Co- Relation between sleep disruption and diabetes mellitus: A review study

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Abstract:

Introduction: Diabetes mellitus is one of the fast-growing chronic diseases in the world and India ranks number second in the population with diabetes. Diabetes comes with a number of associated factors and sleep associated factors come under consideration whenever an individual is associated with chronic disease. It seems to lack certain degree of acceptance and surety with diabetes being directly linked with sleep disruption in suffering individuals.

Aims & Objectives: The main aim of the study is to investigate the co-relation between diabetes mellitus and sleep disruptions.

Material and Method: An electronic database search was conducted between year 2012 to 2023 by using Google Scholar, PubMed, Cochrane, World Journal of diabetes & Indian Journal of Diabetes and Endocrinology. The study was double checked and only full text articles were used for the review. Total 12 studies were selected for the study of co-relation between sleep disruption and diabetes mellitus.

Result: According to data search on May 2023 from January 2012 to April 2023 about 15 free full article shows the positive co-relation between sleep disruption and diabetes.

Conclusion: This review study concluded that diabetes and sleep disruption are co-related with each other and have a significant prevalence.

Key words: Sleep disruption, Diabetes mellitus, Diabetic neuropathy, Neuropathy, Quality of life, Mood.

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Introduction

Collective group of problems which limit in healthy sleep cycle are referred as sleep disruptions[(1)]. A healthy and normal sleep can be termed as absence of sleep disruptions, good quality, continuity & regularity in a flow. lack of basic knowledge could influence the effectiveness of patient education and therefore have dangerous consequences for the patient diagnosed with diabetes mellitus [(2)] Importance of regular sleep governs the fact that any disruptions result into change in systematic physiology, metabolism, cardio-vascular and endocrine systems [(3)] Despite the importance of sleep, up to 70 million people in the US and ~45 million people in Europe have a chronic sleep disorder that impacts daily functioning and health. For example, ~20% of the serious injuries that result from car accidents can be associated with driver sleepiness, independent of the effects of alcohol. Lifestyle and environmental factors, psychosocial issues, and medical conditions all contribute to sleep problems.

Sleep upholds two-third of our life, making it a beneficial active process rather than a passive process. Sleep is termed as a global stage where as the mechanism of sleep generation and maintenance is more of a balance between two systems located within the brain, one is the homeostatic processes, which are functionally the body's "need for sleep" center, and another is circadian rhythm which is an internal clock for the sleep-wake cycle.[(4)] The sleep generation is initiated at the ventrolateral preoptic nucleus (VLPO) of the anterior hypothalamus and acts to inhibit the arousal regions of the brain, including the tuberomammillary nucleus, lateral hypothalamus, locus coeruleus, dorsal raphe, latero dorsal tegmental nucleus, and pedunculopontine tegmental nucleus. Hypocretin (orexin) neurons in the lateral hypothalamus help to facilitate this process in a synergistic effect. [(5)]

NREM sleep is a functional disconnection between the brain stem and the thalamus. The action takes place such that corticothalamic neurons signal the thalamus, which causes hyperpolarization of the thalamic reticular neurons. This process produces delta waves from both thalamic reticular and cortical pyramidal sources. Thus, correlating with the varying stages 1 to 3 of NREM. REM sleep is generated by "REM-on neurons" in the mesencephalic and pontine cholinergic neurons. The pedunculopontine tegmental nucleus and the lateral dorsal tegmental neurons trigger desynchronized cortical waveforms. The tonic component of REM sleep is parasympathetically medicated, and the phasic component is sympathetically mediated.[(6)]

Circadian rhythm is the body's cyclical nature for the desire for sleep. The hypothalamus controls it via the suprachiasmatic nucleus with sensory input from the retino hypothalamic tract based on light levels detected from the retina. The circadian rhythm is approximately 24.2 hours per cycle. Melatonin, produced in the pineal gland, has also been shown to be a modulator of the circadian rhythm that has concentrations varied based on the light level. Specific exercise programs, including ROM, muscle strengthening, circuit training, stretching, gait, and balance exercises can improve gait and balance in diabetics with peripheral neuropathy [(7)]

Melatonin levels are greatest at night and decrease during the daytime. Finally, body temperature has been associated as part of the circadian rhythm. The exact set point varies among different people, but it is expected to have generally lower temperatures in the morning and higher temperatures in the evening.[(8)] Various health consequences are adjoined with the disturbance in sleep loss and sleep disorders which further comprehend in risk of hyper tension, diabetes and heart attack.[(4)]

Diabetes mellitus is leading health problem in India. India is experiencing the burden of communicable disease as well as non-communicable disease. It is believed due to unhealthy life style and faulty food habits. [(9)] With most fast-growing cases of diabetes in India, India is been recognized as Diabetes capital of world [(10)]

Body's organ responsible for the in-appropriate functioning is primarily the pancreas, when pancreas does not secrete enough amount of insulin which results in the non-sufficient breakdown of blood sugar, blood sugar level starts to rise. [(11)] Insulin is a hormone which is responsible for lowering down the blood sugar in the blood, composed of beta cells of pancreas and are released into the blood when glucose level goes up post meal [(12)]

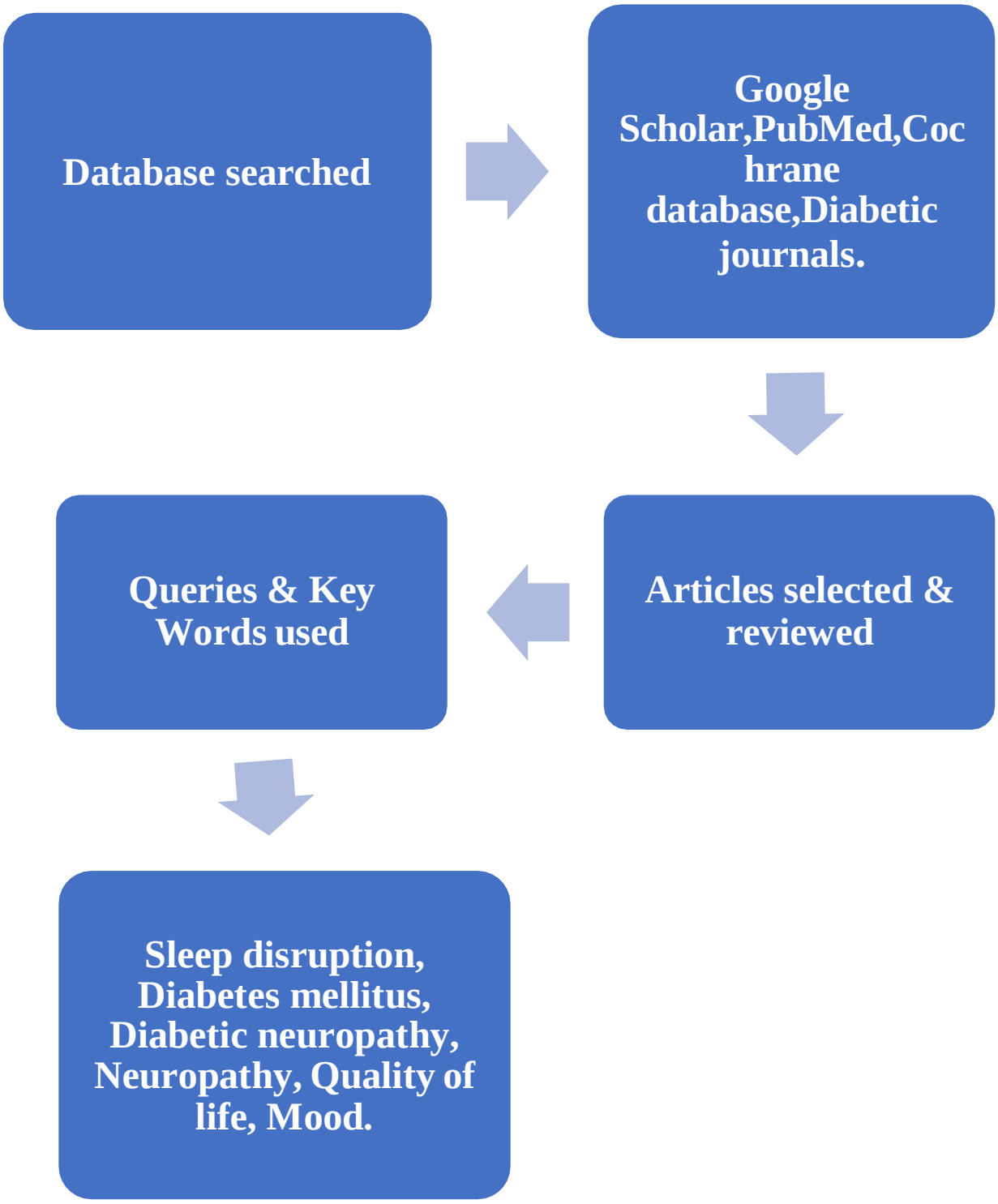
Diabetic patients developing heart failure experiences disturbed sleep by several mechanisms including: sleep disordered breathing Cheyne Stokes breathing and

Obstructive sleep apnea, effects of medicines, symptom of heart failure and health problems including pain and depression.[13] Despite with relevant information and data available we are unaware of the direct linkage between diabetes mellitus and sleep disruptions. Accordingly, we conducted a review to reach out the best and current researches and literature available for future research needs.

Aim: This review aims at studying relation between sleep disruption and diabetes mellitus.

Objective: Objective of this review is to assess the possibility of sleep disruptions resulting due to diabetes mellitus.

Methodology



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Authors/year	**Study design Sample size**	**Duration**	**Outcome measures**	**Result**	**Conclusion**
Herzog N et al . (2013) [14]	Randomized control trial N (16)	30 days (Morning levels)	Selective sleep stage disturbance acoustic tone (532hz) & oral glucose tolerance test	SWS reduction was significantly involved in impairment of glucose control associated with disturbed sleep. (p =0.01)	Glucose metabolism in subjects predisposed to reduced SWS should be thoroughly monitorized.
S Surani et al. (2015) [15]	Literature review	2014 to 2015	Electronic search data base	DM causing sleep disturbances as result of nocturia, diabetic neuropathy & neuropathic pain.	Diabetes mellitus associated patients must be helped for sleep monitoring & addition of sleep education is required as an essential part.

Authors/year	Study design/ sample size	Duration	Outcome measures	Result	Conclusion
Rebecca A Hazen et al. (2015)[16]	Experimental (n= 72) adolescents	Monitoring after sleep disturbance or over sleep episode for further 5 days through out.	Self- report, Hba1c blood monitoring & monitoring data.	Significantly Increased level of glycemia (p=0.001) in blood levels. (p < 0.005) value with corelation b/w glycaemic control and adherence.	Sleep disturbances negatively impact adherence and glycaemic control.
Vijay kumar chattu et al. (2019) [17]	Literature review (n= 97)	Literature available from 2000 till 2019	Electronic search data base of PubMed, Medline, PsycINFO, Web of Science, Scopus, and Global Health databases.	Chronic sleep disturbances would elevate the risk of developing insulin resistance, while diabetes would worsen the quality of sleep	qualitative and quantitative sleep disorders can increase the risk of insulin resistance and diabetes

Shaloo G et al. (2016) [18]	2012 US National Health and Wellness Survey. (n= 7239)	Annual health survey report	Government gathered health data, questionnaires, and self-filled surveys. Hospitals and via internet	59.5% were male, 24.4% were diagnosed with Sleeping Disorder, sleep apnea, 17.4%; daytime sleepiness, 26.8%; Logistic regression models showed the strongest predictors of diagnosed SD were obesity class (OC) III (OR = 2.20), comorbidities (OR = 1.35), all $p < 0.05$	Almost 25% of patients with T2DM were diagnosed with Sleeping Disorder and over 75% reported experiencing at least one sleep symptom regularly
Mohammed A et al. (2016)[19]	case-control study. (Control group = 188) (Exp gp =172)	Reporting was asked on seventh day fasting blood sugar levels. (1 week)	Berlin and Epworth Sleepiness Scale. Personal diary for sleep hours records.	There was significant diff between T2DM and healthy controls ($p = 0.033$). significant association between nocturnal sleep duration of fewer than six hours and T2DM ($\chi2 = 14.0$; $p = 0.0001$)	A nocturnal sleep duration < 6 hours is associated with T2DM.

Anothisentawee T et al. (2016) [20]	a systematic review and meta-analysis	5 years	Medline and Scopus database	Pooled RRs of sleeping ≤5 h, 6 h, and ≥9 h/d were respectively 1.48, 1.18 and 1.36. Poor sleepquality, OSA and shift work were associated with diabetes with a pooled RR of 1.40, 2.02 and 1.40	Sleep disturbances should be considered in clinical guidelines for type 2 diabetes screening.
MM Perfect et al. (2020) [21]	Review Study	included articles through June 2018	parameters searched- T1D, T1DM, type 1 diabetes, or diabetes: sleep, sleep quality, sleep-disordered breathing, SDB, sleepiness, insomnia. additional search engines of EMBASE and SCOPUS	Diabetes-related outcomes included glucose levels via insulin sensitivity; co-morbidities such as nephropathy, neuropathy, and diabetes management variables	prevalence of sleep problems appears to be higher among individuals with T1DM

Eun He Co. et al (2014) [22]	Experimental study. (n= 614)	January 2011 to April 2011	Sleep Apnea subscale (SDQ-SA), Pittsburgh Sleep Quality Index (PSQI), Korean version of the Epworth Sleepiness Scale (K-ESS), and Korean version of the Beck Depression Inventory (K-BDI)	Multivariate logistic regression showed no significant association between HbA1c and sleep disturbances. Sleep disturbances were very common in patients with type 2 diabetes mellitus, no association between poor or short sleep and gluco regulation	Awareness and identifying sleep complaints in such patients are necessary to improve their quality of daily life.
Bahnasy S.W et al. (2018) [23]	Experimental Study (n= 30) (Exp G. = 20) (Control Gr.=10)	1st of April to 1st of December 2015	history taking, neurological examination, and routine laboratory investigations. Clinical diagnosis of DPN by neuropathy symptom score (NSS) and neuropathy disability score (NDS)	Diabetes duration and glycated hb % were significantly higher in DPN group than DNF group with p value = 0.0003 and < 0.0001 Diabetes treatment regimens in DPN patients were cannot be correlated with sleep changes.	Type 2 diabetic patients complicated by peripheral neuropathy are at increased risk of developing sleep disturbances. early diagnosis & management of sleep disturbances in DPN patients is very important for holistic patient's management.

Bingquan Zhu et al. (2017) [24]	Concept analysis	Without time restriction	Rodgers's method of evolutionary concept analysis. Inductive thematic analysis for attributes, antecedents and consequences.	sleep disturbance is a symptom and is characterised by impaired sleep quality and/or abnormal sleep duration. Two antecedents are diabetes-related physiological change and psychological well-being. Sleep disturbance can result in impaired daytime functioning, glucose regulation and quality of life.	Sleep disturbance in people with diabetes is a complex symptom that includes impaired sleep quality and/or abnormal sleep duration

Bouhassira D et al,2013 [25]	Observational study, (N=766)	Duration =3months	questionnaires for detection of chronic pain (i.e. daily pain for more than three months) in the lower limbs, Medical Outcomes Short Form 12 scale, MOS sleep scale, Hospital Anxiety and Depression scale, 7-item DN4-interview questionnaire, monofilament test and the Michigan Neuropathy Screening Instrument (MNSI)	chronic pain with neuropathic characteristics was 20.3% [95% CI 17.4–23.1]. The MNSI, in 80.1% of these patients (89.5% of those with bilateral pain). Patients with chronic pain had a poorer quality of life and more sleep disturbances, anxiety and depression than patients without pain and the presence of neuropathic characteristics was predictive of such impairments.	Neuropathy has a significant impact on quality of life and is not adequately managed

Discussion

Sleep upholds two-third of our life, making it a beneficial active process rather than a passive process. Sleep is termed as a global stage where as the mechanism of sleep generation and maintenance is more of a balance between two systems located within the brain, one is the homeostatic processes, which are functionally the body's "need for sleep" center, and another is circadian rhythm which is an internal clock for the sleep-wake cycle [5]. Difficulty maintaining sleep was associated with an increased risk of type 2 diabetes in men and women from the general population. Both insulin resistance and chronic low-grade systemic inflammation may be involved. [26] Diabetes causes long term chronic effects which too results in sleep hindrances and disruptions due to pain such as diabetic peripheral neuropathy which accompanies pain as a factor along it and causes sleep disruptions. [27]

With researches followed by this review studies suggest some intersecting points of sleep and diabetes relation. Experimental Study conducted by Bahnasy, S.W et al in 2018 stated that diabetes duration & glycated hb percentages were significantly higher in diabetic peripheral neuropathy in comparison with peripheral nephropathy [28]. Another study by Bingquan Zhu et al. in year 2017 stated that sleep disturbance is a symptom and is characterised by impaired sleep quality and/or abnormal sleep duration. [29] Diabetes-related physiological change and psychological well-being are prevalent. Sleep disturbance can result in impaired daytime functioning, glucose regulation and quality of life which concludes Sleep disturbance in people with diabetes is a complex symptom that includes impaired sleep quality and/or abnormal sleep duration. [30] Further when diabetic neuropathy patients trained with equipped wobble board exercises and swiss ball showed improved balance and increased stability.[31] This review supports enough evidence in support of relation between sleep disruptions and diabetes mellitus.

Conclusion

This review concludes that sleep disruptions and sleep disturbances result in metabolic disturbances and blood glucose levels which in term results in close knit development of diabetes mellitus as a metabolic disorder resultant and sleep disruptions – diabetes are co-related with each other. With reduced sleeping hours and quality, person is more prone towards developing diabetes and one's with diabetes suffer sleep disturbances.

Conflict of interest: None.

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