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Indian Journal of Aerospace Medicine

Article in Press

Original Article

Anthropometric surveillance and obesity prevalence in Armed Force personnel: A cross-sectional study

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Received: 12 August 2025
Accepted: 17 October 2025
EPub Ahead of Print: 20 November 2025
Published:

DOI
10.25259/IJASM_23_2025

Quick Response Code:

ABSTRACT

Objectives: The increasing prevalence of overweight and obesity among Indian adults is now a recognized health concern. The concern is equally alarming in Armed Forces personnel. Assessment of the prevalence of overweight and obesity in a representative sample of serving Armed Forces personnel and its correlation with age, rank, and abdominal girth was the desired objective.

Material and Methods: A cross-sectional point prevalence study was conducted in July 2023 across nine data collection centers. Using a convenient sampling technique, anthropometric data, including height, weight, and abdominal girth at the umbilicus, were collected from 1388 serving personnel. BMI was calculated, and data were stratified by age and rank.

Results: Of the 1388 participants, 70.24% were within the normal permissible weight range. The prevalence of overweight and obesity combined was 29.8%, with officers showing the highest rates. Statistically significant correlations were found between body mass index (BMI) and age ($P = 0.024998$), as well as abdominal girth and both age ($P < 0.00001$) and BMI ($P < 0.00001$). Rank-based BMI differences were not statistically significant.

Conclusion: Substantial portions of serving personnel are either overweight or obese, with a clear association to age and abdominal girth. These findings underscore the need for targeted health and fitness interventions to preserve the health of the Armed Forces personnel.

Keywords: Abdominal girth, Armed Forces, Body mass index, Obesity, Overweight

INTRODUCTION

Obesity has emerged as a global health challenge, with current estimates from the National Centre for Disease Control indicating that approximately 880 million adults are affected worldwide.[1] Within the Indian context, a large-scale study involving over 100,000 adults reported a striking obesity prevalence of 40.3%.[2]

This growing health concern is not confined to the civilian population alone. A study among active Indian Army personnel reported obesity rates nearing 30% across all ranks.[3] Similarly, a 2011 analysis of the Indian Air Force (IAF) personnel from five distinct geographic regions revealed a progressive increase in overweight and pre-obesity with advancing age, as measured by body mass index (BMI).[4]

Recognizing the implications of these trends on operational readiness and long-term health, the Indian Armed Forces have implemented stricter fitness protocols, including revised

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promotion policies and elevated benchmarks in physical fitness assessments.[5] These measures aim to cultivate a robust and mission-ready force. Despite the above, there remains a notable gap in the literature concerning the direct correlation between rank, age, and anthropometric measures among Armed Forces personnel. In this context, it becomes pertinent to investigate how variables such as age and rank influence key health indicators such as weight, BMI, and abdominal girth, among service members. This study seeks to bridge that gap by systematically evaluating these parameters and identifying contributing factors, to support targeted interventions and effective health policies within the Armed Forces. The unique demographic structure of the Armed Forces, characterized by a standardized lifestyle and controlled environment across geographic locations, allows for a relatively uniform health profile, potentially making data from one geographical area broadly representative of others.

MATERIAL AND METHODS

Study design and setting

This study was conducted as a cross-sectional prevalence analysis, focused on anthropometric parameters among serving personnel from a geographical area. Data collection took place across nine strategically selected data centers representing diverse geographic locations. To ensure accuracy and reliability, the study was conducted over a three-day window, minimizing variability in individual weight fluctuations due to seasonal or environmental factors and also measurement bias.

Sampling

No previous similar studies were found to provide the prevalence of the anthropometric measurements that have been studied in the scope of this paper, especially among the uniformed personnel who are included in the sample size of this study. Based on the National Family Health Survey 5 (NFHS-5) data, an initial sample size of 161 was estimated at 95% confidence, but deemed inadequate for actual reflection of disease burden as well as for analysis. To that effect, using Slovin's formula, a minimum of 388 was calculated from the total strength of 12,899 using snowballing technique of non-random sampling. However, to ensure robustness, 1,388 personnel (10.8%) were sampled, i.e., every 10th personnel in the pre-established 09 data centers at various points in the study area were studied anthropometrically and included in the study. Data were stratified by service rank to maintain representativeness across all strata.

Anthropometric measurements

The sampling strategy was non-random due to service constraints. Standardized methods were used for anthropometric measurements;[6,7] weight by digital scale, height by wall-mounted stadiometer, and abdominal girth at the umbilicus by standard measuring tape. BMI was calculated and categorized as per the World Health Organization guidelines. All measurements were conducted by trained personnel, ensuring data integrity and reducing variability.

Data analysis and statistical methods

Data analysis was performed using Microsoft Excel, IBM Statistical Package for the Social Sciences Statistics, and SocSciStatistics.com, examining central tendencies, correlations, and inferential statistics.

Ethical considerations

The study maintained strict confidentiality regarding individual health records. Data were collected anonymously, ensuring that participants' personal identifiers were not linked to BMI assessments.

RESULTS

Of the 12,899 personnel stationed in the selected study area across nine data collection centers, a representative sample of 1,388 (10.8%) was assessed for body weight, height, and abdominal girth. Among participants, 70.24% met the service's permissible weight standards. An additional 28.46% exceeded limits by 10–20% and 1.30% surpassed them by over 20%. The average height, weight, and abdominal girth were 171.4 cm, 71.2 kg, and 84.9 cm, respectively.

BMI

The mean BMI was 24.18 kg/m^2. The distribution as per BMI classification is depicted in Figure 1. A significant majority (70.17%) fell within the normal BMI range (18.5–24.9 kg/m^2). 21.90% were in Class I Overweight (BMI 25–27.9) and 6.56% were in Class II Overweight (BMI 28–29.9). Obesity (BMI ≥30 kg/m^2)was present in 1.3% with a significant distribution (χ^2 = 151.0566, P < 0.00001). Only a very small fraction (0.07%) was in the underweight category (BMI <18.5kg/m^2).

The only underweight individual was a non-combatant. Officers had the highest prevalence in Overweight-I (26.12%), Overweight-II (9.70%), and obesity (1.49%). The age-wise distribution of overweight and obese is given in

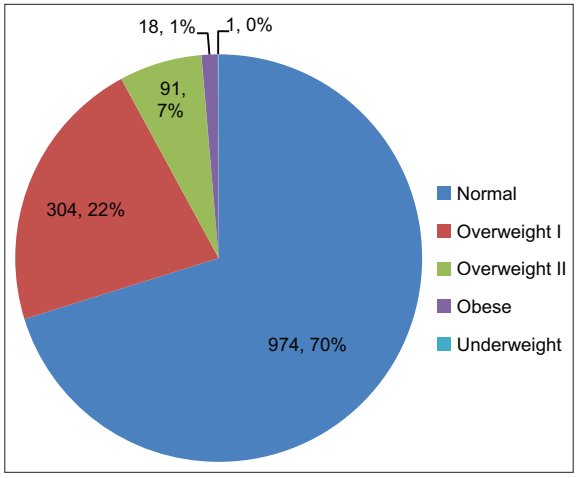

Figure 1: Proportional distribution of the study population as per their body mass index status.

Table 1. Most participants were aged 28–37 years, with this group also showing the highest prevalence of Overweight-I (54.93%) and Overweight-II (50.55%). For obesity, the 28–37 years of age group remained most affected (61.1%), followed by those over 47 years (22.2%).

Abdominal girth distribution

The average abdominal girth was 84.9 cm. In the <85 cm cohort, 73.99% were under 28 years. Among those with larger girths (86–105 cm), the highest prevalence was in the age group more than 47 years. The largest girth group (>105 cm) included nine participants, mostly aged 38 and above [Figure 2].

BMI and abdominal girth trends

Obese individuals were predominantly found in the >96 cm girth range, while Overweight I and II were concentrated in the 86–95 cm cohort. Most with normal BMI (70.94%) had a girth under 85 cm, confirming a strong BMI-girth correlation. Girth >105 cm was found in one officer and two non-combatants. Analysis also showed <85 cm was most prevalent among non-combatants (58.43%), followed by other ranks (57.14%) [Tables 2 and 3].

The study found a mean BMI of 24.18 ± 1.02kg/m² with a Z-score of −1.960, suggesting that BMI values deviate by ± 1.20kg/m². The negative Z-score indicates a significant portion of the population had a BMI below 24.18, skewing towards a healthier category. This trend was statistically significant at a 95% confidence level. Across ranks, the study found a mean BMI of 24.18 ± 0.36 kg/m² with a Z-score of 0, indicating no significant BMI variation across ranks, confirming statistical insignificance at a 95% confidence level [Table 4].

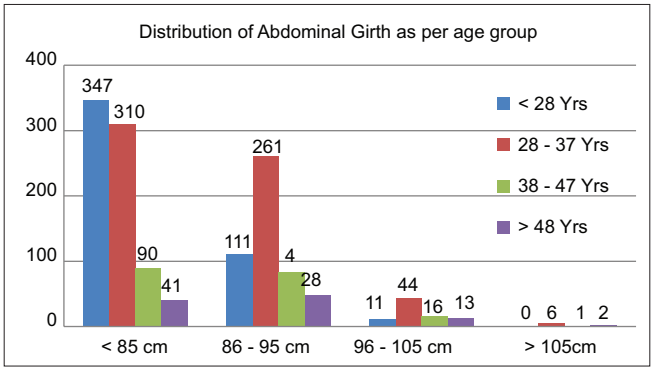

Figure 2: Age wise distribution of abdominal girth at umbilicus.

Table 1: Age-wise distribution of overweight and obese study personnel.

Age (years)	Overweight–I (*n*=304)	Overweight–II (*n*=91)	Obese (*n*=18)	Total (*n*=413)
<28	39	9	0	48
28–37	167	46	11	224
38–47	76	24	3	103
>47	22	12	4	38

The study found a progressive increase in abdominal girth with age, averaging 84.94 ± 2.86 cm with a Z-score of 11.2 ($P < 0.00001$). This confirms a statistical significance at 95% confidence level, supporting a measurable link between age, abdominal girth, and BMI. By rank, the average girth remained 84.94 ± 0.85 cm with a Z-score of 0 ($P < 0.05$), indicating that rank has no significant impact on abdominal girth [Table 5]. A progressive increase in abdominal girth was also observed with rising BMI levels. The average girth was 84.94 ± 8.13 cm, indicating notable variation by BMI classification. A Z-score of 15.97776 ($P < 0.00001$) confirms statistical significance at 95% confidence level, validating the link between higher BMI and increased abdominal girth.

DISCUSSION

The present cross-sectional point prevalence study of Armed Forces personnel provides valuable insights into the prevalence of overweight and obesity among serving personnel, and its correlation with rank, age, and abdominal girth. Although the study employed non-random convenient sampling, its credibility is strengthened by the large sample size (1388 participants) and multi-data collection centers involvement, despite limitations in generalizability.

The findings bring forth both reassuring and cautionary trends that can inform policy and practice in the Armed Forces. Among 1,388 personnel assessed, 70.24% were within the normal weight range, and only 1.3% exceeded

Table 2: Distribution of the study population as per their BMI and abdominal girth at the umbilicus.

Abdominal girth (cm)	Under-weight	Normal	Overweight I	Overweight II	Obese	Total
<85	1	691	74	21	1	788
86–95	0	272	185	47	3	507
96–105	0	11	42	21	10	84
>105	0	0	3	2	4	9
Total	1	974	304	91	18	1388

BMI: Body mass index

Table 3: Rank-wise distribution of the study population as per their abdominal girth at the umbilicus.

Umbilical girth (cm)	Officers	Other ranks	Non-combatants	Total
<85	68	564	156	788
86–95	54	358	95	507
96–105	11	59	14	84
>105	1	6	2	9
Total	134	987	267	1388

Table 4: Distribution of mean BMI across various age groups and ranks.

Age (years)	Mean±SD (kg/m2)	Rank	Mean±SD (kg/m2)
<28	22.96±1.22	Officers	24.56±0.38
28–37	24.64±0.46	Other ranks	24.13±0.05
38–47	25.31±1.13	Non-combatants	23.85±0.33
>47	24.84±0.66	-	-
Z score: 1.960, *P*=0.024998		Z score: 0, *P*=0.5	

BMI: Body mass index, SD: Standard deviation

Table 5: Distribution of the mean abdominal girth at the umbilicus as per age groups and BMI.

Age (years)	Mean±SD (cm)	BMI	Mean±SD (kg/m²)
<28	81.84±3.1	Underweight	79±5.94
28–37	86.13±1.19	Normal	82.67±2.27
38–47	86.60±1.66	Overweight-I	89.46±4.52
>47	88.65±3.71	Overweight-II	90.96±6.02
-	-	Obese	100.05±15.11
Z score: 11.1996, *P*<0.00001		Z score: 15.97776, *P*<0.00001	

BMI: Body mass index, SD: Standard deviation

20% of permissible standards. BMI analysis showed 70.17% had a normal BMI, while 29.8% were overweight or obese. This is notably lower than civilian obesity rates, estimated at 12% among men (NFHS-5),[8] and far below the national prevalence of 40.3%.[2]

The concentration of overweight and obese personnel in middle-aged groups is largely due to their higher numbers. Other ranks often retire around 38 years, reducing the representation of older individuals in the study.[9] This distribution aligns with national and international research showing abdominal girth increases with age,[10] though the study found these differences were not statistically significant. The study also highlights a higher prevalence of overweight and obesity among officers compared to other ranks and non-combatants, likely due to occupational differences, lifestyle, and age distribution, being associated with administrative roles and reduced physical exertion, mirroring trends from a 2011 IAF study on age-related weight gain.[4] The highest prevalence of overweight/obesity was surprisingly observed in the age group of 28–37 years, which is alarming and definitely needs intervention by administrative authorities.

The average BMI of 24.18 kg/m² showed significant variation across age groups ($Z = -1.960$, $P = 0.024998$), though rank-based BMI differences were statistically insignificant, aligning with Indian Army studies on service roles[3]. Abdominal girth at the umbilicus, a strong indicator of weight gain and cardiometabolic risk, was found to have significant correlations with age ($Z = 11.1996$, $P < 0.00001$) and BMI ($Z = 15.97776$, $P < 0.00001$), supporting WHO and NIH recommendations for obesity surveillance.[7,8] Similar findings of strong positive correlation between the BMI and abdominal circumference have also been reported in a cross-sectional study among Belgian and Nigerian adults.[11,12] Overweight and obesity prevalence declined among personnel over 38 years, likely due to early retirements. Personnel record data supports this trend, showing most personnel retire before 38 years, keeping the active cohort younger.[9] Despite a lower prevalence compared to civilian averages,[1,2] the findings underscore the necessity of stringent fitness requirements. Armed Forces have responded with stricter fitness standards, promotion-linked health benchmarks, and comprehensive medical evaluations.[5]

To enhance fitness standards among personnel, existing policies should be reinforced with routine BMI and

abdominal girth monitoring across all ranks and age groups. Targeted wellness programs are particularly necessary for the 28–37year age group, where overweight and obesity are most prevalent. Nutritional education initiatives within messes and canteens should be strengthened to encourage healthier eating habits. In addition, structured physical training programs must be mandatory and tailored to varying fitness levels and age groups to ensure effective participation.

Establishing realistic weight reduction goals can be tough; however, visual materials demonstrating the health and wellness benefits of weight loss may be useful in setting realistic goals and motivating patients to sustain their weight loss. Methods such as motivational interviewing, which focus on addressing resistance to behavioral change in a supportive and hopeful manner, may assist individuals in integrating these changes so that they become part of regular daily life and aid in weight loss maintenance.[13] Psychosocial counseling should be integrated to address stress, sedentary roles, and lack of fitness motivation, which are significant contributors to weight gain. Further studies should be replicated across all services to analyze broader trends and formulate holistic health strategies. There is ample evidence to suggest that abdominal obesity is a strong predictor of cardiovascular disease and type-2 diabetes. However, BMI is the most widely used measure of determining obesity in clinical and research settings. BMI measures an individual's weight and height to classify them as normal, overweight, or obese. However, its diagnostic accuracy is debatable as it often leads to an inaccurate assessment of adiposity. Therefore, it is essential to incorporate additional indicators, along with BMI, to assess the risk of obesity-related diseases accurately.[8] Thus, abdominal girth measurements should be standardized in annual medical check-ups to enable early detection of central obesity and mitigate associated cardiometabolic risks.

Future research should focus on longitudinal weight tracking over a 5-year period to analyze weight progression among serving personnel. Investigating cardiometabolic risks associated with obesity could provide valuable insights into its correlation with heart disease within this demographic. Comparative studies involving all sister services would help identify broader obesity trends across the Armed Forces. In addition, controlled trials assessing the efficacy of structured fitness interventions would be essential to determine their impact on weight management and overall health outcomes.

CONCLUSION

This study offers valuable insights into the prevalence and distribution of overweight and obesity among a representative sample of serving personnel. The analysis confirms a statistically significant correlation between increasing age and both BMI and abdominal girth, reinforcing the trend of progressive central obesity. However, rank did not significantly impact these metrics, suggesting that lifestyle and occupational factors associated with age play a more crucial role than hierarchical status.

By incorporating abdominal girth as a key metric, the study enhances understanding of adiposity distribution and associated health risks, aligning with global recommendations that recognize central obesity as a major concern. These findings highlight the growing need for continuous monitoring and preventive health strategies, even within a physically active and routinely screened population like the Armed Forces.

Ethical approval: The research/study complied with the Helsinki Declaration of 1964.
Declaration of patient consent: Patient's consent not required as patients identity is not disclosed or compromised.
Financial support and sponsorship: Nil.
Conflict of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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How to cite this article: Dutt M, Sakre MM, Gupta A, Tripathy NK. Anthropometric surveillance and obesity prevalence in Armed Force personnel: A cross-sectional study. Indian J Aerosp Med. doi: 10.25259/IJASM_23_2025