The Scientific Temper
JULY 2026 Vol. 17 (7): 6512-6519
ISSN: 0976-8653, E-ISSN: 2231-6396
DOI: 10.58414/SCIENTIFICTEMPER.2026.17.7.2470
https://scientifictemper.com/

RESEARCH ARTICLE

Association Between Work Efficiency and Body Mass Index Among Women Workers in the Foundry Industry of Ajmer (Rajasthan)

CHHAVI ANUPAM[*1], PROF. MEENAKSHI GAHLOT[*2]

[*1,2] *SPC Govt. College, Ajmer, Rajasthan, India*

Corresponding author: Anupamchhavi25@gmail.com

ABSTRACT

This paper evaluates the association between body mass index (BMI) and work efficiency among female workers in the foundry industry of Ajmer, Rajasthan. 30 employees aged between 20 and 55 years were surveyed using the Nordic Standard Questionnaire to collect anthropometric data and workplace observations. From the data gathered, results show the mean work efficiency of workers were 55.08%, and the mean BMI was 22.77 kg/m². According to Pearson's correlation, Statistical analysis showed a negative association ($r = -0.47$, $p = 0.008$), indicating that higher BMI is related to low work efficiency. Workers with underweight and obesity were less efficient compared to those with a normal BMI. This study explains the significance of a normal BMI range for optimal work performance and ergonomic health in foundry industries.

Keywords: *Body Mass Index, work efficiency, foundry industry, Anthropometry, women workers, lethargy*

INTRODUCTION

The foundry industry of India is established and with the production of about 7.44m tonnes over various level which makes them the second-largest producer of castings. Since maximum work is done manually, it causes health hazards and problems for workers in India (Rajasthan). Manual handling is done with unsupported movement of objects, frequent involvement of awkward and twisted postures which leads to musculoskeletal disorders. Due to several economic restrictions, many casting factories in India are small and medium-sized, depending largely on manual work, which lacks advanced technological tools. Factory employees are at high risk of having work-related musculoskeletal diseases.

In the Ajmer district of Rajasthan, there are fewer foundry industries, yet these sectors are growing because they rely heavily on manual labour for tasks such as preparing moulds, pouring molten metal, and performing repetitive work, often in uncomfortable postures and in heat. Participation of women workers in heavy and manufacturing industries has grown. Women's involvement in manufacturing and heavy industries has grown, driven by economic pressures, expansion of the workforce, and gender equity initiatives. For ages, Indian women have participated in home-based production to earn income due to domestic duties. However, they remain underappreciated in physically demanding industrial sectors, and workplace environments frequently fail to address their specific needs. As many studies suggest, industrial work areas are commonly designed for men based on their anthropometric characteristics. For female workers, such gender-insensitive designs can create ergonomic risks, discomfort, and may lead to musculoskeletal problems. This research examines the association between body mass index (BMI) and work efficiency among female workers in the foundry industry. By analysing BMI along with work performance, the study tries to identify and uncover health problems, such as musculoskeletal pain.

Received: 12th June, 2026 **Accepted: 3rd July, 2026** **Published: 28th July, 2026**

METHODOLOGY

Study Area

A survey was conducted on female workers working in the foundry industry in the Ajmer district of Rajasthan, India. It is centrally located and covers an area of about 8,481 km². The study mainly focuses on the Palra Industrial region, that hosts most of the city's foundries. Geographical coordinates (latitudes 25° 38' 48.84"N and 26° 58' 42.97"N, and longitudes 73° 53' 48.20"E and 75° 21' 22.73"E) and specific area measurements have been consolidated for brevity.

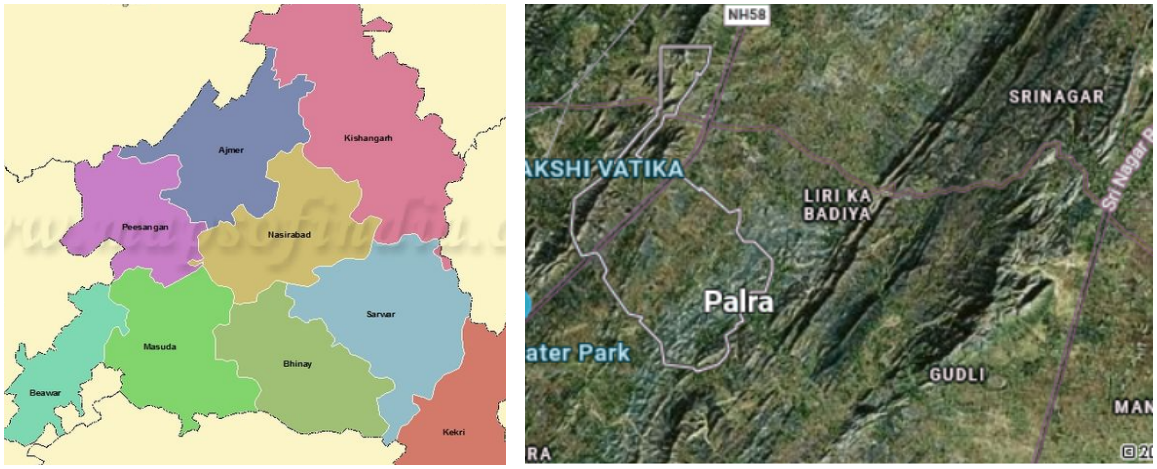

Figure 1,2: Area of the research study in Ajmer District (Rajasthan) (Source: Google Maps)

Study design and sample selection

To calculate the distribution of BMI among female foundry workers, a cross-sectional observational study was conducted. Based on previous research, the study analysed how BMI may affect the work efficiency of female labour and investigated the association between BMI and productivity of work. A pilot study was executed in different sectors; finally, the foundry industry was selected for further evaluation. To ensure the study, a simple random convenience sampling method was used to recruit 30 female workers aged between 20 and 55 years, with their consent obtained in advance. Male and female workers younger than 20 or older than 55 were excluded from the study.

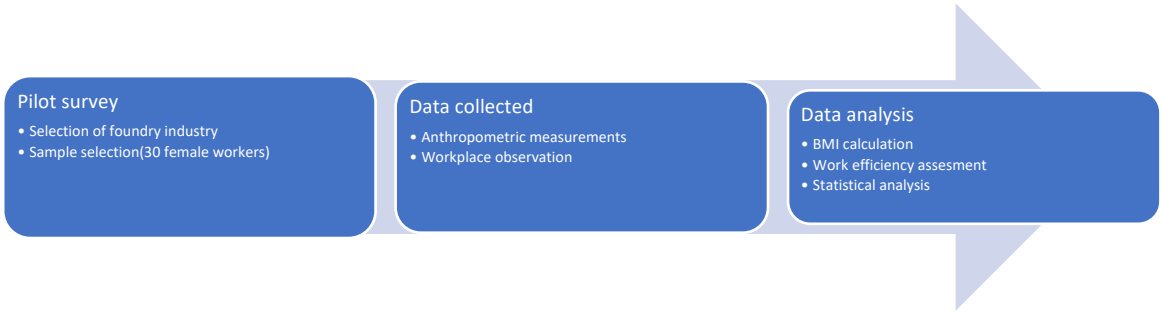

Figure 3: Research methodology flow chart

DATA COLLECTION

Data were collected using the Nordic standard questionnaire (Kuornik et al., 1987), along with anthropometric measurements and workplace observations. The first part of the questionnaire covered personal information such as age, height, weight, and then calculated BMI (underweight as <18.5, normal as 18.5-24.9, overweight as 25-29.9, obese as ≥30). The second part consists of workplace factors like working hours, rest periods, knowledge of the job, musculoskeletal discomfort, and work experience, as reported by the participants.

Figure 4: Data collected from the foundry industry

DATA ANALYSIS

The association between BMI and work efficiency was assessed using Pearson's correlation coefficient, accompanied by mean, standard deviation, and work efficiency of female workers. To evaluate the association between BMI and productivity, linear regression analysis was used.

Body Mass Index Distribution

The study shows the distribution of body mass index, derived from data in Table 1 obtained through anthropometric measurements. These data were analysed to assess the health status of female workers within the foundry industry, utilising the World Health Organisation (WHO) Body Mass Index scale. The average height of the participants was 1.55 meters, and the average weight was 54.98 kilograms. The mean BMI was 23.3 kg/m², with a standard deviation. This is additionally illustrated by a pie chart showing the distribution of BMIs. The BMI was calculated using the formula: BMI = kg/m².

Table 1: Body Mass Index distribution among female workers

S.No.	Name	Height	Weight	BMI	STATUS
1	Seeta	1.55	61.2	25.47346514	OVERWEIGHT
2	Jamta	1.67	63.4	22.73297716	NORMAL
3	Meera	1.49	40.3	18.15233548	UNDERWEIGHT
4	Nani Bai	1.52	56.5	24.45463989	NORMAL
5	Kamla	1.53	55.4	23.66611132	NORMAL
6	Seema	1.49	68.9	31.03463808	OBESE
7	Rekha	1.58	71.3	28.56112802	OVERWEIGHT
8	Roopi	1.67	50.6	18.14335401	UNDERWEIGHT
9	Maya	1.58	71.3	28.56112802	OVERWEIGHT
10	sushma	1.61	69.8	26.92797346	OVERWEIGHT
11	Anita	1.24	41.4	26.92507804	OVERWEIGHT
12	Manju	1.55	61.2	25.47346514	OVERWEIGHT
13	Ganga	1.43	43.5	21.27243386	NORMAL
14	Jamna	1.49	58.7	26.44025044	OVERWEIGHT
15	Sharda	1.67	47.2	16.92423536	UNDERWEIGHT
16	Kamla	1.52	77.4	33.50069252	OBESE
17	janta	1.61	44.3	17.09039003	UNDERWEIGHT
18	Laxmi	1.55	42.2	17.56503642	UNDERWEIGHT
19	Sheela	1.52	46.5	20.12638504	NORMAL
20	Panchi	1.52	49.5	21.4248615	NORMAL
21	Anju	1.54	47.6	20.07083825	NORMAL
22	Deva devi	1.51	68.6	30.08639972	OBESE
23	Sita	1.57	53.2	21.58302568	NORMAL
24	Sharda	1.62	68.3	26.02499619	OVERWEIGHT
25	Sanju	1.58	44.8	17.94584201	UNDERWEIGHT
26	Bhanwari devi	1.61	48.9	18.86501292	NORMAL
27	Prem	1.59	45.7	18.07681658	UNDERWEIGHT
28	Anita	1.56	50.3	20.66896778	NORMAL
29	Mena	1.51	45.6	19.99912285	NORMAL
30	Puspa	1.59	66.4	26.26478383	OVERWEIGHT

Variable	Average	Mean
Height(m)	1.55	1.55
Weight(kg)	54.98	54.01
BMI (kg/m²)	22.90	22.7

From Table 1, the data were then analysed and shown in Pie Chart 1, indicating that of 30 female workers, 8 (26.66) were underweight, 10 (33.33) were normal, 9 (30) were overweight, and 3 (10) were obese, as calculated using calculator.net.

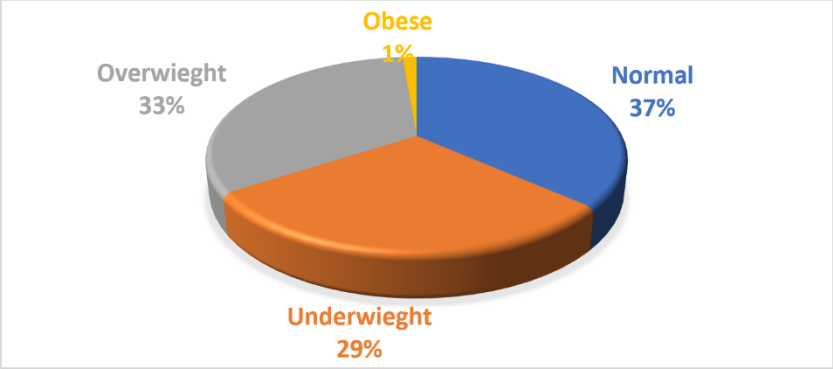

Figure 5: Pie chart showing the distribution of BMI categories (%) among female workers.

Work efficiency assessment

30 female workers were evaluated based on mould output over a one-hour period. The maximum observed output in one hour was 18 moulds, which was considered the expected amount. This was then calculated using the formula: Efficiency (%) = (Actual Output ÷ Expected Output) × 100, as explained in Table 2.

The Pearson correlation (r) formula is: $r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \cdot \sum(Y_i - \bar{Y})^2}}$

Where: X_i = BMI values; Y_i = Work efficiency (%); = means of BMI and work output

And the statistical significance (p-value): $t = r \cdot \sqrt{\frac{n-2}{1-r^2}}$; Where, n=30.

Table 2: Distribution of work efficiency among female workers

S.No.	Name	No. of moulds	Work efficiency (%)	BMI
1	Seeta	13	72.22	25.47
2	Jamta	12	66.66	22.73
3	Meera	7	38.88	18.15
4	Nani bai	9	50	24.45
5	Kamla	15	83.33	23.66
6	Seema	7	38.33	31.03
7	Rekha	11	61.11	28.56
8	Roopi	8	44.44	18.14
9	Maya	12	66.66	28.56
10	Sushma	9	50	26.92
11	Anita	11	61.11	26.92
12	Manju	12	66.66	25.47
13	Ganga	14	77.77	21.27
14	Jamna	10	55.55	26.44
15	Sharda	6	33.33	16.92
16	Kamla	7	38.88	33.5
17	Janta	7	38.88	17.09
18	Laxmi	7	38.88	20.12
19	Sheela	13	72.22	21.42

20	Panchi	9	50	20.07
21	Anju	13	72.22	30.08
22	Deva devi	6	33.33	21.58
23	Sita	12	66.66	26.02
24	Sharda	11	61.11	17.94
25	Sanju	7	38.88	18.86
26	Bhanwari devi	14	77.77	18.07
27	Prem	7	38.88	20.66
28	Anita	11	61.11	17.56
29	Mena	14	77.77	19.99
30	Puspa	9	50	26.26

Data from Table 2 shows the work efficiency of 30 female workers, categorised as good (65<), moderate (40-64), and low (<40). The analysis showed that 11 workers exhibited high work efficiency, 10 moderate, and 9 low. This is further shown in Pie Chart 2.

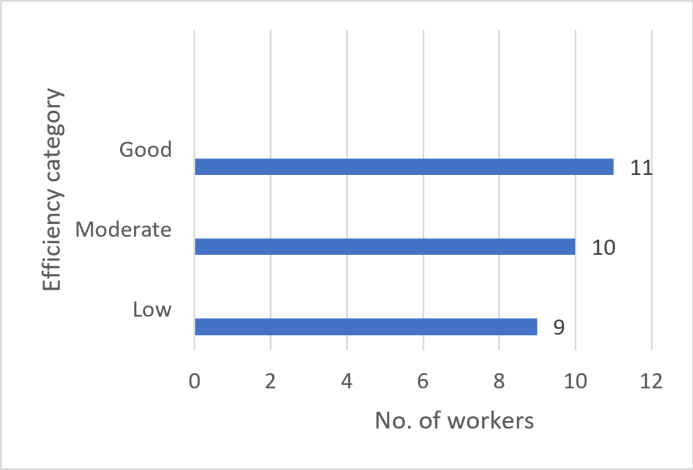

Figure 6: Graph showing the distribution of Work Efficiency among female workers

RESULT

The study displays an association link between Body Mass Index (BMI) and efficiency of female workers working in the foundry industry. As specified in Table 1, according to the WHO BMI classification, 8 workers were underweight, 10 had normal BMI, 9 were overweight, and 3 were obese among 30 female workers. The mean BMI of female workers was 23.3, varying from 16.9 to 31, suggesting an overall normal nutritional level of workers. The data in Table 2 shows a positive association between BMI and working efficiency, as workers with a normal BMI had the highest efficiency, while underweight and obese workers had the lowest efficiency. Lower efficiency among underweight workers is due to reduced physical strength and inadequate diet. Similarly, lower efficiency of work in obese workers may result in lethargy, exhaustion, and tiredness. The average work efficiency obtained from data above was 54.7%, with the highest at 83.33% (15 moulds/hour) and the lowest at 33.33% (6 moulds/hour). This study suggests that keeping an optimal BMI may benefit work performance in labour-intensive occupations. The results are justified by previous studies done, indicating the nutritional value of a worker strongly affects occupational productivity and are prone to musculoskeletal discomfort.

Relationship between BMI and work efficiency

The mean BMI was 23.3 kg/m2 (SD 5.38). The mean work efficiency was 54.7% (SD 14.53). For the statistical analysis, we used Pearson's r = -0.47 (p = 0.008) and a regression slope of -0.212.

Statistic value	Mean BMI	SD BMI	Mean Work Efficiency	SD Work Efficiency	Pearson (r)	p-value	Regression slope
Value	23.3	5.38	54.7	14.53	-0.47	0.008	-0.212

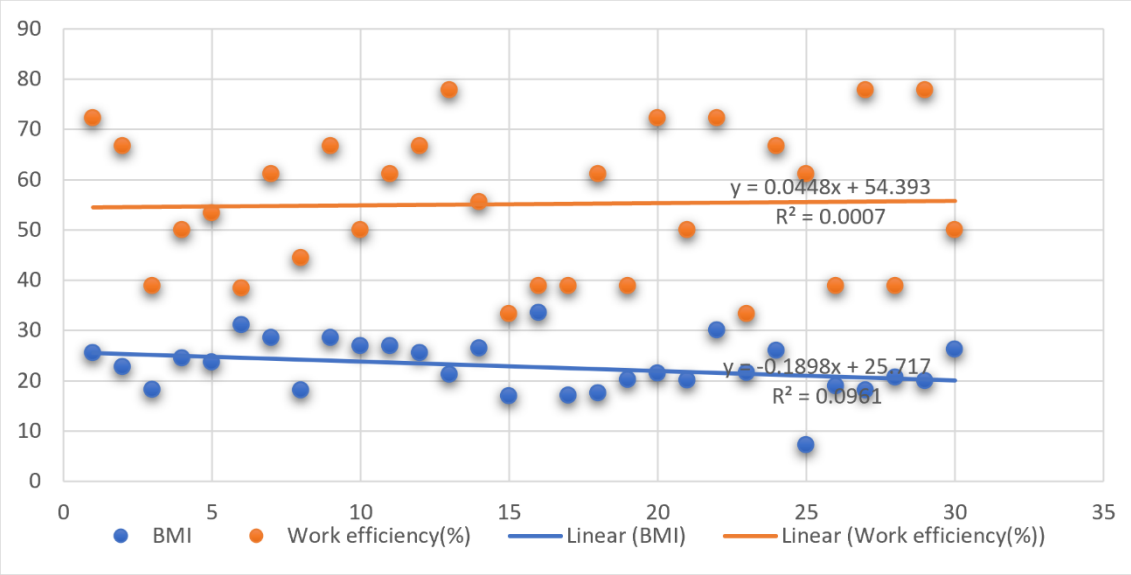

Figure 7: Scatter plot illustrates the relationship between BMI and Work efficiency with regression line

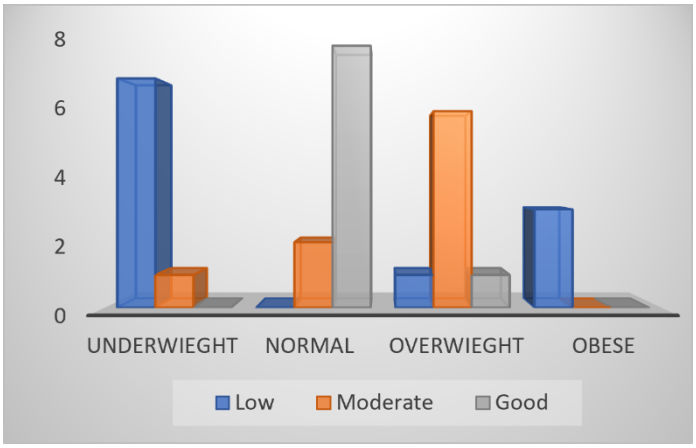

Figure 8: The graph shows the distribution of work efficiency levels across BMI categories

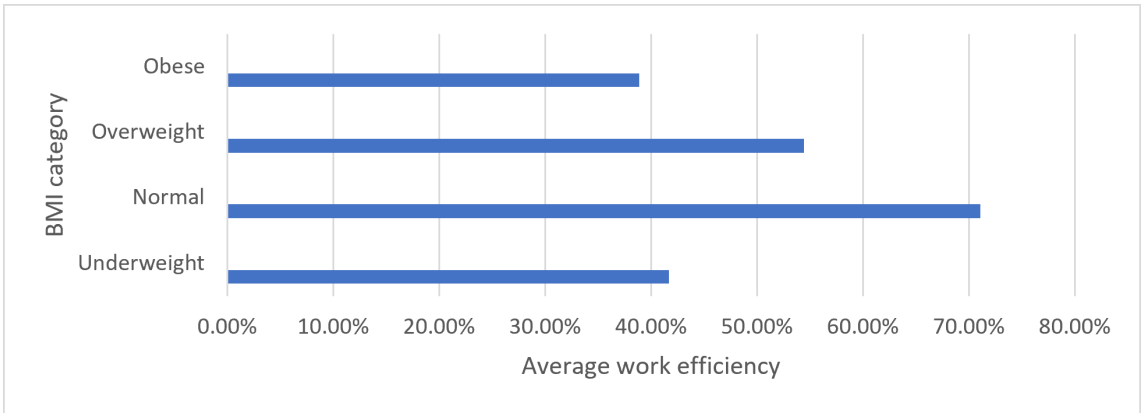

Figure 9: Graph showing the average work efficiency corresponding to each BMI category

DISCUSSION

From the above figures, we observe that a moderate negative relationship (r = -0.47), which means that as BMI increases, the work efficiency of workers tends to decline steadily. Also, the p-value of 0.008 implies the conclusion that this result is statistically significant ($p < 0.01$). Overall,

the data suggest that BMI could alter the efficiency of female foundry workers. In other words, those with a normal BMI were usually more productive than women who were underweight or obese, even if the relationship wasn't extremely strong. Physical work capacity seems to depend quite a bit on someone's nutritional situation, more than you might first assume. A person who is underweight may experience reduced muscle tone, lower energy, and reduced stamina, which can gradually undermine productivity. Still, on the flip side, obesity can bring on drowsiness, slower movement, and extra bodily stress, especially when the job is intense. Therefore, these results are consistent with previously done research linking dietary well-being to physical capacity and work outcomes. Workers who are underweight and obese have been described as less productive, due to more occupational tiredness and show some musculoskeletal discomfort. Since foundry work is physically demanding, having a healthy BMI range may help females perform the job with better consistency and feel more comfortable in their work areas. This research examined the association between Body Mass Index and work efficiency among female employees in foundry factories within Ajmer district, Rajasthan. Women with a normal BMI range generally showed higher work efficiency than underweight or obese women, even though the correlation was weak.

CONCLUSION

This study examined the association between Body Mass Index and work efficiency among women workers employed in the foundry industry in Ajmer district, Rajasthan. From what was observed, those with a normal BMI tended to show better work efficiency when compared with workers who were underweight or obese. More than a few women in the normal BMI group also showed good productivity, while underweight and obese workers were mostly found in the less efficient categories. Even though the correlation between BMI and work efficiency was statistically significant and moderate, we observed the pattern that maintaining an ideal nutritional status support good work performance in labour-oriented factories. Overall, the study emphasises the need for health programmes to be organised in factories, and ergonomic adjustments to improve health and productivity among women in the foundry industry.

ACKNOWLEDGEMENT

The author expresses heartfelt gratitude to the owners, management, and especially the female workers in the foundry industries of Ajmer, who cooperated throughout the research process. The author further acknowledges Professor Meenakshi Gahlot, Department of Zoology, SPC Government College, Ajmer, for her valuable guidance, encouragement, and support during the course of the research.

Source of support: None
Conflict of Interest: None

REFERENCES

Díez Fernández, A., Sánchez López, M., Nieto, J. A., González García, A., Miota Ibarra, J., Ortiz Galeano, I., & Martínez Vizcaíno, V. J. A. (2017). Relationship between cardiorespiratory fitness and blood pressure in young adults: A mediation analysis of body composition. Hypertension Research. https://doi.org/10.1038/hr.2016.177

Kataria, K. K., Sharma, M., Kant, S., Suri, N. M., & Luthra, S. (2022). Analyzing musculoskeletal risk prevalence among workers in developing countries: an analysis of small-scale cast-iron foundries in India. *Archives of Environmental & Occupational Health*, *77*(6), 486-503.

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G., & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 18(3), 233–237.

PEPPLE, E. F., Amadi, E. S., Otike-Odibi, B., & Bell-Gam, H. I. .. (2022). Body Mass Index (BMI) and Cutaneous Lesions among the Elderly Patients in a Tertiary Hospital in Rivers State. European Journal of Nutrition & Food Safety. https://doi.org/10.9734/ejnfs/2022/v14i1030535

Roy, A., Chakrabarti, G., & Das, A. (2015). A study on the pertinent problems faced by the metal and iron casting foundry units in India. *International Journal of Indian Culture and Business Management*, *10*(1), 60-83.

Sharma, R., Singh, R.: Work-related musculoskeletal disorders, job stressors and gender responses in foundry industry. Int. J. Occup. Safety Ergon. 20(2), 363–373 (2014)

Singh, S., Ahlawat, S., Pandya, S., Prafull, B.: Anthropometric measurements and body composition parameters of farm women in North Gujarat. J. Ergon. 3 (2013)

Subramani, A., & Thangavelu, R. B. (2026). Ergonomic challenges and musculoskeletal disorder among female CNC machine operators in the Indian manufacturing industry: An SDG-aligned approach. *WORK*, 10519815261431804.

World Health Organization (WHO). (2000). *Obesity: Preventing and Managing the Global Epidemic*. WHO Technical Report Series No. 894. Geneva: World Health Organization.

Zhang, L., Sun, Y., Zhao, Y., Wu, X., & Han, X. (2025). Relationship Between Fat-to-Muscle

Ratio and Nonalcoholic Fatty Liver Disease in Middle-Aged and Older Adults with Type 2 Diabetes: Cross-Sectional Study. Diabetes, Metabolic Syndrome and Obesity, 18, 2067-2076.