

ASSOCIATION OF SLEEP TIME WITH DIABETES MELLITUS AND IMPAIRED GLUCOSE TOLERANCE

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Article Info: Received 05 May 2021; Accepted 30 June 2021

DOI: <https://doi.org/10.32553/ijmbs.v5i7.2010>

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Conflict of interest: No conflict of interest.

Abstract

Introduction: In the present study, we was examined the relation of self-reported usual sleep time to prevalence DM and IGT in a large hospital based sample of middle-aged and older adults.

Methods: Cross-sectional study was conducted on 625 patients between age group 18-60 yrs and both sex. Usual sleep time was obtained by standardized questionnaire. Diabetes mellitus was defined as a serum glucose level of 126 mg/dL or more fasting or 200 mg/dL or more 2 hours following standard oral glucose challenge or medication use for DM. Impaired glucose tolerance was defined as a 2-hour post challenge glucose level of 140 mg/dL or more and less than 200 mg/dL. The relation of sleep time to DM and IGT was examined using categorical logistic regression.

Results: 49.28% subjects sugar level was more than 200 mg/dl and 13.72% subjects sugar level less than 140 mg/dl. The association between sleeping time and blood sugar level was found statistically significant. The association between Sleeping time and blood sugar level was found statistically significant

Conclusion: A sleep duration of 6 hours or less or 9 hours or more is associated with increased prevalence of DM and IGT. Because this effect was present in subjects without insomnia, voluntary sleep restriction may contribute to the large public health burden of DM.

Keywords: DM, IGT, Hb1Ac

Introduction

National sleep foundation guidelines advise that healthy adults need between 7 and 9 hours of sleep per night. Babies, young children, and teens need even more sleep to enable their growth and development. People over 65 should also get 7 to 8 hours per night. The usual amount of sleep per night has been declining among Indian adults for more than a generation. The median sleep time in adults aged 40 to 79 years was 8 hours per night in 1959, with less than 15% reporting a usual sleep time of less than 7 hours.¹ By 2002, the adult median sleep time had decreased to 7 hours per night, with more than one third of adults sleeping fewer than 7 hours.² Although insomnia is highly prevalent, much of the reduction in sleep time reflects voluntary sleep restriction, with 43% of adults reporting that they often stay up later than they should watching television or using the Internet and 45% reporting that they sleep less to get more work done.³ Several studies have found increased mortality associated with usual sleep times of less than 7 or more than 8 hours per night.^{4,5} Experimental restriction of sleep to 4 hours per night for 6 nights resulted in impaired glucose tolerance (IGT) in healthy young adults.⁶ Because diabetes mellitus (DM) carries a high risk of cardiovascular-related mortality, the impact of sleep restriction on glucose regulation suggests a mechanism whereby short sleep time might increase mortality.

In the present study, we will be examined the relation of self-reported usual sleep time to prevalence DM and IGT in

a large hospital based sample of middle aged and older adults.

Material and methods

Study design: Hospital based cross-sectional study.

Study duration: 12 months

Study place: S.P.Medical College and P.B.M Hospital, Bikaner

Sample size: 623 adult age 18-60 years

$$\text{Sample size} = \frac{Z_{1-\frac{\alpha}{2}}^2 p(1-p)}{d^2}$$

Here, $Z_{1-\frac{\alpha}{2}}$ = Is standard normal variate (at 5% type 1 error [P < 0.05], it is 1.96; at 1% type 1 error [P < 0.01], it is 2.58). As in majority of studies, P < 0.05 was considered statistically significant and hence 1.96 is used in the formula.

p = Expected proportion in population based on previous studies or pilot studies

d = Absolute error or precision – has to be decided by researcher.

P = 50; q = 50; d = 10%.

Using the above values at 95% confidence level, a sample size of 623 patients need to be included in the study.

Sampling Method: Random sampling

Inclusion Criteria:

Adult age 18-60 years

Exclusion Criteria:

1. Those not willing to participate in the study.
2. Obstructive sleep apnea/ hypopnea.

Data Collection:

Ethical approval was obtained from the college research ethics committee. This study was conducted in Bikaner Rajasthan. Informed consent will be obtained.

Height and weight was measured, and BMI was calculated as kilograms per meter squared.

Seated blood pressure (BP) were measured twice in the right arm after a 5-minute rest using mercury sphygmomanometer; the mean of the 2 values will be use in analysis after an adjustment for cuff size.

Waist circumference midway between lower rib margin and iliac crest over light clothing using an unstretched tape meter without any pressure to the body surface to the nearest 0.1cm.

Blood samples were obtained after an overnight fast; person were asked not to eat on the morning of the examination, and those who reported having eaten breakfast will be excluded from analysis. All samples were shipped to a central laboratory within 48 hours. Glucose, hemoglobin A1c (HbA1c), were measured.

Fasting blood glucose by GOD-POD method

Hb1Ac by ion exchange chromatography

Usual sleep time was defined as the response to the question, "How many hours of sleep do you usually get at night (or your main sleep period) on weekdays or

workdays?" Responses was integer values.

Euglycemia, impaired glucose tolerance and frank diabetes was defined according to WHO criteria.

Diabetes mellitus was defined as use of insulin or a hypoglycemic agent or fasting plasma glucose level of ≥ 126 mg/dL (≥ 7.0 mmol/L), or a 2-hour post load plasma glucose level of ≥ 200 mg/dL (≥ 11.0 mmol/L) or Hb1Ac $\geq 6.5\%$ or symptoms of hyperglycemia and random blood glucose level ≥ 200 mg/dl (≥ 11.0 mmol/L). Impaired glucose tolerance was defined as a 2-hour postload plasma glucose level of 140 mg/dL or more (≥ 7.8 mmol/L), in subjects not meeting the criteria for DM.

Data Analysis:

To collect required information from eligible patients a pre-structured pre-tested proforma was used. For data analysis Microsoft excel and statistical software SPSS was used and data was analyzed with the help of frequencies, figures, proportions, measures of central tendency. Chi-square test was use for qualitative data and t-test was used for quantitative data. Co-relation co-efficient were used for correlation.

Result

In our study out of 625 subjects, maximum (86.08%) subjects were 46-60 Yrs age group followed by 7.84% subjects were 31-45 Yrs age group and only 6.08% subjects were below 30 Yrs age group. 362 (56.92%) subject were male and 263(43.08%) subjects were female. 49.28% subjects sugar level was more than 200 mg/dl and 13.72% subjects sugar level less than 140 mg/dl

Table1: Association between sleeping time and OGTT

Blood sugar after 2 hours	Sleeping time (Hrs)				Total
	≤ 6	7	8	≥ 9	
<140 mg/dl	11	62	12	1	86
141-200 mg/dl	94	51	65	21	231
>200 mg/dl	107	93	47	61	308
Total	212	206	124	83	625

P-value=0.01(S)

The association between sleeping time and blood sugar level was found statistically significant.

Discussion

In our study the association between sleeping time and impaired blood glucose level was found statically significant. Short sleeping time & long sleeping time both were more prone to develop diabetes.

By using uniformly applied objective measures to assess glycemic status, the present study provides epidemiologic evidence that short and long sleep time is associated with DM and IGT in community-dwelling middle-aged and older adults under conditions of sleep deprivation that are

highly prevalent in the India now.

This finding persisted after adjustment for known DM risk factors, and was independent of the presence of insomnia symptoms, suggesting that voluntary sleep restriction may be a cause of impaired glucose regulation.

The association of short & long sleep times with DM and IGT may explain in part the association between short sleep time and myocardial infarction⁷ and mortality,⁸⁻¹¹ and lends empirical support to the common recommendation to obtain 7 to 8 hours of sleep per night. Moreover, it suggests that

obtaining an adequate total sleep time should be tested as a non pharmacologic treatment modality in the management of patients with DM and IGT.

These results are consistent with a prior report from the Nurses' Health Study in which the adjusted ORs for incident DM over a mean follow-up of 10 years were 1.18, 1.10, and 1.29 in subjects sleeping 5 or less, 6, or 9 or more hours per night, respectively, compared with those sleeping 8 hours per night.¹² Although the association of sleep time with incident DM in the Nurses' Health Study was significant only in the subset of diabetic patients with severe symptoms, and not in the entire cohort, the power of that study may have been limited by use of self-report to identify incident cases of DM or by changes in sleep habits during the long follow-up period.

A study using an intravenous glucose tolerance test in a small sample of healthy, nonobese, young adults with habitual short sleep times (mean, 5.3 hours per night) found that, compared with subjects sleeping 7.5 to 8.5 hours per night, short sleepers were not glucose intolerant but did have reduced insulin sensitivity.¹³ Perhaps with additional risk factors, such as advancing age or greater adiposity, this reduced insulin sensitivity would result in glucose intolerance.

Studies of experimental sleep restriction suggest a likely causal association between short sleep and impaired glucose regulation. Sleep restriction to 4 hours per night for 6 nights caused IGT in healthy young adults, which resolved after 1 week of increased sleep duration. The biological mechanisms underlying this effect are uncertain. Sleep deprivation may lead to increased sympathetic nervous system activity,¹⁴ which may impair glucose regulation via the lipolytic effects of α -adrenergic stimulation of visceral adipose tissue.¹⁵ Sleep deprivation also alters activity of the hypothalamic-pituitary-adrenal axis, with short-term partial sleep deprivation causing a shorter quiescent period of cortisol secretion and slower clearance of free cortisol.¹⁶ Experimentally delaying sleep onset is associated with a presleep burst of growth hormone secretion followed by the usual sleep-onset growth hormone secretion,¹⁷ possibly causing morning glucose intolerance, although persistence of this pattern of growth hormone secretion with long-term delayed sleep onset is uncertain. Primary insomnia is associated with increased activity of the hypothalamic-pituitary-adrenal axis,¹⁸ and patients with insomnia often underestimate their actual sleep time. However, the observed association of short sleep time with DM and IGT in the present study remained significant after adjustment for insomnia or excluding subjects with insomnia, implying that voluntary sleep restriction at levels common in the population may lead to impaired glucose regulation.

The mechanisms mediating the association of long sleep time with impaired glucose regulation are more speculative. Seven days of extending time in bed to 12 hours per night was not associated with evidence of glucose intolerance.

Nurses' Health Study subjects who reported sleeping 9 hours or more per night reported 15% less physical activity per week than those sleeping 7 to 8 hours per night.¹⁹ This might lead to impaired glucose regulation through direct effects of inactivity^{20,21} or through an association of inactivity with a greater degree of visceral adiposity for a given level of total body adiposity, as suggested by the greater reduction in visceral compared with total body fat with daily walking.²² Depression is associated with increased cortisol level and may cause increased sleep time. Although depression was not formally assessed in our subjects, sleep time was not significantly associated with depressive symptoms obtained from the medical outcomes study 36-Item short form health survey; confounding by depression is, therefore, unlikely. While adjustment for usual alcohol consumption did not meaningfully alter the association of sleep time with DM or IGT, sleep time was significantly associated with alcohol consumption. Because heavy alcohol users may under report their actual consumption, it is possible that alcohol use contributes to the higher prevalence of impaired glucose regulation in those sleeping 9 hours or more per night. An alternative hypothesis is that conditions associated with mild chronic inflammation, such as subclinical cardiovascular disease or visceral obesity per se, cause long sleep time and alteration in glycemic control via the sleep-inducing and metabolic effects of inflammatory cytokines, including interleukin 1 and tumor necrosis factor²³⁻²⁴

Conclusion

A sleep duration of 6 hours or less or 9 hours or more is associated with increased prevalence of DM and IGT. Because this effect was present in subjects without insomnia, voluntary sleep restriction may contribute to the large public health burden of DM.

References

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27:1047-53.
2. Giugliano D, Esposito K. Mediterranean diet and metabolic diseases. *Curr Opin Lipidol*. 2008;19:63-8.
3. Hammond EC, Garfinkel L. Coronary heart disease, stroke, and aortic aneurysm: factors in the etiology. *Arch Environ Health*. 1969;19:167-182.
4. Sleep in America Poll. Washington, DC: National Sleep Foundation; 2003.
5. Wingard DL, Berkman LF, Brand RJ. A multivariate analysis of health-related practices: a nine-year mortality follow-up of the Alameda County Study. *Am J Epidemiol*. 1982;116:765-775.
6. Spiegel K, Leproult R, Van Cauter CE. Impact of sleep debt on metabolic and endocrine function. *Lancet*. 1999;354:1435-1439.
7. Psaty BM, Lee M, Savage PJ, Rutan GH, German PS, Lyles M; Cardiovascular Health Study

- Collaborative Research Group. Assessing the use of medications in the elderly: methods and initial experience in the Cardiovascular Health Study. *J ClinEpidemiol.* 1992;45:683-692.
8. Nieto FJ, Young TB, Lind BK, et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. *JAMA.* 2000; 283:1829-1836.
 9. Ayas NT, White DP, Manson JE, et al. A prospective study of sleep duration and coronary heart disease in women. *Arch Intern Med.* 2003;163:205-209.
 10. Ayas NT, White DP, Al Delaimy WK, et al. A prospective study of self-reported sleep duration and incident diabetes in women. *Diabetes Care.* 2003;26:380-384.
 11. Mander BA, Colecchia E, Spiegel K, Van Cauter EY. Short sleep: a risk factor for insulin resistance and obesity [abstract]. *Sleep.* 2001;24:A74-A75.
 12. Punjabi NM, Sorkin JD, Katzel LI, Goldberg AP, Schwartz AR, Smith PL. Sleepdisordered breathing and insulin resistance in middle-aged and overweight men. *Am J RespirCrit Care Med.* 2002;165:677-682.
 13. Ip MS, Lam B, Ng MM, Lam WK, Tsang KW, Lam KS. Obstructive sleep apnea is independently associated with insulin resistance. *Am J RespirCrit Care Med.* 2002; 165:670-676.
 14. Pouliot MC, Despres JP, Lemieux S, et al. Waist circumference and abdominal sagittal diameter: best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. *Am J Cardiol.* 1994;73:460-468.
 15. Despres JP. Health consequences of visceral obesity. *Ann Med.* 2001;33:534-541.
 16. Wajchenberg BL. Subcutaneous and visceral adipose tissue: their relation to the metabolic syndrome. *Endocr Rev.* 2000;21:697-738.
 17. Spiegel K, Leproult R, Copinschi G, Van Cauter E. Impact of sleep length on the 24-h leptin profile [abstract]. *Sleep.* 2001;24:A74.
 18. Hasler G, Buysse DJ, Klaghofer R, et al. The association between short sleep duration and obesity in young adults: a 13-year prospective study. *Sleep.* 2004; 27:661-666
 19. Irwin M, Thompson J, Miller C, Gillin JC, Ziegler M. Effects of sleep and sleep deprivation on catecholamine and interleukin-2 levels in humans: clinical implications. *J ClinEndocrinolMetab.* 1999;84:1979-1985.
 20. Lonnqvist F, Thorne A, Large V, Arner P. Sex differences in visceral fat lipolysis and metabolic complications of obesity. *ArteriosclerThrombVasc Biol.* 1997; 17:1472-1480.
 21. Leproult R, Copinschi G, Buxton O, Van CE. Sleep loss results in an elevation of cortisol levels the next evening. *Sleep.* 1997;20:865-870.
 22. Spiegel K, Leproult R, Colecchia EF, et al. Adaptation of the 24-h growth hormone profile to a state of sleep debt. *Am J PhysiolRegulIntegr Comp Physiol.* 2000;279:R874-R883.
 23. Vgontzas AN, Bixler EO, Lin HM, et al. Chronic insomnia is associated with nyctohemeral activation of the hypothalamic-pituitary-adrenal axis: clinical implications. *J ClinEndocrinolMetab.* 2001;86:3787-3794.
 24. Rodenbeck A, Huether G, Ruther E, Hajak G. Interactions between evening and nocturnal cortisol secretion and sleep parameters in subjects with severe chronic primary insomnia. *NeurosciLett.* 2002;324:159-163.