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# THE RELATIONSHIP BETWEEN SLEEP APNEA AND GLYCEMIC CONTROL IN PEOPLE WITH TYPE 1 AND 2 DIABETES MELLITUS: AN INTEGRATIVE REVIEW

***Luana Bibiano Anastacio***
http://lattes.cnpq.br/1655734895035793

***Izadora Ribeiro Castro***
http://lattes.cnpq.br/7639954966147703

***Gilvano Sousa Nunes***
http://lattes.cnpq.br/7338888555700915

***Maria Clara Leal Coutinho***
https://lattes.cnpq.br/9219855948619017

***Ana Thamires Branco de Oliveira***
http://lattes.cnpq.br/0382007590231396

***Isabel Pereira de Oliveira***
https://lattes.cnpq.br/5246069276441301

***Kayron Ayslan de Abreu Lacerda***
http://lattes.cnpq.br/3393138288283735

***Saulo Freitas do Ó***
https://lattes.cnpq.br/4654289287284584

***Nirvana Ramos de Araújo***
http://lattes.cnpq.br/1864865483192591

***Ronan Sales Farias***
https://lattes.cnpq.br/8109737751226590

***Moisés de Souza Mello***
https://lattes.cnpq.br/1131542847794835

*Willy Erick Beckman*
https://orcid.org/0009-0003-2655-7288

**Abstract: Objective**: To analyze population information on the relationship between sleep apnea and glycemic control in people with type 1 and 2 diabetes mellitus, through an integrative literature review. **Method:** This is an integrative review of the literature, research was carried out using databases available in the Virtual Health Library (VHL), Medical Literature Analysis and Retrieval System Online (MEDLINE), National Library of Medicine/PubMed, SciELO. The descriptors used were: The descriptors used were: Diabetes Mellitus, Obstructive Sleep Apnea, Glycemic Control, Sleep Apnea, Obstructive, Glycemic Control. Combined with the Boolean operators OR / AND. **Results:** Of the selected articles, the majority were cross-sectional. Articles with research on populations in America and Europe. In the studies, scales and instruments were used to check the symptoms of sleep disorders in patients, among them the instruments most mentioned in the studies were the Pittsburgh Scale, the Epworth Scale and the Berlin Questionnaire. **Conclusion:** Greater training of the multidisciplinary team is necessary so that care can be carried out in order to prevent or alleviate the magnitude of this problem, thus requiring professional action that is based on the principles of humanization and comprehensiveness in care.
**Keywords:** Diabetes Mellitus, Obstructive Sleep Apnea, Glycemic Control, Sleep Apnea, Obstructive, Glycemic Control.

## INTRODUCTION

Diabetes is a disease characterized by insufficient production or poor absorption of insulin, a hormone responsible for regulating blood glucose. Insulin deficiency can result in high glucose levels, which can cause complications in the heart, arteries, eyes, kidneys and nerves. Without proper care, diabetes can be fatal. (BRAZIL, 2024). According to data, Brazil is the 5th country

with the highest incidence of diabetes in the world, with around 16.8 million adults between 20 and 79 years old affected. The estimate for 2030 is that the number of cases will reach 21.5 million. (INTERNATIONAL DIABETES FEDERATION, 2021)

Sleep apnea/hypopnea syndrome has been shown to be the most frequent and important sleep-related breathing disorder. This condition results from repeated upper airway (UA) occlusions or semi-occlusions during sleep, causing respiratory pauses of varying duration. It is a common disorder that affects all ages and both sexes, regardless of body weight, although it is more prevalent in obese or overweight individuals (SILVA, 2006).

During episodes of apnea, sleep fragmentation, intermittent hypoxia and increased intrathoracic pressure occur, resulting in oxidative stress, mitochondrial dysfunction, insulin resistance, hypercapnia, reduced oxygen levels and hemoglobin desaturation (BOREL,2019). Intermittent hypoxia (IH) can affect glucose metabolism by inducing sympathetic activation, increasing systemic inflammation, elevating counterregulatory hormones and fatty acids, and causing direct damage to pancreatic beta cells. (Drager LF et al, 2010).

Cortisol inhibits insulin secretion, and intermittent hypoxia with sleep fragmentation activates the Hypothalamic-Pituitary-Adrenal (HHA) axis, resulting in an increase in glucocorticoid levels, which directly affect insulin resistance and its secretion. These effects include increased lipolysis, inhibition of glucose transporter type 4 (GLUT 4) translocation in muscle cells, suppression of glycogen synthesis, and increased gluconeogenesis. (FIGUEIREDO, F O. et al., 2016).

In one study, it was investigated whether hypoxia is a cause of glucose intolerance in healthy individuals. In a double-blind crossover design, hypoxic versus normoxic conditions were induced in 14 healthy men for 30 minutes, reducing oxygen saturation to 75% (compared to 96% in control subjects). The dextrose infusion rate required to maintain stable blood glucose levels was monitored. The results showed a significant decrease in the dextrose infusion rate over a period of 150 minutes after the onset of hypoxia, indicating that hypoxia causes acute glucose intolerance. (OLTMANNS K. M. et al., 2004.)

In a prospective study, more than 4000 Japanese people aged 40 to 69 participated in sleep investigations between 2001 and 2005. Intermittent nocturnal hypoxia was assessed by pulse oximetry and was defined by the number of oxygen desaturation measurements ≤3% per hour, with five to <15 events per hour classifying as mild and 15 or more events per hour classifying as moderate to severe. The results identified 210 people who developed diabetes. It was concluded that intermittent nocturnal hypoxia is associated with an increased risk of developing type 2 diabetes among middle-aged Japanese people. (MURAKI I. et al., 2010.).

To analyze population information on the relationship between sleep apnea and glycemic control in people with type 1 and 2 diabetes mellitus, through an integrative literature review.

## METHOD

This is an integrative review of the literature on sleep apnea as it relates to glycemic control in people with Type 1 and 2 Diabetes Mellitus.

For its elaboration, the steps proposed by Mendes, Silveira and Galvão were followed: formulation of the theme, establishment of criteria for inclusion and exclusion of studies, definition of information to be extracted from selected studies, evaluation of studies, interpretation of results and synthesis of the knowledge.

In formulating the present study, the following guiding question was created: What is the relationship between sleep apnea and glycemic control in patients with Diabetes Mellitus? To prepare the guiding question, the PICo strategy was used, an acronym for P: Problem or target population; I: Intervention or phenomenon of interest; Co: Context.

| ACRONYM | DESCRIPTORS |
|---|---|
| **P** | Type I and II diabetes patients |
| **I** | Therapy |
| **Co** | Sleep Apnea / Glycemic Control |

Searches were carried out using databases available in the Virtual Health Library (VHL), Medical Literature Analysis and Retrieval System Online (MEDLINE), National Library of Medicine/PubMed, SciELO.

The descriptors used were: Diabetes Mellitus, Obstructive Sleep Apnea, Glycemic Control, Sleep Apnea, Obstructive, Glycemic Control. Combined with the Boolean operators OR / AND. To establish criteria for inclusion and exclusion of studies, articles that did not meet the topic discussed were discarded, as well as course completion works, theses and dissertations. To select the articles, articles were read through the databases and 4 articles were selected for study. At the end of the study, the knowledge synthesis stage was carried out, in which the main results of the analysis of the articles included in the study were studied.

## RESULTS

Of the selected articles, the majority were cross-sectional. Articles with research on populations in America and Europe. In the studies, scales and instruments were used to check the symptoms of sleep disorders in patients, among them the instruments most mentioned in the studies were the Pittsburgh Scale, the Epworth Scale and the Berlin Questionnaire.

Records identified in Databases/ Libraries/ Search Engines (n=50 publications))

Registration after removing duplicates and reading titles and abstracts (n=21 publications)

Full articles assessed for eligibility (n=14 publications)

Studies Included (n=4)

**Figure 1:** Process of identification, selection, eligibility and inclusion of articles

Source: Written by the author

## DISCUSSION

In the results of the selected studies, the significant influence of sleep apnea on glycemic and metabolic changes in individuals with type 1 and type 2 Diabetes Mellitus is clearly evident. Research shows that sleep apnea has a considerable impact on glucose levels in the blood and metabolism of these people, highlighting the importance of paying attention to this condition in the care and management of diabetes.

In study E1, the research was conducted using the SF-36 quality of life questionnaire, the Pittsburgh Scale, the Epworth Scale and the Berlin Questionnaire. From the evaluation of the sample with these instruments, results were observed indicating poor sleep quality and excessive sleepiness, confirming the relationship between type II diabetes mellitus and sleep disorders. In the data obtained with the Berlin Questionnaire, it was revealed that 52.7% of patients are at high risk of developing Obstructive Sleep Apnea Syndrome (OSAS), while 47.3% are at low risk.

The application of the PSQI (Pittsburgh Sleep Quality Index) showed that the majority of the sample had poor sleep quality (45.5%) or had sleep disorders (38.2%).

In research carried out in 2015, the objective was to determine whether subchronic Sleep Restriction (SR) altered (1) hepatic insulin sensitivity, (2) peripheral insulin sensitivity and (3) substrate use. This was a randomized

| IDENTIFICATION | ARTICLE | AUTHOR | STUDY LOCATION, YEAR | OBJECTIVE |
|---|---|---|---|---|
| **E1** | Analysis of the relationship between type II diabetes mellitus and sleep disorders | Justo, Giane Schipinski da Cruz Daniel, Thelry Garcia Pizzolo | UNESC Integrated Clinics, Criciúma, Santa Catarina, Brazil 2018 | The research aims to evaluate the relationship between the diabetes mellitus and sleep disorders. |
| **E2** | SLEEP QUALITY IN TYPE 2 DIABETIC PEOPLE | Maria Carolina Belo da Cunha, Maria Lúcia Zanetti, Vanderlei José Hass | Center for Research and University Extension of Interior Paulista, Brazil 2005 | To analyze the quality of sleep in a population of diabetic patients at a University Research and Extension Center in a city in the interior of São Paulo. |
| **E3** | The association between OSA and glycemic control in diabetes | Mojtaba Mehrdad, Mehrnaz Azarian, Amir Sharafkhaneh, Ali Alavi, Ehsan Kazemnezhad Leili, Afagh Hassanzadeh Rad, Setila Dalili | Guilan University of Medical Sciences, Iran 2020 | evaluate the association between the risk of OSA and glycemic control in patients, exploring the association between glycemic control and OSA |
| **E4** | Prevalence of sleep apnea in diabetic patients | Anne-Katrin Schober, Markus Friedrich Neurath, Igor Alexander Harsch | Sydney, Austrália, 2011 | Investigate the prevalence of sleep-disordered breathing in diabetic patients and the variables that influence it |

**Table 1:** Synthesis of information extracted from selected articles

| IDENTIFICATION | PREVALENCE IN THE SAMPLE |
|---|---|
| **E1** | The data obtained demonstrate that 52.7% of patients have a high risk of developing OSAS and 47.3% have a low risk of developing it. |
| **E2** | It was verified that 26 (52%) of the type 2 diabetics investigated were allocated to the good sleep quality category. For 24 (48%) the data obtained points to poor sleep quality |
| **E3** | A total of 266 DM patients were included in this study, based on the Berlin Questionnaire, 38.6% of all participants were at high risk of developing OSA. Based on the STOP-BANG Questionnaire (SBQ), 45.1% were at moderate and high risk. |
| **E4** | Our data show a high prevalence of sleep-disordered breathing in 556 patients with DM; 37.4% of our patients had an AHI ≥ 15, suggesting the presence of sleep apnea syndrome. |

**Table 2:** Synthesis of information extracted from selected articles

Source: The author

crossover study involving 14 individuals, in which periods of restricted sleep (4 hours in bed) were compared with normal sleep (8 hours in bed). Compared to normal sleep, whole-body insulin sensitivity decreased by 25% with sleep restriction, while peripheral insulin sensitivity decreased by 29%. Stress hormones showed modest increases, with cortisol rising 21% and metanephrine 8%. Therefore, sleep restriction causes specific metabolic disorders characterized by peripheral insulin resistance, and elevated levels of cortisol and metanephrine may contribute to this resistance. (RAO M N. et al., 2015).

Sleep quality was investigated in a group of 50 individuals with type 2 diabetes, in study E2, using the Pittsburgh Sleep Quality Index (PSQI). The analysis revealed that the majority of participants (52%) had PSQI scores indicative of poor sleep quality. Furthermore, it was observed that those diagnosed with diabetes for more than 10 years and who also suffer from hypertension had an even more compromised quality of sleep. These findings highlight the relationship between the duration of diabetes diagnosis and deterioration in sleep quality among the patients studied.

Data also analyzed and confirmed in studies E3 and E4, both focused on the relationship between Diabetes Mellitus and sleep disorders. In study E3, among the 266 patients with Diabetes Mellitus evaluated using the Berlin Questionnaire, 38.6% were at high risk of developing obstructive sleep apnea syndrome (OSA). Furthermore, according to the results obtained with the STOP-BANG Questionnaire (SBQ), 45.1% of patients had a moderate to high risk of having OSA. In study E4, analysis of data from 556 patients with Diabetes Mellitus revealed a high prevalence of sleep-disordered breathing. The results showed that 37.4% of patients had an Apnea-Hypopnea Index (AHI) equal to or greater than 15, suggesting the presence of sleep apnea syndrome. These studies highlight the importance of screening and monitoring sleep disorders in patients with Diabetes Mellitus, given the high prevalence and significant impact of these disorders on the general health of these individuals.

Therefore, studies have shown that short sleep duration is associated with an increased risk of type 2 diabetes mellitus, showing that subchronic sleep restriction (2–8 nights) decreases glucose tolerance and impairs insulin sensitivity. Insulin resistance affects tissues such as fat, skeletal muscle and the liver.

In peripheral tissues, it is characterized by a reduction in insulin-mediated glucose uptake, while in the liver, it results in an increase in endogenous glucose production and a decrease in the ability of insulin to suppress this production.

Furthermore, insulin resistance is associated with less suppression of lipolysis in adipose tissue, increasing levels of nonesterified fatty acids. Mechanisms proposed to explain the effects of sleep restriction on glucose metabolism include sympathetic activation, inflammation, and changes in the 24-hour profiles of stress hormones such as cortisol and catecholamines.

Hypoxia caused by Obstructive Sleep Apnea can reduce insulin secretion and action due to decreased ATP production in B cells and reduced tyrosine kinase activity of insulin receptors. In addition to the effects of intermittent hypoxia, there is evidence that sleep abnormalities alone can alter glucose metabolism. For example, sleep restriction (4 hours per night for 6 nights) in normal subjects worsened glucose tolerance, increased cortisol levels, activated the sympathetic nervous system, and provoked an inflammatory response.

## FINAL CONSIDERATIONS

In this integrative review, it was observed that there is a relationship little explored in scientific articles between sleep disorders and patients with diabetes mellitus. Within this substantial relationship, factors such as obstructive sleep apnea stand out, which can contribute to the development of diabetes mellitus, as well as to uncontrolled glycemic levels. This interaction between sleep disorders and diabetes mellitus reveals the complexity and importance of adequately addressing sleep in the management and treatment of diabetes, aiming to improve clinical outcomes and quality of life for patients. Therefore, professional performance that is based on the principles of humanization and comprehensive care is necessary.

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