.006	.31	.02	.16	.21
SF 36-Vitality	-.48	<.001	-.46	<.001	-.20	.13
SF 36-Physical function	-.35	.006	-.34	.01	.02	.90

ISI: Insomnia Severity Index; FSS: Fatigue Severity Scale; ESS: Epworth Sleepiness Scale

Model 1: No covariates

Model 2: Age was controlled

Model 3: depression symptoms was controlled

Figures

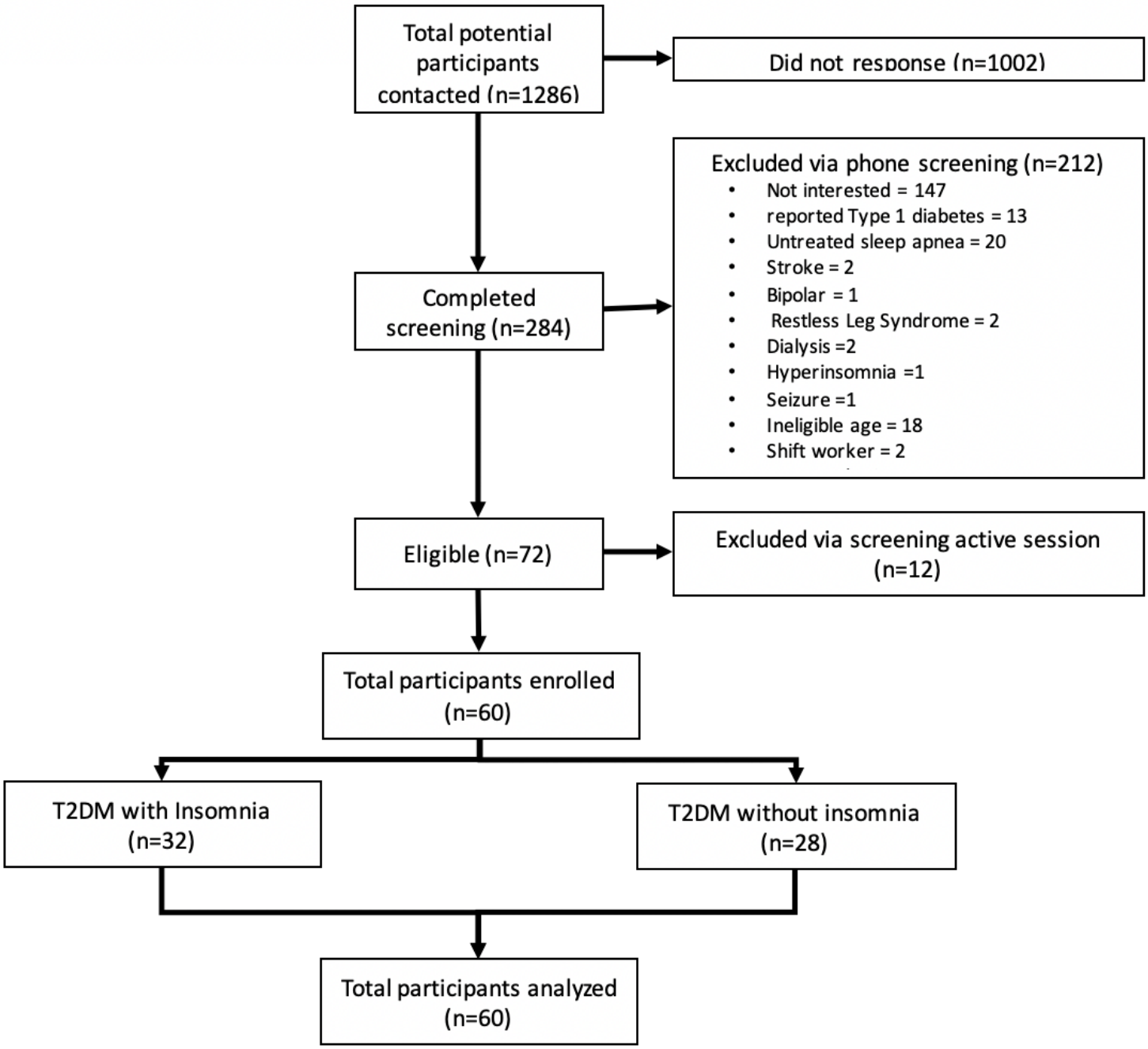

Figure 1

Participant recruitment process