The Relationship between Occupation, Sleep Disorders, and Health Impacts: An Analysis Based On Maximum Spanning Tree

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Abstract. The health challenges of sleep quality disorders are notable, especially in certain occupational groups and their interactions with the professional job environment. The adversities in such a professional atmosphere can compromise the excellence of activities, quality of life, and physical and mental health. The present study proposes an analysis model to investigate the relationship between health and job occupation in developing sleep disorders. The objective is to identify the professional groups most susceptible to these problems, thus highlighting the predominant characteristics in the manifestation of such disorders. In this context, based on Kruskal's algorithm, the maximum spanning tree strategy was adopted to investigate the sleep quality datasets available on the Kaggle platform. The results show a broad relationship between hereditary conditions, such as high blood pressure, with the professional occupation and several sleep quality disorders, such as insomnia and apnea. These findings have the potential to significantly impact your work or research, as they amplify the discussions and evidence that certain occupational groups, due to high levels of occupational stress, tend to suffer considerable influence on indicators such as increased blood pressure and sleep quality disorders, having relevant impacts on the lives of these individuals.

Keywords: Sleep disorders, Professional occupation, Occupational health, Graph theory.

1 Introduction

Mental health is intrinsically related to our ability to understand a wide range of human emotional reactions, ranging from joy and fun to grief over loss, disappointment, and facing challenges [1]. Dealing with these adversities and their multiple nuances, especially in widespread stress, remains a significant challenge. Within this scenario of uncertainty, the influence of work-related concerns and their importance as one of the pillars in the integration of the individual into society plays a crucial role in the socioeconomic structure, affecting fundamental aspects such as personal fulfillment, the expression of creativity, and the establishment of healthy relationships [2].

Work-related stress is becoming a topic of increasing relevance and discussion, delineating the work environment as a determining factor for the emergence of adverse physical and emotional conditions, including musculoskeletal disorders, hypertension, anxiety, depression, and burnout. Such conditions often amplify the individual's temporary or permanent inability to contribute to society. As highlighted by Souto (2018) [3], these factors can potentially aggravate the negative impacts of the relationship between work activities and sleep quality.

Studies conducted with Dutch workers have shown a strong correlation between intense work demands, increased stress levels, and progressive deterioration in sleep quality. It was observed that this association manifests itself through the frequent complaints of workers about the adverse effects of the inadequate work environment, contributing to the negative and increasing impacts on physical and mental health [4]. These findings underscore the importance of the relationship between the work environment and sleep patterns, emphasizing the need for a broad investigation toward a comprehensive understanding of these dynamics [5].

After observing the impacts of work-related stress on quality of life, it becomes evident that there is a need to expand studies that investigate the interactions between sleep disorders, variable blood pressure, and occupational stress. These aspects are key to understanding the factors influencing individuals' mental health and well-being. Given this scenario, this article aims to explore and contextualize such relationships, offering a detailed analysis of the potential impacts involved with physical, mental, and occupational factors on sleep quality. To achieve this goal, we used graph theory and Kruskal's algorithm to develop an analysis model that shows the most predominant

relationships through the concept of the maximum spanning tree. The aim is to broaden the discussions around patterns that can elucidate the influence of the multiple factors mentioned in sleep disorders and blood pressure variability. Such contributes to a clear understanding of these interactions and their effects on an individual's physical and mental health.

To perform the evaluation as mentioned, this work is structured as follows: Section 2 details and discusses the theoretical framework, addressing the problem and the method of exploration. It also provides a comprehensive review of related works, highlighting their contributions to the literature and the knowledge discussed in the article. Section 3 describes the methodology used to obtain the results, outlining the analysis steps and providing information about the algorithm employed. Section 4 discusses the results obtained, highlighting the points of greatest evidence in the relationships identified. Finally, in section 5, we present the final considerations and possible directions for future developments of the adopted approach.

2 Background

The relationship between occupational stress and health problems is a topic of great relevance and concern in the scientific literature. Occupational stress has been identified as a triggering factor for a variety of diseases, including systemic arterial hypertension (SAH), dyspnea, and insomnia. The work environment often serves as a propitious scenario for the intensification of this stress, directly influencing workers' health. This influence can result in decreased productivity, as well as the development of anxiety and depression. The negative impact is particularly significant when considering the specific characteristics of the activities performed and the factors that contribute to the adversity of the work environment [6].

Sleep disorders, which include conditions such as insomnia, sleep apnea, narcolepsy, and restless legs syndrome, often stem from a complex interplay between genetic, environmental, and behavioral factors. As evidenced by Junior et al. in [7], unsafe work environments may predispose certain individuals to these disorders while amplifying susceptibility to autoimmune diseases, raising serious concerns about health and its consequences in this occupational context.

Regarding health problems related to the work environment, several studies have consistently highlighted a strong association between high blood pressure and impaired sleep quality [8–10]. As elucidated in [11], this increase in blood pressure occurs due to different pathophysiological mechanisms. Recent scientific advances have identified a connection between short sleep duration, poor sleep efficiency, insomnia, and subsequent greater sympathetic activation. This sympathetic activation is a broad-spectrum influencing factor in investigations of increased blood pressure.

The contributing factors to sleep disturbances among different occupational groups are multifaceted, with work schedules accounting for only a fraction of this problem. Groups exposed to irregular schedules or night shifts often manifest a higher incidence of sleep disturbances [12]. However, it is crucial to point out that factors such as stress and health issues play an equally significant role in the variations observed in sleep disorders between different occupations.

As previously mentioned, various perspectives exist regarding the relationship between occupation, sleep disorders, and health impacts. Therefore, this paper investigates the connection between health and sleep quality. Our study examines how blood pressure affects sleep quality across different professional groups to identify potential correlations between these factors and enhance understanding of how occupational health impacts the quality of life. Mathematical modeling techniques, particularly graph theory, will be employed in this study. Specifically, Kruskal's algorithm, a method for finding the minimum-spanning tree of a graph, will be used to generate a maximum-spanning tree. This will highlight the most influential characteristics of the relationship under investigation.

2.1 Related Works

In the context of the relationships discussed above, several studies have played a crucial role in providing an informative basis that supports the strategy adopted in this literature review [13–16]. These studies provide essential data, theories, and computational models on the interaction between blood pressure, occupational stress, occupation, and sleep patterns, contributing to advanced understanding.

The study by Thele et al. (2023), entitled *Evaluation of sleep and risk of apnea in people with systemic arterial hypertension who use basic health units (UBS)*, investigated the relationship between hypertension and sleep disorders in a group of 42 patients treated at UBSs. The results highlighted a high prevalence of sleep disorders, with 57% of participants experiencing poor sleep quality or disturbances and 67% at high risk of apnea [13]. In addition, it was observed that individuals with a high degree of sedentary lifestyle exhibited worse sleep

patterns. Based on these findings, the study emphasizes the importance of sleep assessment in the follow-up of patients with SAH and targeted interventions to improve their quality of life.

Corroborating this evidence, the study by Meier et al. (2016) [15] investigated sleep quality in basic education teachers. This study analyzed the relationship between sleep quality and several variables, such as sociodemographic characteristics, lifestyle, health, and perceptions about work. The results revealed significant associations between lower sleep quality and experiences of physical or psychological violence in the workplace, as well as a negative perception of leisure and work-life balance.

In computational approaches, the study presented in [16] offers a valuable analysis of Kruskal's algorithm and its application in graphs. This research, centered on fundamental graph-related algorithms, is essential for understanding the concepts underlying discrete structures and their relevance in topology, logic, and number theory. It provides a solid foundation for analyzing the factors and problems addressed in this review.

Another relevant study is that of Maskar et al. (2020) [14], who used the Maximum Coverage Tree Graph (MST) algorithm to analyze data from national secondary school exams in Lampung Province, Indonesia. The application of Kruskal's algorithm allowed the identification of students' learning and thinking patterns, evidencing the applicability and benefits of this approach in the analysis of educational data.

Given the factors with the greatest impact on work activity, work environment, and sleep quality, this article addresses the relationship between occupation, sleep disorders, and quality of life, proposing an innovative computational approach. We observed that studies in this area have yet to explore such relationships using graph theory, specifically Kruskal's algorithm. In this regard, by advancing this field of study, we hope to contribute to the existing body of knowledge and provide valuable insights that can inform occupational health policies and intervention practices. Understanding the interactions between occupation, sleep disorders, and health is critical to developing more effective strategies to promote workers' well-being and improve their quality of life. To this end, we present the proposed evaluation process below.

3 Sleep Rate Analysis Based On Kruskal and Maximum Spanning Tree

As previously discussed, a variety of studies in the literature have investigated sleep disorders from different perspectives and contexts to identify their correlations with high-stress-inducing environments. To address this question, we employed the *Sleep Health and Lifestyle Dataset* to analyze this relationship across various professions and its impact on individuals' quality of life. We chose this dataset because of its wealth of information, including occupation, health data, stress levels, and various sleep-related disorders.

Given the interpretative complexity of the available data, we propose a ten-step assessment to address data complexity. We refine and debug the data to extract relevant information and identify *outliers*. During this process, we excluded the professional category *"Manager"* due to its low representativeness, which could affect the validity of the conclusions.

After refining the data, we applied the resulting set to modeling the relationships, establishing metrics to assign weightings to the edges based on how often individuals share professional interests, health characteristics, and work pace. We used Kruskal's algorithm to compose the resulting networks efficiently, considering the relationships' complexity and the analyzed data's structure.

Once the resulting network is obtained, we transform it into an acyclic structure using the maximum spanning tree concept to highlight the most significant features. We prioritized the most relevant connections, resulting in a tree that maximizes the sum of edge weightings, allowing a detailed analysis of the relationships between observed variables, including occupation, sleep disturbances, and blood pressure. Kruskal's algorithm was an effective choice due to its ability to avoid forming cycles in the composition of relations, considering the importance of the weighting order of the edges.

After what we consider first-order interactions, we investigated the relationships between the observed factors and blood pressure variability. We adopt specific criteria based on medical guidelines and epidemiological studies to identify potential risks, such as heart disease, insomnia, and apnea. We use systolic and diastolic blood pressure values to identify health conditions, following standards established by recognized medical organizations. For other sleep disorders and health problems, we use the scientific literature to define diagnostic criteria, ensuring a rigorous approach to identifying relevant risk factors.

Finally, we carried out a pruning process to improve the identification of the relationship between blood pressure and sleep disorders. We removed relationships in which blood pressure remained within normal levels and indices considered below for the conditions evidenced in this study. The pruning resulted in the trees being in maximum range for subsequent analysis. The flowchart presented in Figure 1 illustrates the steps that make up the methodological process of this work, in addition to the distribution of individuals by profession observed.

To validate the effectiveness of the proposed approach, we will examine in detail, in the next section, the results derived from the execution of the flow presented in Figure 1 on the data from the Kaggle set. In this

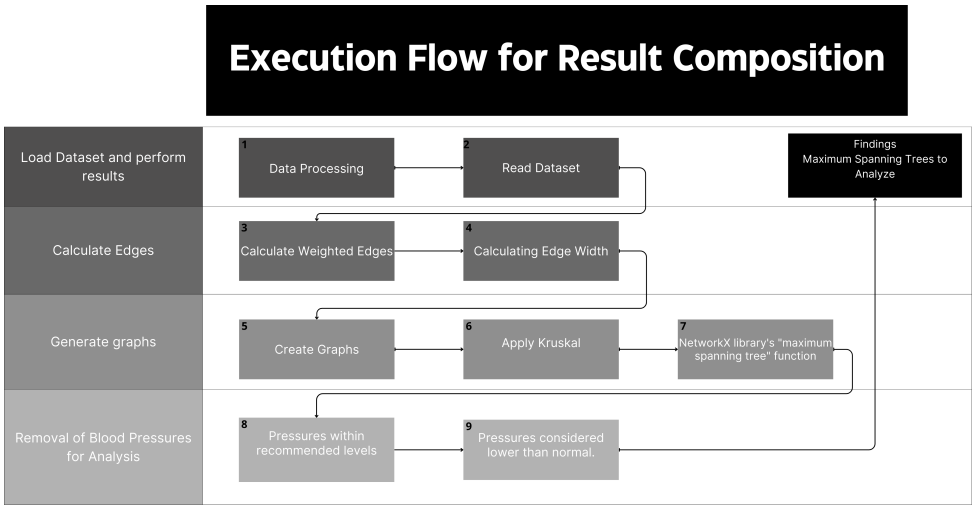

Figure 1. Workflow illustrating the stages of the analysis process conducted in this study. Starting with steps 1-2, the process begins with preprocessing and reading the raw database. In steps 3-4, the processing and composition of the connection network are carried out by calculating the edges. Then, in steps 5-7, the graphs are modeled using Kruskal's algorithm in combination with the maximum spanning tree. Finally, in steps 8-10, edge pruning is performed to ensure blood pressure remains within the recommended range, culminating in interpreting the obtained results.

context, we will thoroughly analyze the results, emphasizing the identified relationships between occupation, sleep disorders, and blood pressure and discussing the significant implications of these findings for workers' occupational health and quality of life.

4 Result Discussion

After defining the methodological process, the results obtained in this study provide valuable insights into the relationship between occupation, sleep disorders, blood pressure, and quality of life. This section will discuss the main findings derived from applying the methodological flow outlined in Figure 1, highlighting the most significant findings and their implications for understanding the factors influencing sleep quality in different occupational groups.

The graph in Figure 2 details the initial connections between occupations, sleep disturbances, and blood pressure levels. This initial representation, composed of 66 edges and 38 nodes, is sparsely connected and did not generate substantial observations at first glance but served as a fundamental starting point to guide the implementation of subsequent algorithms.

To improve the visualization and understanding of the connections between different professions and the prevalence of sleep disorders, we used the *maximum_spanning_tree* function in Python, as described in step six of the methodological process (Figure 1).

Applying the *maximum_spanning_tree* function reduced the number of edges by half, highlighting the most significant correlations between vertices, as illustrated in figure 3. This disposition revealed a trend where higher blood pressures are associated with certain professions, such as teachers, salespeople, nurses, and sales representatives, who are very close to nodes with sleep disorders. In contrast, normal or lower pressures indicate the absence of these disorders and are related to professions such as engineers, accountants, and lawyers.

After the first filtering of the CSV file "SemPressureaoNormal," we created a maximum spanning tree with 28 edges (Figure 4 - (A)) to analyze anomalous blood pressures and their connections to sleep disorders in various occupations. In the second step, we remove the low pressures, generating the "SemPressaoBaixa.csv" file and a new tree with 22 edges (Figure 4 - (B)). Information reported in Figure 4 - (C) analyzes the stress trend in various professions and its correlations with sleep disorders, aiming to understand the factors that influence these disorders in professional contexts.

Excluding individuals with ideal blood pressure, certain professions, such as teachers, sales representatives, salespeople, and nurses, exhibited a persistent trend of sleep disturbances. High blood pressure is strongly associated with the presence of sleep disorders, with occupations predominantly characterized by elevated blood pressure showing a significant correlation with these disorders.

Figure 3 shows that the physicians were initially close to the group without sleep disturbances. After remov-

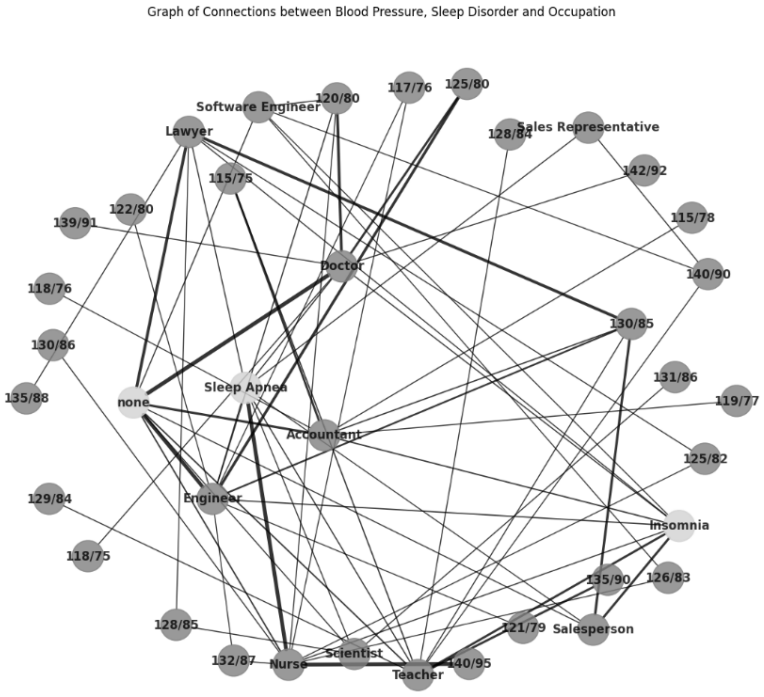

Figure 2. An overview based on graph to report the relationships between occupation, systemic arterial hypertension (SAH) and sleep disorders

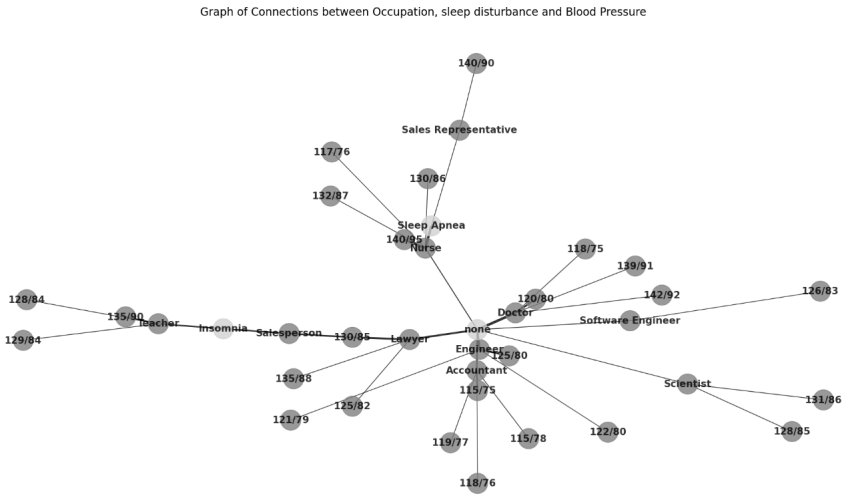

Figure 3. Maximum Range Tree Graph Illustrating the Connections Between Occupancy, Blood Pressure, and Sleep Disorders

ing subjects with normal blood pressure (Figure 4A), they approached the group with sleep disturbances, indicating a direct relationship between high blood pressure and sleep problems. A similar trend was observed among scientists and software engineers, reinforcing this link. These findings suggest that occupations with high demands or stress may significantly contribute to sleep problems due to the impact on blood pressure.

As reported in Figure 4 - (B), where only high blood pressures remained, the previous analyses were maintained, and most of the professions, along with the pressures, approached the vertices that represent the presence of sleep disorders. This suggests that the higher the blood pressure, the less likely you are not to have a sleep disorder. Notably, the legal profession remained close to the *none* vertex, indicating a lower propensity for sleep disturbances.

As reported by Figure 4 - (C), it is observed that certain professional groups, such as nurses, sales representatives, salespeople, and teachers, are not only strongly associated with sleep disorders but also with high levels of stress, evidencing a significant connection between these factors. Stress at work emerges as a key factor in the increase in blood pressure, and it can vary according to the specific work environments in which the profes-

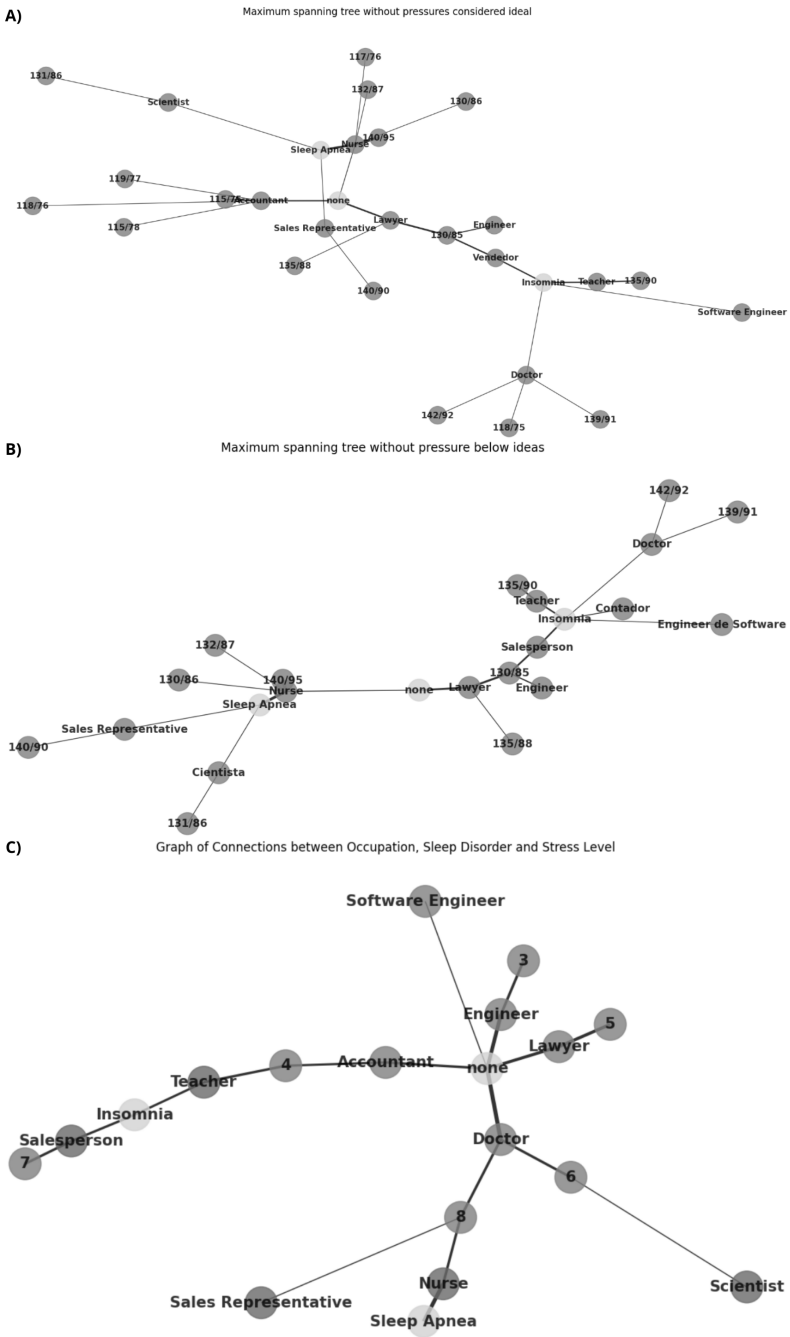

Figure 4. The image shows three graphs, designated as A, B, and C. In graph A, pressures are shown without considering normal values. On the other hand, in graph B, in addition to not considering normal pressures, pressures below normal are also excluded. Graph C shows the relationship between stress levels, occupations, and sleep disorders.

sions operate and the challenges these individuals face in these environments. Thus, the stress level in the work environment results in sleep disorders that directly impact workers' health.

5 Final considerations

This study highlights the relationship between stressful occupations and health problems, especially sleep disturbances and high blood pressure. We observed that professions such as nursing, education, science, and sales show significant trends in these aspects. The results highlight the urgent need for specific preventive measures for professionals in these sectors to mitigate the adverse health impacts resulting from compromised sleep patterns.

It is evident that a stressful work environment can significantly impact workers' health, affecting several

areas of their lives. Therefore, it is essential to implement employee stress management programs to reduce the negative effects on professionals' health. In addition, it is vital to explore computational approaches and innovative methodologies to deepen our understanding and promote advanced practices in occupational health.

A promising future focus would be to investigate other social aspects of these groups, such as gender, ethnicity, and region, as well as health factors, such as physical activity and body mass index (BMI). This would help identify the challenges faced by these groups in their professions, which often result in mental burnout associated with stress levels and sleep disturbances. This more comprehensive approach would provide a more solid understanding of this complex interaction.

A more detailed analysis of the different types of sleep disorders and their specific relationship to various professions can provide good results for implementing targeted interventions. With evidence-based research, we can more effectively address the challenges faced by professionals between work and sleep, aiming to significantly improve the well-being of workers and the quality of work environments.

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