Sleep Duration and Metabolic Syndrome

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The recommend daily duration of sleep for adults is 7–8 hours. Sleeping <7 hours could be detrimental for overall well-being, health, and performance. Literature shows some associations between metabolic syndrome and sleep duration.

Keywords: sleep ; metabolic syndrome ; metabolic syndrome severity score ; generalized additive model ; effect modification

1. Introduction

The recommend daily duration of sleep for adults is 7–8 hours [1]. Sleeping <7 hours could be detrimental for overall well-being, health, and performance [2]. Literature shows some associations between metabolic syndrome and sleep duration [3][4][5][6][7][8]. The associations were not consistent for both genders. The association of short and/or long sleep duration was also insignificant in some other studies [9][10][11][12][13]. Overall, no universal agreements were found on the significance of associations for both short and long sleep durations. Moreover, the long duration of sleep was defined differently in various studies, more than 7, 8, 9, or 10 hours. The inconsistencies justified further studies along with the application of more sophisticated methods of analysis to draw the non-linear associations of metabolic syndrome and sleep.

2. Current Insights on Sleep Duration and Metabolic Syndrome

Few studies evaluated the relationship of sleep duration and cardiometabolic outcomes in the NHANES database. We evaluated the cross-sectional association of sleep duration and metabolic syndrome/metabolic syndrome severity score through the generalized additive model. In both univariable and multivariable metabolic syndrome/metabolic syndrome severity score models, EDF was greater than 2, indicating the curved association of sleep and metabolic syndrome/metabolic syndrome severity score. This means assuming linearity for the association of sleep duration with metabolic syndrome/metabolic syndrome severity score is not appropriate. The lowest risk of metabolic syndrome was observed in people sleeping 7 hours per night. Similarly, the mean score of those sleeping less than 7 hours or more than 7 hours was higher than that in those sleeping 7 hours. We may be able to predict the risk of metabolic syndrome or the score of metabolic syndrome severity score through the final models having age, sex, race, sitting time, and sleep duration. Short sleep duration had similar association with risk of metabolic syndrome in men and women. Nevertheless, models with effect modification of sex showed remarkably stronger association of long sleep duration and metabolic syndrome severity score in women vs. men. The possible mechanisms of association of sleep and metabolic syndrome have been discussed elsewhere. In summary, stage 3 is the most important stage of sleep since the growth hormone (GH) and GH releasing hormone (GHRH) are released at this time. They induce fat burning, bone building, and general repair and regeneration. The longest part of stage 3 in sleep takes place before midnight. Delayed sleep onset until midnight or later, would suppress the largest GH pulse. Sleep restriction induces high levels of ghrelin and low levels of leptin. Ghrelin stimulates appetite whereas leptin does the reverse. Advanced glycation end products (AGEs) are significantly increased in chronic sleep insufficiency and are also associated with insulin resistance in males with chronic sleep insufficiency. Sleep insufficiency increases sympathetic activity and pro-inflammatory cytokines, both of which increase insulin resistance. Accumulations of extracellular β amyloid protein plaques and intracellular tau neurofibrillary tangles in brain tissues start immediately after one night of sleep insufficiency. These plaques and tangles are neurotoxins that potentiate each other’s destructive effects on the structures and functions of brain cells and cause neuronal death. The consequence is a global decrease in cognition and decision making, manifested in increased consumption of fatty foods and unhealthy snacks in late sleepers. High levels of β amyloid and proteins might lead to sleep fragmentation, worsening of sleep quality, and daytime somnolence. Concentration will be more difficult, and performance will be reduced [14].

The main strengths of the current study were the method of analysis and the employment of the metabolic syndrome severity score. Application of the generalized additive model to explore the nonlinear association of sleep and metabolic syndrome/metabolic syndrome severity score improved the risk adjustment compared to linear models or categorization of linear terms [15][16]. Categorizing the sleep duration, using dummy variables on categories for adjusting the risk and using linear/logistic regression for nonlinear associations may induce some residual confounding [17][18][19][20][21][22]. In addition, calculating the metabolic syndrome severity score improved the strength of association because first, it provided a continuous measure of risk of metabolic status whereas metabolic syndrome is just a categorical measure of yes or no; second, the metabolic syndrome severity score is sex and race specific whereas in metabolic syndrome only HDL-cholesterol and waist circumference are sex specific; third, all five components of metabolic syndrome actually contribute in the score calculation, whether they are high, borderline, or low, whereas in metabolic syndrome, only the high components defined based on one-point threshold are considered to diagnose metabolic syndrome [23]. Imagine a person with three borderline components and two high components vs. a person with three high components and two normal components. The metabolic condition of the first person could be worse than the metabolic condition of the second one. But according to the definition of metabolic syndrome, only the second one would be diagnosed with metabolic syndrome, not the first one. This shortcoming would be tackled by calculating the metabolic syndrome severity score which includes the actual measurements of all five components. The precision of the metabolic syndrome severity score in predicting the risk of health outcomes has been demonstrated by other studies [24][25][26][27][28][29]. Interestingly, investigation on the components of metabolic syndrome in NHANES 2013/2014 demonstrated significant U-shape association of sleep duration and triglyceride levels and reverse U-shape association of sleep duration and HDL cholesterol [30]. Similar findings on the association of sleep duration and metabolic syndrome/metabolic syndrome severity score/metabolic syndrome components were observed in two other datasets, the Reasons for Geographic and Racial Differences in Stroke (REGARDS) and the Jackson Heart Study [31].

3. Conclusion

Given the current prevalent lack of enough sleep and the growing prevalence and incidence of metabolic syndrome and obesity, finding the U-shaped relationship of sleep duration and metabolic syndrome may target sleep as a serious risk factor for cardiovascular outcomes. Longitudinal studies may improve the reliability and the generalizability of findings.

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