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SLEEP DEPRIVATION AS RISK FACTOR FOR OBESITY

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ABSTRACT

The prevalence of chronic partial deprivation has increased dramatically in the past half century, with rising epidemics of overweight & obesity. Adequate sleep is a critical factor for adolescent's health & health-related behavior. Although genetic factors, altered food selection, physical inactivity are strong contributors of obesity pandemic, but partial sleep deprivation results in metabolic changes which may contribute to the development of obesity This association seems to be related to both sides of the energy balance equation due to combination of increased food intake & more sedentary habits.

KEYWORDS: Short sleep, Obesity, Body mass index, Leptin, Ghrelin

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INTRODUCTION

Inadequate sleep and obesity are important public health challenges with enormous personal, social and health care costs[1]. Adequate sleep is a critical factor for individual's health & health related behaviors[2]. In people, sleep influences physical & mental wellbeing (brain maturation, biological & psychological factors)[3,4]. Sleep duration may play important role in regulating body weight & metabolism. It has shown that habitual sleep duration as a risk factor for mortality & morbidity[5]. The increasing prevalence of obesity has now become a major public health problem in both developed & developing countries. In the last few decades, there has been a significant increase in the prevalence of obesity worldwide and World Health Organization has declared it a global epidemic[6]. In 2005,more than 200 million men and nearly 300 million women were obese & this number is projected as many as 1.1 billion by 2030[7]. It has also been found, over the past decades the rise in obesity in our society has been paralleled by a reduction in sleep time[8]. Various morbidities & mortalities have been associated with obesity like cardiovascular disease, hypertension, insulin resistance, dyslipidemia and it is a challenge to the physician. Because of this obesity emphasizes the importance of identifying multiple factors that may contribute to its high prevalence in the population. Although genetic factors, altered food selection, physical inactivity are strong contributors to obesity pandemic[9] but partial sleep deprivation results in metabolic changes which may contribute to the development of obesity. An association between short sleep time & obesity has been reported in large population studies.

ASSOCIATION BETWEEN SHORT SLEEP DURATION & OBESITY

The prevalence of chronic partial sleep deprivation has increased dramatically in the past half century, in parallel with the rising epidemics of overweight & obesity[10]. Sleep duration was coded as either very short sleep (<5 hours/night), short sleep (5-6hours/night), or long sleep (>8hours/night), referenced to 7-8 hours/night as healthy sleep[11]. These cut off points showed significant associations with health risks[12]. Data from the Alameda County Health and Ways of Living Study show a 72% increase in the prevalence of short sleep (<7hours) from 1965 to 1999[13]. Data from the National Health and Nutrition Examination Surveys show a 52% increase in the prevalence of obesity from 1971 to 1999[13]. Increased prevalence of inadequate sleep seems to parallel increased prevalence of obesity for the same period. Examination of data obtained from 1995 to 2005 reveals a decrease in modal sleep duration of approximately 1.5 hours[13]. In 1969, sleep duration used to be between 8.0-8.9h per night while in 1995 it dropped to 7h[14]. Now a days ≥30% of adults reports sleeping <6h per night[15]. In population studies, a dose-response relationship between short sleep duration and high body mass index (BMI) has been reported across all age groups[16, 17]. Importantly, a recent prospective study identified a longitudinal association between sleep curtailment and future weight gain[17]. In a large adult population sample (Wisconsin sleep cohort study), showed short sleep duration was associated with obesity[18]. It was found that habitual sleep duration below 7.7 h was associated with increased BMI, similar to findings in other studies including children [19], adolescent[20] and adults[12]. An effect of short sleep duration on obesity was reported by Patel et al., who studied 68,183 women for 16 years since 1986, subjects who slept for less than 5 h had gained weight by 1.14 kg when compared with those who slept for 7 h or more[21]. Compared with sleeping 7–8 h per night, sleeping less than 5 h was associated with a BMI that was, on average, more than 2.5 kg/m^2 in men and1.8 kg/m^2 in women, after adjustments were made for multiple potentially confounding variables[22]. Epidemiologic data, which have consistently shown a U-shaped curvilinear relationship of sleep duration with obesity[12]. A more recent analysis of National Health and Nutrition Examination Survey 2005–2010 data obtained from13,742 participants (ages ≥ 20 years)

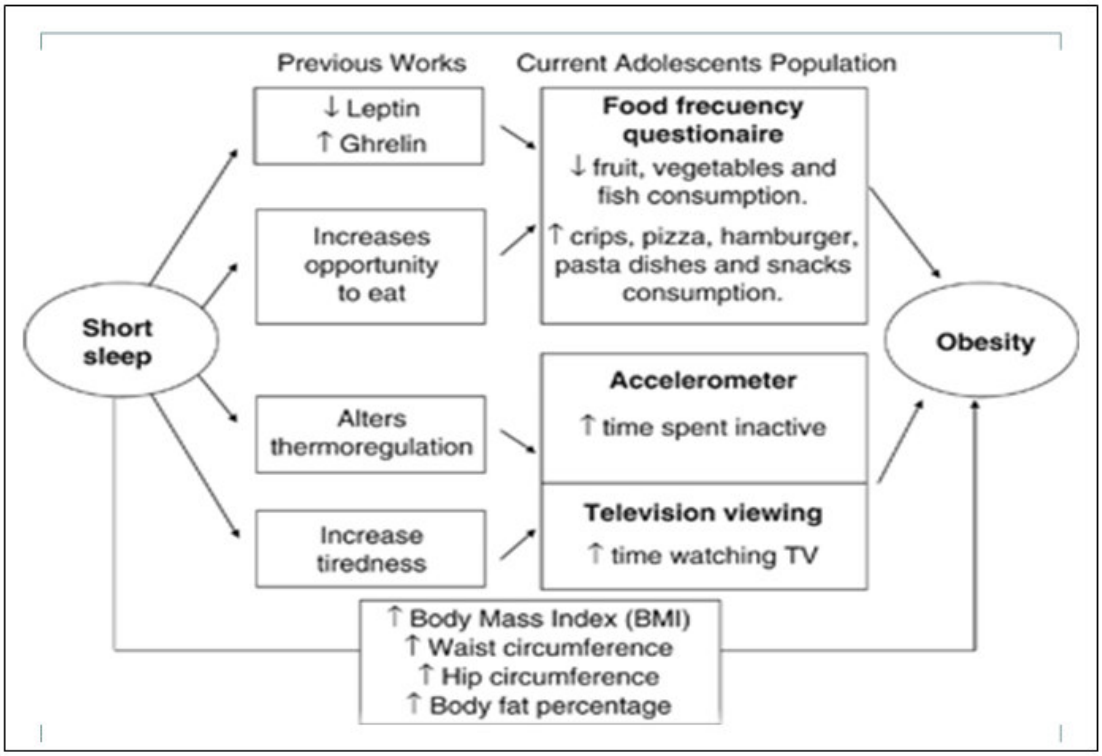
found that short sleepers were more likely to be obese and have abdominal obesity [23]. A pooled regression analysis in adults also suggests that a reduction in one hour of sleep per day would be associated with a 0.35kg/m² increase in BMI[24]. The National Health & Nutrition Examination Survey 1 (NHANES 1) cohort also linked baseline sleep duration to change in weight[25].

MECHANISM SHOWING ASSOCIATION BETWEEN SLEEP DEPRIVATION AND OBESITY

The mechanism showing association between short sleep & obesity not clearly understood. Different causes have been explained, showing the association between short sleep duration & obesity. But several investigations have tested the hypothesis that the human sleep curtailment could promote excessive energy intake. Van cauter & Knutson, postulated that both the lower energy expenditure & an excess intake could be implicated in this interaction[15]. It is thought that this relationship may be mediated via changes in the levels of some of the peptides involved in the regulation of appetite. Short-term sleep restriction appears to impair glucose tolerance & insulin sensitivity, if these effects continue over the long term; sleep restriction could also lead to obesity via changes in the hunger hormones leptin and ghrelin[26-28]. A number of other hormones may be involved in the interaction between short sleep duration, metabolism & obesity. Sleep loss results in changes in levels of several hormones including leptin, ghrelin, insulin, cortisol, interleukin 6 and growth hormone[29]. Many other potential hormones may also be associated including peptide tyrosine, adiponectin, resistin, visfatin and tumour necrosis factor α[29]. Hormonal changes could contribute to selection of calorie-dense food, excessive food intake, changes in energy expenditure and insulin resistance which may lead to obesity. The precise mechanism through which the brain signals the changes in hormone release with sleep deprivation is unknown, but one possibility is increased sympathetic nervous system activity[29]. Studies in people suggested the two key opposing hormones in appetite regulation, leptin and ghrelin[30], play a significant role in the interaction between short sleep duration and high BMI. Leptin is an adipocyte derived hormone that signals the extent of fat stores to hypothalamus & suppresses appetite[31]. Ghrelin is predominantly a stomach-derived peptide that stimulates hunger[30]. Due to reduced sleep duration there occurs, decrease in leptin level & increase in ghrelin which may affect hunger & appetite, increasing the risk of overeating & consequently weight gain[26]. Importantly, low leptin as observed with sleep loss has a greater impact on appetite than high leptin levels, which are associated with leptin resistance, as occurs with obesity[32]. Levels of ghrelin, a potent stimulator of appetite[33], were higher in those with shorter sleep. Ghrelin levels are also positively associated with hunger ratings[34, 35]. So these altered levels of these hormones are the important contributing factor for obesity in sleep deprivation. It has been found that after 3-5 days of sleep deprivation TSH level markedly depressed and this altered thyroid activity may be the contributing factor for obesity[27].The activity of the hypothalamic-pituitary-adrenal axis is reduced in sleep curtailment which may lead to increased weight[36]. Serum cortisol concentration also increases towards the evening in conditions of total & partial sleep deprivation[27]. Cortisol has lipogenic activity which may contribute to weight gain. We know that nocturnal growth hormone secretion is dependent on sleep. In the absence of sleep growth hormone secretion is markedly decreased[37]. Growth hormone is essential for maintaining lipolysis during night[37]. Decreased growth hormone secretion causes decreased lipolysis which may lead to increased BMI. Neurons in the hypothalamus producing orexin are involved in the regulation of both feeding and wakefulness and aberration in the orexin mediated pathway may provide one link between sleep and obesity[38]. The finding of Spiegel et al[26] indicated that sleep deprivation may lead to increase of orexin levels. High orexin level may be necessary to the maintenance of wakefulness during sleep restriction and responsible for high appetite which may contribute to obesity. Total sleep

deprivation experiment in animals found sleep deprivation produces hyperphagia[39]. Partial sleep deprivation in humans suggests similar effect[26]. Short sleep duration could lead to obesity by increasing the time available to eat. It has also been suggested that sleep deprivation not only increase the appetite but also preference for lipid-rich, high-calorie foods which may contribute to high BMI[40]. In terms of morbidity associated with shorter sleep time, reduction of sleep to 6hrs or less per night has been shown to result in decreased alertness and cognitive performance even after a single night[41]. It has also been found that sleep deprivation decrease the energy expenditure by feeling of fatigue[42]. This tiredness leads to decreased physical activity & increased risk of obesity. Acute sleep deprivation in humans found a drop in core body temperature, suggesting that sleep loss may impact energy expenditure through thermoregulation which may contribute to high BMI in sleep deprivation[43]. Moreover, short sleepers reported more time watching TV. In different studies it was found that number of hours spent in TV viewing have been associated with increased BMI[44]. A report suggests that most television viewing is carried out at or near bedtime & this leads to reduced sleep time[44]. Food intake also has a major role in this association. Various works have shown that bedtime curtailment is accompanied by increased consumption of snacks[45]. When we sleep less, we have more time and more opportunities to eat. Recurrent bedtime restriction can modify the amount, composition & distribution of human food intake and sleeping short hours in an obesity-promoting environment may facilitate the excessive consumption of energy from snacks but not meals[45]. Sleep restriction can cause disruption of circadian clock which can have metabolic effects. Knock out of the clock gene, an integral component of circadian clock, in mouse models leads to obesity and metabolic dysfunction[46]. Obesity could be considered as a chronobiological illness, in which a failure of external synchronizers (shortened sleep) of the central internal clock gives to a failure in the circadian system (chronodisruption), which is accompanied by several behavioral changes which increase weight gain[47]. A confounding factor in the relationship between sleep duration & obesity is psychiatric comorbidity, particularly depression[48]. Activation of inflammatory pathways by short sleep may also be implicated in the development of obesity[49]. Recent studies have shown that adipose tissue as an endocrine organ capable of secreting inflammatory cytokines. It is therefore possible that a lack of sleep acting via the regulatory hormones above may lead to increased fat accumulation and increased secretion of pro-inflammatory cytokines. There is evidence to suggest that inflammatory processes may be important in obesity and may mediate some of the effects observed with increased weight[49]. Socioeconomic status (SES) may also confound the sleep–weight relationship. However, many studies have adjusted for SES status in multivariate analyses and have found that the sleep–weight association persisted[25].

Potential mechanism by which sleep deprivation may predispose to obesity, Patel and Hu[50]



CONCLUSION

In conclusion, Short sleep duration appears to be a novel and independent risk factor for obesity[51]. This association may be due to the combination of alteration in levels of hormones, elevated sympathovagal activity, increased intake of energy dense food & more sedentary habits. Since short sleep duration is a modifiable risk factor,[8] increasing sleep duration may be clinically implicated for prevention & treatment of obesity. In order to improve the health, we should promote a healthy diet, physical activity and adequate sleep.

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