Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 5582 - 5590
Received 25 April 2021; Accepted 08 May 2021.

Correlation Body Mass Index with Resting Metabolic Rate, Body Age, and Sleep Quality among Healthcare Workers

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Abstract
Obesity has emerged as a major public health concern in recent years, with prevalence rising globally. As with other occupations, healthcare workers (HCWs) are affected by higher body mass index (BMI). According to a systematic review of the impact of personal health behaviors on health promotion practice, patients are more likely to accept advice from a visibly healthy healthcare professional than advice from a visibly overweight (higher BMI) healthcare professional. We aimed at several variables that were expected to affect BMI, such as resting metabolic rate (RMR), body age, and sleep quality. This is a randomized observational analytical study using a cross-sectional method. It was conducted from August to October 2020 in RSU Tadulako, Palu, Indonesia. Omron Karada scan HBF 375 measured body mass index, resting metabolic rate, and body age. Sleep quality was calculated by the Pittsburgh Sleep Quality Index. A total of 40 subjects (16 males/24 females) 40% vs 60%. The participants' ages ranged from 25 to 52 (39.78±6.94) years old, while their body ages ranged from 29 to 66 (47.70±9.32). The body mass index ranges from 15 to 33 (25.85±3.24). The Resting Metabolic Rate (RMR) ranged from 1084 to 1780 (1420.78±219.11). The Body mass index showed correlation using the Spearmann Two-Tailed Test of resting metabolic rate ($r = 0.580$, $p = 0.000$), body age ($r = 0.722$, $p = 0.000$), and sleep quality ($r = 0.592$, $p = 0.000$). This study implies that body mass index is statistically correlated with RMR, body age, and sleep quality.

Keywords: body mass index, resting metabolic rate, body age, PSQI

Introduction
Obesity has now been widely accepted as a distinct disorder, accounting for roughly 37% of the global burden of disease in 2013. Obesity numbers have continuously rising over the last three decades, nearly doubling globally between 1980 and 2014.[1] Obesity, according to studies,

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increases the risk of developing a variety of disorders and diseases in humans. Obesity and type 2 diabetes mellitus are inextricably linked, which explains how most countries have such a high prevalence of type 2 diabetes mellitus. Type 2 diabetes mellitus is a significant risk factor for cardiovascular disease. Due to the frequent association of obesity with hypertension and dyslipidemia, many high-risk obese patients exhibit a similarity of metabolic, cardiovascular, cancer, obstructive sleep apnea, and osteoarthritis risk factors.[2]

Obesity, historically characterized as an abnormal accumulation of body fat that impairs health, is typically quantified in clinical practice using the body mass index (BMI), which is calculated as the ratio of a person's body weight in kilograms divided by their height in square meters (kg/m2). 1 Since its inception, numerous broad population studies have shown a J-shaped association between BMI and mortality/morbidity risk.[2] Health care workers, teachers, and bankers have been identified as high-risk occupational groups that are more vulnerable to risk factors for overweight and obesity than the general population.They spend extended periods of time performing physical activities as a result of the existence of their employment, and their socioeconomic status can impact their tolerance towards less physical exercise.[3]

Obesity has emerged as a major public health concern in recent years, with prevalence rising globally. As with other occupations, healthcare workers (HCWs) are affected by obesity. Health care staff should serve as role models, raising community awareness about obesity prevention and encouraging patients to adopt a healthier lifestyle. Despite operating in a disease prevention and health promotion setting, multiple studies have shown that HCWs have a tendency toward obesity throughout the period and also have a greater rate of obesity than the overall population.[4]

Individuals with a low Resting Metabolic Rate (RMR) are potentially more likely to experience obesity-related disorders, since a greater portion of their daily calorie intake is processed as fat, even with comparable calorie intake. Previous research found that obese people with higher RMR had a better metabolic profile than obese people with a low Resting Metabolic Rate. [5]

In equating people of different body sizes, recent studies have adjusted RMR per kg body weight or, to a lesser degree, BMI. When RMR is expressed as a ratio to body weight or BMI, it means that RMR is proportional to body weight or BMI, and that body weight or BMI contributes to RMR in a consistent manner over a broad spectrum of body weight or BMI. Schofield previously commented on RMR's propensity to grow more slowly as body weight increases. Furthermore, Owen et al. looked at data that showed RMR per kg of body weight decreases as body weight rises. In order to predict the risk of obesity and obesity-related disorders, it has been stated that the best RMR per kg body weight cut-off value is 20 kcal/24 h/kg.[5]

The Resting Metabolic Rate is a critical component of daily energy requirements, accounting for roughly 60% to 70% of energy demand in sedentary individuals. Calculating regular energy requirements accurately is essential for ensuring an optimum body composition and improving dietary strategies to meet body requirements.[6] While a healthy energy balance raises body weight and contributes to weight-related health problems such as obesity and metabolic disorders[1], a negative energy balance can result in a variety of nutritional deficiencies, exhaustion, an abnormal body image, and muscle mass loss.[7]

The resting metabolic rate varies across life and has been shown to be associated with health conditions. It is a measure of the amount of energy consumed by the human body during rest period in the lack of food digestion, physical or cognitive activity.[8] As such, RMR can be viewed as the cost of living. In other words, the energy cost of maintaining all metabolic functions

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required for homeostasis stability and mental wakefulness, as well as paving the way for certain daily activities.According to an analysing the data from the Baltimore Longitudinal Study of Aging (BLSA), participants in excellent health and physical status had a lower RMR than those affected by chronic diseases and limited mobility. Higher RMR was cross-sectionally correlated with both a greater variety of chronic diseases and a significantly increased risk of death, regardless of age, gender, or associated body composition.[9]

At numerous biochemical rates, higher BMI and metabolic syndrome were consistently linked to accelerated aging. Biological age or body age is a complicated parameter that includes a human's calendar age, their wellbeing as it relates to their age, and medical indicators of when they may die of old age.[10]Recent advances in epigenetics indicate that our epigenome—the chemical modifications that occur above and beyond our DNA sequence—might be the best way to explain and measure biological ageing in humans. The difference regarding biological and chronological age might have a big impact on how people think of our legal ages. Currently, chronological age is used as a predictor for an individual's ability to work. However, epigenetics research suggests that calculating a person's biological age accurately could be possible soon.[11] Biological age more reliably predicts death or age-related illnesses than chronological age.[12]

Several studies showed sleep efficiency (SE), sleep duration (SD), and body mass index were adversely linked, which suggests that greater BMI could lead to reduced SE and SD. As we know, SE and SD are crucial determinants for human sleep quality. Sleep is critical to one's wellbeing. Sleep deprivation has been linked to a variety of negative health outcomes, including obesity, depression, cardiovascular disease, and all-cause mortality. Adult humans should get at least 7–9 hours of sleep a night to preserve their health and well-being, according to the recommendations. However, the incidence of poor sleep quality remains high.[13]

Healthcare workers when compared to employees with fixed schedules, rotating shift workers reported a higher number of awakenings, especially following shift schedules. The irregular and insecure sleeping pattern is reflected in the changing routine.[14] Additionally, healthcare professionals contribute to overday sleepiness and lengthy sleep disturbances as a result of workplace stress.[15] Based on the preceding explanation, the aim of this study is to explore the relationship between body mass index, resting metabolic rate, age, and sleep quality in health workers.

Method

Study population and participants

The population consists of all healthcare workers only at Tadulako Public Hospital in Palu, Central Sulawesi, Indonesia, that have been there for at least six months at the beginning of the survey. The data set for this analysis was calculated with a 95% confidence interval and a 5% error margin using an online statistical tool, and the samples were chosen at random.

Data collection procedure

This is a longitudinal cross-sectional study. It was conducted at RSU Tadulako in Palu, Indonesia, from August to October 2020. The Pittsburgh Sleep Quality (PSQI) questionnaire was used to assess sleep quality. Good sleep quality was defined as Global Pittsburgh Sleep Quality (GPSQI) 5, while bad sleep quality was defined as GPSQI > 5.[16,17] The Omron Karada Scan HBF 375 is being used to measure body mass index, age, and resting metabolic rate.

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Result

In the study findings, we analyzed the nature of participants based on age and gender. The study included 40 participants, of which 16 were male (40%) whereas 24 were female (60%). The participants' ages ranged from 25 to 52 (39.78±6.94) years old, while their body ages ranged from 29 to 66 (47.70±9.32). The body mass index ranges from 15 to 33 (25.85±3.24). The Resting Metabolic Rate (RMR) ranged from 1084 to 1780 (1420.78±219.11). The characteristics of gender, body mass index, and sleep quality were shown in Table 1. Females (22.5%) seem to have worse sleep quality than males (7.5%). Males are more likely to have an overweight body mass index (22.5%) than females, who are more likely to have a moderate BMI (27.5%) or an overweight BMI (27.5%).

Table 1. The Characteristic Body Mass Index and Sleep Quality Among Sex

Characteristics	Sex					
	Male		Female		Total	
	n	%	n	%	n	%
Sleep Quality						
Good	9	22.5	15	37.5	24	60
Poor	7	7.5	9	22.5	16	40
Total	16	40	24	60	40	100
Body Mass Index						
Underweight	0	0	1	2.5	1	2.5
Normal	5	12.5	11	27.5	16	40
Overweight	9	22.5	11	27.5	20	50
Obese I	2	5	1	2.5	3	7.5
Total	16	40	24	60	40	100

Table 2 explained the relationship involving body mass index (BMI) and resting metabolic rate (RMR), as well as body age and Global Pittsburgh Sleep Quality (GPSQI). The association between BMI and RMR was weak (r = 0.580, p = 0.000), as was the correlation between BMI and GPSQI (r = 0.592, p = 0.000). The relationship between BMI and body age was moderate (r = 0.722, p = 0.000).

Table 2. Correlation Body Mass Indexwith Resting Metabolic Rate, Body Age, and Global Pittsburgh Sleep Quality Index (GPSQI) Score

Varaible	Statistic	Resting Metabolic Rate	Body Age	GPSQI
Body Mass Index	r	0.580	0.722	0.592
	p	0.000	0.000	0.000
	n	40	40	40

Note. Using methode Spearmen Two-Tailed test.

Discussion

Table 1 showed characteristic body mass index and sleep quality among sex. There were 7 (7.5%) males with poor sleep quality compare with females with 9 (22.5%) participants. Gender has a significant impact on how sleep problems manifest; research suggests that females sleep worse than males. In females, poor sleep quality can be associated with the menstrual cycle.[18]Premenstrual syndrome, which is believed to be caused by hormonal disruption, has been linked to mood swings, extreme dysmenorrhea, and insomnia.Additionally, dysmenorrheic pain caused by an increase in uterine contractility during the night contributes to decreased sleep quality and rapid eye movement sleep length,[19] as well as a longer sleep onset delay. Additionally, higher progesterone levels during the periovulatory to mid-luteal phases may result in an increase in wakefulness following sleep onset, leading to an increase in sleep fragmentation.[18,20]

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Body Mass Index and Resting Metabolic Rate Correlation

The RMR is energy needed by our body to perform the most basic functions while humans are at rest. Breathing, blood circulation, and basic brain functions are examples of these vital functions. Our study showed there is a correlation between body mass index and resting metabolic rate ($p < 0.005$) based on our research. As we know, RMR is the amount of energy consumed by a person during physical activity; it is expressed in terms of Total Energy Expenditure (TEE). (Pavlidou) severe study showed RMR increases with body weight, the energy demand per unit weight decreases. Thus, as a person's weight changes from 40 to 160 kg, the RMR per kilogram of body weight falls from 30 to 15 kcal per kilogram per 24 hours.[21,22]

As we know, body mass index (BMI) is a person’s weight in kilograms divided by the square of height in meters. Several studies show that even though they are the same body weight and height, women's metabolic rates are around 5% to 10% lower than men's. Differences in androgenic-anabolic hormone status, skeletal muscle metabolism, and sympathetic nervous system function are due to the slightly reduced RMR. Body surface area can also play a part, as larger, thinner people have a slightly higher RMR, and men are typically taller than women.[21,22]

Reducing the amount of food consumed is one of the most frequently used ways to lose weight. Information about a person's RMR importance can be applied to the diet program for weight loss.[23] As the body attempts to maintain energy reserves, a reduction in food consumption may lead to a decrease in energy expenditure. A study shows a very low calorie diet of less than 800 kcal/day lowers RMR by more than 10%. Obesity is indicated by a BMI of $30kg/m^2$. Excess fat in obesity may be of the subcutaneous or visceral variety (around the organs; less visible). Adipose tissue (fat cells) expends less metabolic energy than other tissues such as skeletal muscle. As a result, increased body fatness adds to total body mass, resulting in an increase in RMR, albeit to a much smaller degree than it would be if muscle is added.[4,22,24]

Obese people are more likely to develop chronic inflammation and type 2 diabetes, as well as hypertension, hypercholesterolemia, heart disease, stroke, sleep problems, digestive problems, hyperuricemia, gout, and osteoarthritis. The calculation of a person's body mass index makes it simple to enforce the diagnosis of obesity. The calculation of a person's body mass index makes it simple to enforce the diagnosis of obesity.[25]

Obesity is becoming a significant condition for human health because it is related to a higher risk of developing a variety of life-threatening illnesses. As a result of many surveys revealing that a large proportion of healthcare workers are obese, these issues have become more pressing. A higher BMI raises the risk of musculo-skeletal disorders and mental health conditions among healthcare workers, which are the primary causes of work-related illness and injury. In addition to being linked to the onset of chronic diseases, these disorders and their related sick leave rates pose a threat to the healthcare system's effectiveness and long-term viability by reducing overall the workforce's capability.[25]

Contrasting obesity rates in healthcare professions with those in the general population would aid in identifying occupational issues such as a lack of nutritious food, as well as the relationship between high demand and low control as factors contributing to higher obesity rates in healthcare professionals. According to a systematic review of the impact of personal health behaviors on health promotion practice, patients are more likely to accept advice from a visibly healthy healthcare professional than advice from a visibly overweight (higher BMI) healthcare professional, and there is data that health workers' lifestyle behaviors alter the intensity and commitment patients have to lose weight.[24,25]

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Body Mass Index and Body Age Correlation

The most significant risk factor for most illnesses is age. There is a great deal of interest in lowering the risk of age-related disorders through the use of lifestyle, medicinal, and environmental approaches to slow down biological aging.[26]Table 2 showed the relationship between BMI and body age was moderate (r = 0.722, p = 0.000). Body age or biological age (BA) has been suggested as a better predictor of death and disease than chronological age, as it is derived from morphological and cellular variables.

Sophisticated epigenetic aging is also being attributed to lower somatic health, death, depression and post-traumatic psychiatric disorders, despite certain research finding the reverse impact. Those with higher blood pressure, cholesterol, fasting blood glucose, and body mass index had accelerated transcriptomic aging.[27] High BMI was strongly aligned with epigenetic aging, transcriptomic aging, proteomic aging, and metabolomic aging, according to a study based on somatic health determinants.[28] This suggests that a significant higher body mass index is linked to a faster rate of body aging.

The average biological age of living people was almost identical to the average chronological age. The biological age of the deceased was greater than the chronological age: the highest biological increase over chronological age was found when their chronological baseline age was between 50 and 59 years. The mortality rate increased dramatically as the biological age was increased by linear trend testing.[29] Sex was linked to all biologically aging markers excluding proteomic aging: females appeared biologically younger than men (telomere length, epigenetic aging, transcriptomic aging, metabolomic aging). [28,30]

Body Mass Index and Sleep Quality Correlation

Our study showed a correlation between body mass index and sleep quality using the overall score GPSQI (r = 0.592, p = 0.000). Prior research on the relationship between sleep and the control of ghrelin (a hunger-promoting hormone) and leptin (a hormone that contributes to the sense of satiety) found that sleep inhibited ghrelin regulation. Simply put, individuals' ghrelin release may escalate with sleep deprivation, contributing to further energy demand during the nighttime, which could contribute significantly to an energy surplus, and therefore an increased risk of developing higher BMI (overweightness/obesity).[13]

As predicted, our findings reported a clear correlation between sleep quality and BMI. Additionally, in some conditions, this relationship tends to be independent of genetic confounding. Sleep deprivation has been implicated as a metabolic stressor, with elevated cortisol quantities as a result. Short sleep periods can enhance the risk of weight gain by interfering with the preservation of hormonal characteristics that regulate appetite (homeostatic drives to eat). As previously stated, insufficient sleep has been shown in some studies to lower leptin levels, increase ghrelin and cortisol levels, alter glucose tolerance, and trigger the orexin system.[22]

Conclussion

As per this report, body mass index is statistically related to resting metabolic rate, body age, and sleep quality. If higher BMI levels among healthcare workers are observed, and physical activity and dietary changes are introduced to reduce the incidence of obesity, this result become meaningful. Future research may use additional work-time schedules and dietary measures among healthcare workers to improve study design.

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