

## **Relationship between self-care and sleep impairment on glycemic control in patients with type 2 Diabetes in a hospital population– A cross sectional study**

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### **ABSTRACT**

**Introduction:** Diabetes mellitus being a chronic metabolic disease responds well to self-care practices. Improper self-care and insomnia have been associated with poor glycemic status with its associated micro and macrovascular complications.

**Materials and methods:** The data regarding self-care and insomnia were collected from 90 consecutive adult patients with type 2 diabetes at a tertiary care teaching hospital, using Diabetes Self-Management Questionnaire and Insomnia Severity Index questionnaire. Glycated haemoglobin was used as a measure of glycemic status.

**Results:** There was a significant association between poor self-care with insomnia ( $p=0.001$ ) and glycemic status ( $p=0.03$ ), but there was no association between insomnia and glycemic status (0.95). **Conclusion:** Poor self-care is associated with poor glycemic status and insomnia.

**Keywords:** insomnia, DSMQ, ISI, A1C

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### **INTRODUCTION**

Diabetes mellitus (DM) is a chronic metabolic condition with hyperglycaemia due to absolute (Type 1 DM) or relative (Type 2 DM or T2DM) deficiency of insulin hormone [1]. In India 74 million people in the age group 20-79 years have DM with a prevalence of 9.6%. [2]. It has been projected that the prevalence may rise to 10.8% by 2045. The Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) population based cross-sectional study of the prevalence of Diabetes reported a prevalence of 8.4% in Andhra Pradesh, with self-reported Diabetes being 5.8%. [3].

Treatment of Diabetes and self-care is the cornerstone of its management and prevents morbidity due to acute and chronic complications [1]. Diabetes self-care mainly involves different behaviours like being physically active, having a good dietary regimen, being compliant with medication, regular monitoring of blood glucose, problem solving, reducing risks and healthy coping [4]. Diabetes self-care necessitates the assisting role of healthcare personnel, in order to maintain a better level of self-care [1]. The term 'Diabetes Self-management Education (DSME)' is increasing self awareness skill and ability to combat T2DM by the patients [5]. Among the T2DM patients in the world, only 9% - 15% of them manage to maintain optimum glycemic control [6]. Proper self-management of Diabetes is associated with better glycemic control as evidenced by lower glycated haemoglobin (A1C) [6,7]. Glycated haemoglobin (A1C) estimation informs us about long term glycemic control.

It is used for monitoring compliance with treatment. High A1C values are associated with chronic micro and macrovascular complications [8].

Insomnia has a detrimental influence on work productivity and quality of life. Many experimental and epidemiological studies have found that inadequate sleep quantity and quality are associated with an increased risk of chronic systemic disorders such as hypertension, obesity, cardiovascular disease, inflammatory conditions, and insulin resistance [9-15]. Poor sleep quality is a common complaint among persons with T2DM, with prevalence rates ranging from 42% to 76.8%. Chronic sleep deprivation has been proven to lower glucose tolerance and potentially reduce insulin sensitivity, which may increase the risk of chronic diabetes sequelae [16]. Insomnia was found to worsen the diabetic status of the individual. [16-19].

Decreased sleep quantity and duration has been linked to poor self-care in diabetics [20]. Diabetes leads to certain conditions like obesity and overweight, sleep related respiratory problems like Obstructive Sleep Apnea, pain due to diabetic neuropathy, poor urinary and bowel movements control caused by autonomic neuropathy and nocturnal polyuria caused by hyperglycemia which further affects sleep and self-care [16]. Daytime drowsiness has also been linked to poor self-care, thus starting a vicious cycle of complications and morbidity [20].

Patients who divided their sleep duration into many episodes over the course of a 24-hour period had a lower A1C. Similarly, the patients who slept for longer durations in a single episode within a period of 24 hours were found to have lower A1C [19].

A standardized structured psychometric assessment technique is essential for researchers who need to quantify diabetic self-management as part of research [21]. Self-management of Diabetes can be assessed by different scales; the common ones being “Summary of Diabetes Self-care Activities Measure” (SDSCA) and the “Diabetes Self-management Questionnaire-Revised” (DSMQ-R). The SDSCA has a limitation, that is, its poor association with glycemic control as measured by A1C. DSMQ was introduced in 2013. Schmitt et al have reported a good association of DSMQ-R with glycemic control [21]. Bastien et al have validated the Insomnia Severity Index (ISI) scale that assesses sleep disturbances [22]. This is a brief seven item inventory to assess insomnia. It has shown good validity and reliability. As objective methods of self-care assessment are not economical, we used a standardized self-report questionnaire which has been used in several studies, i.e. the DSMQ. Similarly ISI was used to assess insomnia as it is a brief instrument with 7 items and is also a validated instrument.

With this background the present study was undertaken, as Andhra Pradesh ranks 10<sup>th</sup> in India in relation to DM prevalence [23]. Srivastava et al have reported that there are several studies on self-care from developed countries but not many from developing countries [1].

There have been no studies to the best of our knowledge in this rural area in Andhra Pradesh, that have determined the relationship of self-care with A1C using DSMQ-R, or the impact of insomnia on self-care and glycemic control.

### **Aims and Objectives:**

To;

1. Determine the relationship between the self-care score using DSMQ-R and A1C
2. Determine the relationship between insomnia severity score and A1C.
3. Determine the relationship between sleep impairment and self care.

## **MATERIAL & METHODS**

**Study population:** People with T2DM coming to the outpatient diabetology department of a tertiary care teaching hospital in a rural area in Andhra Pradesh.

**Inclusion criteria:**

1. All adults belonging to both sexes above 30 years of age having T2DM as defined by American Diabetes Association criteria who consented to participate in the study [24].
2. Participants with diabetes of >1 year duration.
3. Participants with an A1C value not older than 8 weeks before the date of the interview.
4. They should be able to speak and understand Telugu.

**Exclusion criteria**

1. Subjects with terminal illness or cognitive impairment.
2. Pregnancy.

**Sampling and sample size:** Non probability sampling of the subjects who attended the diabetology outpatient department of the hospital during the 2 months of the study- May and June 2021 and gave informed consent for their participation.

**Study design:** observational cross sectional analytical study.

**Study tools:** Case record form to record baseline data, self-care questionnaire DSMQ-R, and Insomnia Severity Index scale (ISI). The self-care questionnaire has 16 items and 4 subscales. The subscales are a) glucose management consisting of 5 statements (1,4,6,10 and 12) related to medication adherence and blood glucose monitoring, b) dietary control consisting of 4 statements (2,5,9 and 13) related to diabetes associated dietary management behaviours, c) physical activity (PA) consisting of 3 statements (8,11 and 15) which are related to exercise or activity for management of diabetes and d) health care use (HU) consisting of 3 statements (3,7 and 14) which are related to diabetes related physicians appointments. The last item is related to the overall diabetes self-care score and its score is included only in the sum scale. The scoring is done by adding the sub scale scores, after reversing the scores of negatively keyed items (5,7, 10-16). Then the scores are transformed to a scale ranging from 0 to 10, where a score of 10 will indicate the most effective self-care behaviour. A score of >6 was considered good self-care.

The Insomnia Severity index (ISI) was used to assess the severity of sleep disturbance. It has 7 items and the highest score is 28 and the least is 0. There are 4 grades of insomnia. A score of 7 or less indicates no significant insomnia, a score between 8-14 is sub threshold insomnia, between 15-21 is clinical insomnia of moderate severity and between 22-28 is clinical insomnia that is of severe intensity [22].

These two English questionnaires were translated to Telugu with the help of an expert and back translated to English by a bilingual expert proficient in Telugu and English. Then they were tested on a sample of 30 people with T2DM. The validity was tested for the items using Cronbach's alpha, which was 0.9 showing good internal consistency.

Then the two questionnaires were administered to the participants after giving them proper instructions.

The latest report of A1C done not later than 8 weeks before administration of the questionnaire was noted. The A1C was estimated using Biorad D10 that uses High Performance Liquid Chromatography (HPLC) and complies with the National Glycohaemoglobin Standardization programme (NGSP) that was implemented so that the results are traceable to Diabetes Chronic Complications Trial (DCCT) and United Kingdom Prospective Diabetes Study (UKPDS) trials [8]. These are landmark trials that showed evidence that tight glycemic control has beneficial effects on cardiovascular and microvascular endpoints. According to the American Diabetes Association (ADA) guidelines an A1C of >7 is considered poor control [25].

**Statistics:** For deciphering a relationship between the DSMQ-R score and A1C, between ISI score and A1C and between DSMQ-R score and ISI score, Spearman's rank order was applied. Descriptive statistics was used for the socio-demographic variables. A 'p' value of  $\leq 0.05$  was considered significant.

**Ethics consideration:** institutional ethical committee clearance was obtained.(IEC NRIMC 152).

## OBSERVATIONS AND RESULTS

The data of 90 patients was analysed. The descriptive data are given in

**Table 1: Baseline data are as follows;**

Parameters	Specifier	Frequency	%
Gender	Female	51	56.67
	Male	39	43.33
Age range in years	31-40	5	5.56
	41-50	22	24.44
	51-60	34	37.78
	61-70	26	28.89
	71-80	3	3.33
Region	Rural	31	34.44
	Urban	59	65.56
Occupation	Employed	63	70
	Unemployed	27	30
Smoking status	Non smokers	86	95.56
	Smoking >1pack/day	4	4.44
Family history of DM	No	16	17.78
	Yes	84	82.22
Duration of DM in years	1- <5	21	23.33
	5-9	25	27.78
	10-14	15	16.67
	$\geq 15$	29	32.22
Complications	Yes	60	66.67
	No	30	33.33
Comorbidities	No	19	21.11
	Yes	71	78.89
Use of oral hypoglycemic agents.	Yes	89	98.89
	No	1	1.11
Use of insulin	Yes	28	31.11
	No	62	68.89
BMI	<25	19	21.11
	>25	71	78.89
HbA1C	<7	18	20
	>7	72	80
DSMQ score	$\leq 6$	48	53.3
	>6	42	46.4
ISI	<15	69	76.6
	$\geq 15$	21	23.4

**Table 2: Spearman's rank correlation between Glycated haemoglobin (A1C), Body mass index**

Parameter	Spearman's correlation	p value
A1C and BMI	-0.083	0.438
A1C and DSMQ-R score	-0.230	0.028 significant
A1C and ISI score	-0.006	0.955
DSMQ-R≤6 with ISI scores	-0.21	0.14
DSMQ-R>6 with ISI scores	-0.31	0.05 significant
DSMQ-R with ISI scores	-0.337	0.001 significant

(BMI), Diabetes Self-Management Questionnaire-Revised score (DSMQ-R), Insomnia Severity Index (ISI) score.

**Table 3: Median and interquartile range of Glycated haemoglobin(A1C), Body mass index (BMI), Diabetes Self-Management Questionnaire-Revised score (DSMQ-R), Insomnia Severity Index score(ISI).**

Parameter	Median	Interquartile range
A1C	7.9	2.3(7.17-9.42)
<7	6.7	0.4(6.6-6.8)
>7	9	2.7(7.5-10.2)
BMI	28.2	6.5(25-31.5)
ISI score	7.0	14 (0-10)
DSMQ-R score	5.9	2.7(4.8-7.5)
DSMQ-R subscores		
Glucose control	6.7	3.3(5.5-8.6)
Diet control	5.9	3.3 (4.2-7.5)
Physical activity	3.3	5.8 (1.1-6.9)
Health care utilisation	7.8	4.5 (4.4-8.9)

As seen in Table 1 there were more females in the sample (56.6%) and 37% of the participants were from the 50-60 years age group. The majority were employed, were from urban areas and had a family history of T2DM. Most of them had other comorbidities or complications due to T2DM, had a BMI >25 and an A1C >7; which indicates that they were obese and had poor glycemic control. One third of the participants had diabetes duration of more than 15 years and were on insulin. The self-care behaviour of the participants as shown by the score on DSMQ-R was equivocal; with almost equal participants showing good self-care (49%) and others showing poor self-care(51%). According to the ISI score 76% appeared to be having very minor sleep issues whereas the rest had moderate to severe insomnia.

Table 2. shows a significant negative relation between self-care behaviour and A1C values (p,0.03), which indicates that the lower the self-care the higher is the A1C value which indicates poor control of diabetes. Similarly it was observed that the lower the self-care the higher was the insomnia score which indicates poor sleep (p, 0.001).

Table 3. shows us the median and interquartile range of A1C, DSMQ-R, BMI and ISI values. The BMI of most participants was in the obese range (median being 28.1) according to the BMI guidelines for Asian Indians [26].It also shows us the sub-scale scores of DSMQ-R. It can be seen that diet control and physical activity score was low in the participants (with a

median of 5.9 and 3.3 respectively) and they scored very high on utilisation of health services (median being 7.8).

## DISCUSSION

Type 2 Diabetes mellitus (T2DM) being a chronic metabolic disorder, it becomes important that patients are made aware of the importance of self-care practices that will help them to remain euglycemic. Overall the participants in this study showed inadequate self-care behaviour as evidenced by the median DSMQ-R sum score of 5.9 with an interquartile range (iqr) 4.8-7.5. Our study has shown that there is a significant negative correlation between the DSMQ-R and A1C values ( $r_s=0.23$   $p,0.03$ ). This indicates that the better the self-care in patients with diabetes the better will be their glycemic status; observed as lower A1C values. Bukhshet al reported in their sample the median DSMQ-R score of 3.54 with an interquartile range (iqr) of 2.71-5.21 in patients with an A1C value  $>7$ ; which was 83% of their sample, very similar to our sample where 80% had A1C values  $>7$  [7]. Their sample size was 218, and it was also a hospital-based sample. They found that patients with good glycemic control with A1C values  $\leq 7$  showed a higher DSMQ-R sum score (median DSMQ-R scores being 7.7 versus 3.5) compared to patients with values  $>7$ . This was statistically significant with a 'p' value  $<0.01$ . The reason for such poor self-care behaviour in both the samples could be that it was a hospital sample and patients would visit the health care facility only when they were not well. Their study did not find demographic variables influencing the glycemic status but observed that smoking, education, anti-diabetic therapy and A1C values had an influence on self-care behaviour as evidenced by statistically significant p value  $<0.05$ . Ying-Ang et al reported that in Malaysian patients with T2DM, the mean DSMQ-R score was  $7.48 \pm 1.32$  and only 16% had poor scores. This was a public hospital-based study [27]. The scores were better than our study indicating better self-care. The higher score could be due to the greater literacy in Malaysia, due to which the people make more informed choices.[28] They found that "Health-Care Use" had the highest score ( $8.36 \pm 1.99$ ), while "Physical Activity" had the lowest score ( $6.82 \pm 2.56$ ). This is similar to our study with median values for Health care use being 7.8 (iqr 4.4- 8.9) and for physical activity the median value was 3.3(iqr 1.1-6.9). It is a well-established fact that regular physical exercise improves insulin sensitivity and reduces blood glucose values [29]. It also improves immunity, compliance and reactivity of blood vessels and cardiac output. The patients in our study showed very poor physical activity which could be the reason for poor glycemic control, though they used the health care facility more often as observed by the highest score in that sub scale. Shrivastava et al, reported that the physical activity subscale score was lower than total sum scale and other subscale scores.[30]The reason for poor physical activity was not investigated.

Chandrakhar et al in a study from Andhra Pradesh observed that 42% of the patients had poor glycemic control with  $A1C > 7$  and nearly 60% of patients had achieved glycemic control. The patients showed better glycemic status as this was a community study unlike our study.[31]

A meta-analytic study done by Koopman et al found that the prevalence of insomnia was 39% in T2DM population and was associated with poor glycemic control. In our study, moderate to severe insomnia was found in 23% of the participants [32]. It was found that there was no influence of insomnia on the glycemic status. Koopman et al also found that the prevalence was higher in Asia (49%) versus Europe/America (40%). The method of data collection of insomnia was Pittsburgh Sleep Quality Index (PSQI). They found that the four studies where a meta-analysis was done and which adjusted for confounders, showed no significant association among insomnia and poor glycemic control, which was in concordance with our study.

Zhu et al, found that subjective sleep disturbance and frequent nocturnal awakenings were associated with poor diabetes self-care in adults with T2DM [20]. The mean A1C level reported in their study was  $7.9 \pm 2$  which was similar to our study and 61% had poor glycemic status. They found that sleep disturbance was significantly related to diabetes overall self-care ( $r = -0.36$ ). They observed that the number of nocturnal awakenings was significantly related to self-care. Frequent nocturnal awakenings were related to difficulty in concentrating, memory problems and mood which influenced self-care behaviour. Several physiological pathways have been proposed to explain the relationship between sleep disturbance and diabetes. These pathways include decreased brain glucose utilization, increased sympathetic system activity, increased inflammation, abnormal adipocyte function and alteration in appetite regulating hormones caused by sleep disturbance. In addition, behavioural mechanisms that link sleep disturbance and diabetes have also been suggested. It includes suboptimal self-care activities with fatigue leading to impaired decision making like; unhealthy food choices, sedentary behaviours and poor medication compliance which leads to poor glycemic control. In addition, sleep fragmentation and intermittent hypoxia may trigger some of the changes in glycemic control. It has also been found that sleep restriction increased evening cortisol levels, which decreases insulin sensitivity the next morning [33]. As this study used an objective assessment of sleep, it could be that it led to a better association with diabetes self-care. Chasens et al reported that insomnia alone or in association with obstructive sleep apnea can lead to poor metabolic outcomes in patients with DM. They used ISI for assessing sleep [34].

The strengths of our study are that it is the first such study being done in this area to determine the association of diabetes self-care on glycemic status and on sleep. It has used a validated questionnaire to report sleep quality and diabetes self-care in the local language (Telugu). The questionnaires were pilot tested and then after ensuring internal validity, it was used in the study. The limitations of our study are that it is a hospital-based study and used consecutive sampling, with a small sample size and therefore the findings cannot be generalizable. Further studies with probability sampling from the community can be used to increase the generalizability of the research findings. Also the reason for poor physical activity should be investigated. It is not clear whether it is due to the complications of the illness or other psychological factors like diabetes distress or depression. These factors must be studied to see their association with self-care and insomnia.

## CONCLUSIONS

This study has shown that majority of patients have poor self-care practices which is affecting their sleep and glycemic status. It has also been found that patients mainly shirk physical exercise, which worsened their glycemic status. This calls for diabetes education to be given to the patients by doctors and nurses, every time the patient comes for a consultation. Also the reasons for a low score on physical activity must be investigated. Further studies on risk factors for poor self-care must be studied as this will help in reducing them.

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