Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 8 (2025)
https://www.jneonatalsurg.com
OPEN ACCESS

Association of BMI with Anthropometric Measurements, Perceived Stress and Sleep Quality among Industrial Workers

Akshaya V[1], Rohini Durairaj[2*], Suganthi V[3], Shobana Chandrasekar[4], Usharani Boopathi[5]

[1]Research Scholar, Department of Biochemistry, School of Life Sciences, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, Tamil Nadu

[2*]Assistant Professor, Department of Biochemistry, School of Life Sciences, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, Tamil Nadu

[3]Associate Professor, Department of Home Science – Nutrition, Food service management and Dietetics, Anna Adarsh College for Women, Chennai, India

[4,5] Associate Professor, Department of Biochemistry, School of Life Sciences, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, Tamil Nadu

[*]**Corresponding Author:**

Rohini Durairaj

Email ID: drrohinidurairaj@gmail.com

Cite this paper as: Akshaya V, Rohini Durairaj, Suganthi V, Shobana Chandrasekar, Usharani Boopathi, (2025) Association of BMI with Anthropometric Measurements, Perceived Stress and Sleep Quality among Industrial Workers. *Journal of Neonatal Surgery*, 14 (8), 567-573.

ABSTRACT

Obesity is a thoughtful public health worry. One method to gauge the prevalence of obesity in the population is the body mass index or BMI. An Exploratory Research Design involving 500 industrial workers, comprising 325 males and 175 females was used in this study. Anthropometrical data, including height, weight, BMI, body fat percentage, hip circumference, neck circumference, waist circumference (WC), and waist-to-hip ratio (WHR) were recorded and additionally, perceived stress levels and sleep quality were assessed using validated questionnaires. The results revealed significant positive correlations between BMI and WC (r=0.813), hip circumference (r=0.820) and WHR (r=0.683), body fat percentage (r= 0.868) indicating that higher BMI is associated with greater central adiposity and overall body fat. Furthermore, perceived stress was significantly related to BMI (r=0.722, p<0.001), with higher stress levels correlating with higher BMI values. Sleep quality also showed a momentous inverse relationship with BMI (r=-0.728, p<0.001), suggesting that poorer sleep quality is related with higher BMI. The strong associations between BMI, anthropometric measurements, stress, and sleep quality highlight the need for integrated health interventions that address both physical and psychological aspects that could potentially mitigate the adverse health effects associated with high BMI, stress, and poor sleep quality in industrial settings.

Keywords: *Anthropometric Measurements, BMI, Industrial Workers, Perceived Stress, Sleep Quality.*

1. INTRODUCTION

Industries have brought tremendous changes in the health status of industrial workers. Achieving productivity at work is significantly influenced by one's health. The workplace represents one of the environments in which a multitude of hazards and implications about well-being, productivity, and life quality may manifest [1].

Obesity is a stern public health fear. One method to gauge the prevalence of obesity in the population is BMI. Additional metrics for assessing obesity are the WHR, visceral fat percentage, and WC. A person's height, weight, and other mathematical operations can be used to compute their BMI, which is a measure of their overall health. BMI is commonly used as a metric to assess the likelihood of acquiring enduring health issues like cancer, depression, diabetes, and high blood pressure [2].

Pandemics of obesity and overweight are increasing globally. The World Health Organization (WHO) estimated that two billion adults globally were obese in 2016, and that obesity-related causes of death account for about 2.8 million deaths annually. Several research studies have indicated that obesity (BMI ≥ 30 kg/m^2) carries a greater health peril than overweight (BMI = 25–29.9 kg/m^2). However, the WHO classified being overweight or obese as abnormal or excessive fat accumulation that might be a sign of significant health risk and may negatively impact one's health [3].

The WHR gained prominence after epidemiologists demonstrated that WHR alone or in conjunction with BMI was linked to an elevated risk of cardiovascular disease (CVD). These findings were later validated in numerous other investigations. Later research, however, showed that WC alone was more significantly correlated with the complete quantity of visceral or intra-abdominal fat, the fat deposit that carries the most health risk, as opposed to the WHR [4]. Patel *et al*. (2022) showed that WHR is significantly correlated with CVD risk factors [5].

The BMI, weight, and height are anthropometric parameters that are frequently employed as markers of nutritional status. Undernutrition results in stunted or short height for age, along with low BMI, compromised immune system, and increased susceptibility to diseases. Alternatively, increased BMI indicates obesity, increasing the menace of evolving chronic illnesses including CVD, diabetes, and numerous cancer types [6].

Lifestyle has a crucial role in determining an individual's stress levels and sleep quality [7]. A disturbance to one's psychological well-being is defined as stress [8] and has a profound impact on an person's health status leading to both bodily and psychological health problems, including chronic diseases like obesity, CVD, and diabetes [9].

The COVID-19 pandemic has created challenges for workers by disrupting their health and stress levels as a result of their work schedule changes. Elevated weight gain and alterations in body composition within the pandemic highlighted the necessity of ongoing surveillance and health evaluations in work environments [10].

Because of the severe nature of their work, which frequently entails long hours, physical exertion, and exposure to hazardous conditions, industrial workers in particular face major challenges resulting in increased stress and irregular sleep schedules, which have been connected to negative health consequences like obesity and metabolic diseases [11]

Prior research indicated that high perceived stress was linked to poor anthropometric profiles and elevated BMI. Long-lasting stress causes dysregulation of cortisol levels, which encourages the buildup of belly fat and raises the peril of disorders linked with obesity. In the same way, low-quality sleep was connected to hostile variations in body conformation, weight gain, and a higher BMI. Hormonal balances, which include those regulated by ghrelin and leptin to control hunger and energy expenditure, were disrupted by inadequate sleep [12].

This study aims to explore the relationships between BMI and anthropometric measures, perceived stress, and sleep quality among Tamil Nadu's industrial workers across various types of industrial sectors.

2. METHODOLOGY

Study Design

An investigative study design was used for this study focusing on determining the connection between BMI and anthropometric indicators, perceived stress, and sleep quality among 500 industrial workers in Tamil Nadu's several industrial sectors.

Sample size and selection

Purposive sampling was employed for selecting 500 industrial workers from various of Tamil Nadu's industrial sectors. The criteria were willingness to participate in the study and industrial workers between the ages of 21 to 60.

Data collection

The purpose of the research was described to the partakers and notified permission was obtained along with the partaker's commitment. A consistent questionnaire was utilized to produce information on anthropometric measurements like height, weight, BMI, neck circumference, WC, hip circumference, WHR, body fat percentage, sleep quality, and perceived stress levels

Anthropometric measurements

Anthropometric measures are a set of numerical calculations of bone, fat, and muscle tissue that are employed to evaluate the body's conformation. The fundamental components of anthropometry like skinfold thickness, body circumferences (waist, hip, and leg), height, weight, and BMI are critical as they aid as indicative standards for obesity, a condition that dramatically increases the peril of numerous other sicknesses, together with diabetes mellitus, hypertension, CVD, etc., Anthropometric measurements were also used to track fitness progress and establish a baseline for physical fitness [13]. Anthropometric measurements such as height, weight, BMI, body fat percentage, neck circumference, WC, hip circumference, and WHR were assessed during the study

Body Mass Index

A commonly used metric to determine a person's body weight to height is the BMI which is a useful metric for evaluating a population's general health and spotting patterns in the distribution of weight among various demographic groupings [14]. Rather than the total excess weight indicated by BMI, abdominal fat is considerably linked to chronic metabolic diseases. Multiple studies have found that the Indian population has a higher frequency of metabolic irregularities. For every given

BMI level, the same research has gone on to show that Indians had a higher frequency of cardio-metabolic disorders [15].

Waist circumference

The National Institutes of Health (NIH) insisted the threshold values for WC equal to 102 cm or greater than that in men and equal to 88 cm or greater than that in women [16]. WC was determined using a flexible but rigid tape, and the measurements were obtained to the nearest 0.1cm by placing the tape around the slimmest area of the waist. The industrial workers were asked to stand straight with their feet together, relaxed abdominal muscles, and arms at the side.

Hip circumference

Hip circumference was quantified using a flexible but rigid gauging tape, placed at the broadest area of the hip at the greatest protuberance of the buttocks [17].

WHR

WHR was obtained by dividing the WC by the hip circumference. WHO indicated that the ratio values more than 0.90 for males and 0.85 for females were at the menace of metabolic syndrome.

Neck circumference

An early screening method for obesity that is potentially effective is neck circumference which distinguishes between typical and abnormal fat distribution [18]. The threshold for being classified as overweight or obese should be a neck circumference greater than or equal to 35.5 cm for men and 32 cm for women [19]. Using non-stretchable plastic tape, while the industrial workers were standing straight, the neck circumference was determined from the neck middle starting at the Adam's apple region.

Total Body Fat Percentage

The body fat acts as a stored form of energy in our body and protects visceral organs. The body fats are classified as essential and non-essential fats. Essential fats are stored in small amounts for the protection layer the excess fat stored is used as an energy source for physical activity. Omron Karada Scan Body Composition Monitor HBF-375 was used to measure the Total body fat percent.

Statistical Analysis

SPSS (version 23) software was employed for the statistical analysis in this study, and the percentages were used to express categorical variables. Pearsons Correlation was the test performed

3. RESULTS

Five hundred industrial laborers from different industrial sectors in the state of Tamil Nadu were included in the present research. The BMI Classification of these participants comprised of Normal Weight, Overweight, and Obesity - Class I is presented in Table 1.

Table 1 - BMI Classification of Industrial Workers

BMI Classification	**Frequency**	**Percentage**
Gender		
Male	325	65.0
Female	175	35.0
BMI Classification		
Normal Weight	114	22.8
Overweight	355	71.0
Obesity – Class I	31	6.2

Table 1, revealed that 65% of the participants were men and the remaining were women. Based on the WHO BMI Classification, the industrial workers were categorized into normal weight, overweight, and Obesity Class – I. The majority (71%) of the industrial workers were overweight, 22.8 percent of the industrial workers maintained a normal healthy weight. Only 6.2 percent of the participants were in the Obesity Class – I category.

Anthropometrical quantities like body fat percentage, height, weight, BMI, neck circumference, WC, hip circumference, and

WHR were assessed among 500 industrial workers. The mean values for anthropometric measurements of both male and female participants are depicted in Table 2.

Table 2 - Anthropometric Measurements of Industrial Workers

Anthropometric Measurements	**Male (n= 325)**	**Female (n= 175)**	**Total (n=500)**
	Mean ± SD	Mean ± SD	Mean ± SD
Height ($m^{2)}$	2.92 ± 0.14	2.62 ± 0.16	2.82 ± 0.21
Weight (kg)	81.47 ± 5.89	68.9 ± 6.45	77.1 ± 8.52
BMI	27.8 ± 1.83	26.3 ±3.05	27.3 ± 2.43
WC (cm)	99 ± 8.99	79.45 ±15.2	92.16 ± 14.84
Hip circumference (cm)	103.08 ± 7.38	94.7 ± 10.9	100.1 ± 9.65
WHR	0.95 ± 0.02	0.83 ± 0.58	0.91 ± 0.72
Neck circumference (cm)	35.07 ± 1.39	32.7 ± 0.88	34.2 ± 1.65
Body fat percentage	28.6 ± 6.26	29.2 ± 11.2	28.8 ± 8.35

Table 2 infers that Males have a higher average height (2.92 ± 0.14) compared to females (2.62 ± 0.16). The overall average height is 2.82 ± 0.21. Men have a higher average weight (81.47 ± 5.89 kg) compared to women (68.9 ± 6.45 kg). The overall average weight is 77.1 ± 8.52 kg. Males have a slightly higher average BMI (27.8 ± 1.83) compared to females (26.3 ± 3.05). The overall average BMI is 27.3 ± 2.43. WC is significantly higher for males (99 ± 8.99 cm) compared to females (79.45 ± 15.2 cm). The overall average WC is 92.16 ± 14.84 cm.

Males have a higher average hip circumference (103.08 ± 7.38 cm) compared to females (94.7 ± 10.9 cm). The overall average hip circumference is 100.1 ± 9.65 cm. The WHR in males was comparatively higher (0.95 ± 0.02) than in females (0.83 ± 0.58). The overall WHR is 0.91 ± 0.72. Males have a higher average neck circumference (35.07 ± 1.39 cm) compared to females (32.7 ± 0.88 cm). The overall average neck circumference is 34.2 ± 1.65 cm. The body fat percentage of females was found to be higher (29.2 ± 11.2) compared to males (28.6 ± 6.26). The overall average body fat percentage is 28.8 ± 8.35.

Table 3 - Correlation between BMI and Anthropometrical quantities

		WC	**Hip circumference**	**WHR**	**Body fat percentage**
BMI	Pearson Correlation	0.813	0.820	0.683	0.868
	Sig (2 tailed)	0.000	0.000	0.000	0.000
	N	500	500	500	500

Table 3 infers that BMI is strongly positively linked with WC (r = 0.813), Hip Circumference (r = 0.820), and WHR (r= 0.683). Correlation is substantial at 0.01 level. Higher BMI exists the increasing body fat percentage (r = 0.868). These relationships are statistically significant, indicating that as BMI increases anthropometrical quantities also increase.

Table 4 - Correlation between BMI and Stress Score and Sleep Quality

		Stress Score	**Sleep Quality**
BMI	Pearson Correlation	0.722	0.728
	Sig (2 tailed)	0.000	0.000
	N	500	500

Table 4 infers that higher BMI exists with higher stress scores indicating a substantial relation amid the BMI and Stress Scores of the participants (r = 0.722). A higher BMI has an impact on higher stress levels. When BMI is higher, poorer is the sleep quality, indicating a substantial link between BMI and Sleep Quality. Relationships are substantial at 0.01 level.

4. DISCUSSION

The development of technological advances and industrialization are major contributors to a nation's progress. This study investigated the sleep patterns and stress levels of Tamil Nadu's industrial laborers across a range of industries. A significant majority of industrial workers in the current study (65%) were men, while only 35% were women. The majority (71%) of the industrial workers were overweight, and 22.8 percent of the industrial workers maintained a normal healthy weight. Based on BMI Classification, BMI, weight, and height are anthropometric parameters that are frequently employed as markers of nutritional status. Stunting, or short height for age, is a sign of undernutrition and can cause stunting, low BMI, compromised immune system, and increased susceptibility to diseases.

Male industrial workers have higher average values for height, weight, BMI, WC, hip circumference, WHR, and neck circumference. The body fat percentage is comparatively slightly more in women than men. These findings are consistent with typical gender differences in body conformation and spreading of body fat. Research has indicated that males generally have higher WC and hip circumferences, along with a higher WHR, compared to female industrial workers.

One commonly used measure of body fat composition and nutritional health is the BMI. Measurements of anthropometry, such as hip and WCs and the WHR, provide further evidence about the fat distribution and the health risks related to it. Research studies have continuously proven a strong relationship between BMI and other anthropometric measures, emphasizing the need for a thorough approach to evaluating the health risks related to body weight and fat distribution [20]. This is in line with the current study carried out among industrial workers.

Jones *et al*. (2021) identified that adult males had significantly greater waist and hip measurements than their female counterparts, reflecting differences in fat distribution patterns [21]. These differences are partly attributed to hormonal variations that influence fat storage, with males tending to accumulate more visceral fat, which is associated with higher metabolic risk [22]. Liu *et al*., (2023) observed that females have more body fat percentage compared to their male counterparts. Men have higher muscle mass compared to females [23].

The connection between BMI and other anthropometrical quantities is particularly significant for industrial workers, whose physical demands may result in distinct body composition profiles. Compared to the general population, industrial workers may have distinct muscle mass and fat distribution due to their frequent participation in repetitive and demanding physical activities [24].

Stress levels were higher among industrial laborers indicating a strong positive link amid stress levels and BMI. Two public health issues that are inextricably linked are stress and obesity. Stress causes obesity through unsuitable eating habits brought on by an ineffective reaction to ghrelin levels. Furthermore, one of the main causes of stress is obesity. Those who are stressed out have the hardest time cutting weight. People who are obese exhibit a longer and higher response, highlighting the connection between stress and obesity [25].

Hamurcu (2023) found that stress and depression levels elevated in association with rising BMI. Similarly, higher BMIs are associated with higher levels of anxiety, stress, and depression. As a person's body weight increases, this circumstance can be linked to a decline in their sense of self-worth and level of body pleasure [26]. Thus, the negative reflection of the person's mental disorders accounts for this condition. Smith *et al.* (2021) found that industrial workers with high perceived stress levels had significantly higher BMIs and WCs [27].

In this research, industrial workers experienced poor sleep quality due to work pressure and hectic work schedules. Sleep quality also showed a significant inverse relationship with BMI suggesting that poorer sleep quality is associated with higher BMI.

Sleeping for the optimum amount of time is vital for sustaining metabolic balance. Research revealed a link between prolonged sleep deprivation or excessive sleep and a higher risk of all-cause mortality as well as prevalent chronic conditions like hypertension, type 2 diabetes, and metabolic syndrome [28].

Numerous studies have indicated a possible link between sleep and obesity, however, the adiposity measurements utilized in many of the earlier studies were BMI or other traditional anthropometric indices like WC and WHR. The detrimental effect on health was related to both the bulk and particular anatomical locations of adipose depots. Therefore, several metabolic syndrome characteristics, including dyslipidemia, systemic inflammation, hyperinsulinemia, and atherosclerosis, are influenced by visceral fat content [29].

Lee and Kim (2021) scrutinized the impact of sleep quality on metabolic health and found that poor sleep was consistently linked to higher BMI and adverse changes in body composition [30]. The findings highlighted the necessity of addressing sleep concerns in occupational health programs. Rogers *et al,* (2024) found that sleep disruption alters the body composition and deposition of visceral body fat [31].

Industrial workers experienced higher stress levels and poor sleep quality and this had a significant relationship with higher BMIs. Martinez *et al.* (2021), also examined the combined effects of stress and sleep quality on BMI and found that stress levels and poor sleep quality affect higher BMI [32]. The observed synergistic impact implies that therapies aimed at enhancing both sleep quality and stress reduction could be especially useful in treating obesity and associated health problems among industrial populations.

5. CONCLUSION

The present study showed the complex interplay between BMI, anthropometric measurements, perceived stress, and sleep quality among industrial workers. The findings confirm significant positive correlations between BMI and key anthropometric indicators such as WC, hip circumference, and WHR which highlights the prevalence of central adiposity and overall body fat among individuals with higher BMI, emphasizing the importance of using multiple anthropometric measures for a comprehensive assessment of obesity-related health risks. The significant association between perceived stress and BMI suggests that stress management is crucial for this population. Industrial workers often face high-stress levels due to demanding work conditions, which can lead to adverse health outcomes, including increased BMI. Interventions aimed at reducing workplace stress could therefore play a vital role in managing obesity and enhancing overall health. The inverse relationship between sleep quality and BMI underscores the impact of sleep on body weight and health. Poor sleep quality, commonly reported among industrial laborers, is linked to higher BMI, suggesting that improving sleep hygiene could be a key component of health interventions in this demographic. Workplace health programs should incorporate strategies for managing stress and improving sleep quality, alongside traditional measures to control body weight for a hale and hearty life.

Conflict of Interest

Nil

Acknowledgment

The authors thank all the participants of the study for their contribution in data collection.

REFERENCES

[1] Vinayaga Murthy, Akshaya & V, Suganthi & Chandrasekar, Shobana & Usharani, Boopathy & Durairaj, Rohini. (2023). Stress Levels and Sleep Pattern of Industrial Workers. Journal of Advanced Zoology. 44. 3109-3116. 10.17762/jaz.v44iS5.2393.

[2] Khanna, D., Peltzer, C., Kahar, P., & Parmar, M. S. (2022). Body mass index (BMI): a screening tool analysis. *Cureus*, *Volume 14* , Issue 2.

[3] World Health Organization (WHO). Obesity and overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

[4] Neeland IJ, Ross R, Després JP, Matsuzawa Y, Yamashita S, Shai I, Seidell J, Magni P, Santos RD, Arsenault B, Cuevas A, Hu FB, Griffin B, Zambon A, Barter P, Fruchart JC, Eckel RH; International Atherosclerosis Society; International Chair on Cardiometabolic Risk Working Group on Visceral Obesity. Visceral and ectopic fat, atherosclerosis, and cardiometabolic disease: a position statement. Lancet Diabetes Endocrinol. 2019 Sep;7(9):715-725.

[5] Patel, A. R., Shah, R. M., & Mehta, K. (2022). Waist-to-hip ratio and cardiovascular risk factors: A cross-sectional study. American Journal of Preventive Medicine, Volume 62 Issue 3, Pp - 301-307.

[6] Danesh-Shakiba, M., Poorolajal, J., & Alirezaei, P. (2020). Androgenetic alopecia: relationship to anthropometric indices, blood pressure and life-style habits. *Clinical, cosmetic and investigational dermatology*, 137-143.

[7] Bi J, Huang Y, Xiao Y, et al Association of lifestyle factors and suboptimal health status: a cross-sectional study of Chinese students BMJ Open 2014;4:e005156.

[8] National Research Council. *Recognition and Alleivation of Distress in Laboratory Animals*; National Academies Press: Washington, DC, USA, 2008; p. 2.

[9] Wunsch K, Kasten N, Fuchs R. The effect of physical activity on sleep quality, well-being, and affect in academic stress periods. Nat Sci Sleep. 2017;9:117-126

[10] Nogueira, P. J., de Oliveira, P. A., & Machado, M. F. (2022). Impact of the COVID-19 pandemic on body weight and composition in industrial workers: A longitudinal study. BMC Public Health, Volume 22, Issue 1 Pp -677.

[11] Mamalaki, E., Anastasiou, C. A., Ntanasi, E., Tsapanou, A., Kosmidis, M. H., Dardiotis, E., . & Yannakoulia, M. (2018). Associations between the mediterranean diet and sleep in older adults: Results from the hellenic longitudinal investigation of aging and diet study. *Geriatrics & gerontology international*, *18*(11), 1543-1548.

[12] Park, S. H., & Lee, C. Y. (2020). The relationship between anthropometric indices and body composition in adults. Korean Journal of Community Nutrition, Volume 25, Issue 1, pp - 32-40.

[13] Obaje, S. G., Danborno, B., Akuyam, S. A., & Timbuak, J. A. (2023). Anthropometric measurements as nutritional indicators and association with sociodemographic factors among the Idoma ethnic group in Nigeria. *Precision Nutrition*, *Volume 2*, Issue -3 e00048.

[14] Tobias DK, Pan A, Jackson CL, O'Reilly EJ, Ding EL, Willett WC, et al. (2014) Body-mass index and mortality among adults with incident type 2 diabetes. N Engl J Med. Volume 370: 233 pp –44.

[15] Mahadevan, S., Ali, I. (2016) Is body mass index a good indicator of obesity?. *Int J Diabetes Dev Ctries* Volume 36, pp - 140–142

[16] Browning LM, Hsieh SD, Ashwell M. (2010) A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0·5 could be a suitable global boundary value. Nutr Res Rev. 2010 Dec;23(2):247-69.

[17] Mahan, L. Kathleen and Janice L Raymond, (2017), 14th edition, Krauses food and nutrition care process, Elsevier

[18] Aswathappa J, Garg S, Kutty K, Shankar V. Neck circumference as an anthropometric measure of obesity in diabetics. N Am J Med Sci. 2013 Jan; Volume 5, Issue 1, pp -28-31.

[19] Hingorjo MR, Qureshi MA, Mehdi A. Neck circumference as a useful marker of obesity: a comparison with body mass index and waist circumference. J Pak Med Assoc. 2012 Jan; Volume 62, Issue - 136-40.

[20] Kaur, P., Singh, A., & Minhas, S. (2018). Correlation between Body Mass Index and Waist-to-Hip Ratio with Blood Pressure in Young Adult Females. Journal of Clinical and Diagnostic Research, Volume 12, Issue 1, pp – 10 – 13.

[21] Jones, D. A., Wilson, A. M., & Brown, C. M. (2021). Comparative analysis of waist and hip circumferences between male and female adults. *Nutrition & Metabolism*, Volume 18 Issue (1), pp -1-9.

[22] Katzmarzyk, P. T., Janssen, I., & Ross, R. (2021). Body mass index, waist circumference, and health risk. *Journal of Clinical Endocrinology & Metabolism*, Volume 106 Issue 5 e1987-e1996.

[23] Liu, C., Cheng, K. Y. K., Tong, X., Cheung, W. H., Chow, S. K. H., Law, S. W., & Wong, R. M. Y. (2023). The role of obesity in sarcopenia and the optimal body composition to prevent against sarcopenia and obesity. Frontiers in Endocrinology, Volume 14, 1077255.

[24] Gopalakrishnan, S., Ganeshkumar, P., & Arvind, S. (2021). Body composition and health status among industrial workers. Journal of Occupational Health, Volume 63, Issue 5, e12245.

[25] Bouillon-Minois, J. B., Trousselard, M., Thivel, D., Gordon, B. A., Schmidt, J., Moustafa, F., ... & Dutheil, F. (2021). Ghrelin as a biomarker of stress: A systematic review and meta-analysis. *Nutrients*, *Volume 13*, Issue 3, pp - 784.

[26] Hamurcu P. Impact of Perceived Body Weight on Depression, Anxiety and Stress Levels of Young Adults in Turkey. Iran J Public Health. (2023) Mar; Volume 52, Issue 3, pp- 603-611.

[27] Smith, J. P., Anderson, B. R., & Thompson, R. A. (2021). Perceived stress and body mass index among industrial workers: A cross-sectional study. Journal of Occupational Health Volume 63 Issue 3, Pp - 210-219.

[28] Liu, T. Z., Xu, C., Rota, M., Cai, H., Zhang, C., Shi, M. J., & Sun, X. (2017). Sleep duration and risk of all-cause mortality: a flexible, non-linear, meta-regression of 40 prospective cohort studies. *Sleep medicine reviews*, *Volume 32*, 28-36.

[29] Tse, L. A., Wang, C., Rangarajan, S., Liu, Z., Teo, K., Yusufali, A., & Yusuf, S. (2021). Timing and length of nocturnal sleep and daytime napping and associations with obesity types in high-, middle-, and low-income countries. *JAMA network open*, *Volume 4*, Issue 6, e2113775-e2113775.

[30] Lee, H., & Kim, Y. S. (2021). The impact of sleep quality on metabolic health: A comprehensive review. Sleep Medicine Reviews, Volume 55, Issue 1, pp - 373

[31] Rogers, E. M., Banks, N. F., & Jenkins, N. D. (2024). The effects of sleep disruption on metabolism, hunger, and satiety, and the influence of psychosocial stress and exercise: A narrative review. Diabetes/metabolism research and reviews, Volume 40, Issue 2 e3667.

[32] Martinez, S. M., Flores, M. L., & Garcia, J. M. (2021). Combined effects of stress and sleep quality on body mass index in industrial workers. International Journal of Environmental Research and Public Health, Volume 18, Issue 4, Pp -1952.