

# Anemia in Relation to Body Mass Index and Waist Circumference among Andhra Pradesh Women

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## Abstract

This study is aimed to investigate into the relationship of anemia and body mass index among adult women in Guntur and Krishna districts, Andhra Pradesh, India. Data are collected in a sub-national cross-sectional survey, and 1,537 women aged 20-30 years are included in the analyses. According to Body Mass Index (BMI), the subjects are categorized as underweight, normal weight, overweight and obese according to WHO standard. Central obesity is defined as a waist circumference  $\geq 80$  cm. Anemia was defined as hemoglobin concentration  $< 12$  g/dl. Prevalence ratios (PRs) of the relationship between anemia and BMI or waist circumference were calculated using Poisson regression. Overall, 31.1% of the Andhra Pradesh women were anemic. The prevalence of overweight, obesity and central obesity is in the order of 34.2%, 5.8% and 36.2%, respectively. The obese group had the highest concentrations of hemoglobin compared with other BMI groups. After adjustment for confounders, overweight and obese women had a lower PR for anemia. Central obesity was inversely associated with anemia. In this population, women with overweight/obesity or central obesity were less likely to be anemic as compared to normal weight women. However no measures are required currently to target anemia specifically for overweight and obese people of Krishna & Guntur Districts in Andhra Pradesh.

**Keywords:** Anemia; Body mass index; Waist circumference; Prevalence ratio; Women

## Introduction

Anemia can increase risk of maternal and child mortality, impairs cognitive and physical development in children, and endangers physical performance in adults [1,2]. In India, 20% of preschool children and a 20% of non-pregnant women at reproductive age are affected by anemia [3], which can be classified as a moderate public health problem according to world health organization criteria (WHO) [2]. Obesity has been reported to be associated with anemia in adults in some countries [4-10]. This may be due to up-regulated hepcidin expression that hampers iron absorption [11]. Therefore, obesity could potentially add to the burden of anemia in India, since the country has experienced an alarming increase in obesity-related chronic diseases over the past decade [12]. Therefore, we investigated the relationship between central obesity and anemia among the female Indian population.

High overweight and obesity prevalence has been observed in developed and developing countries, and obesity is considered an important public health problem worldwide [13,14], mainly due to the close relationship between inadequate nutritional status and development of cardiovascular diseases and early mortality [15,16]. Overweight is multifactorial in origin, with important genetic [17] and environmental factors such as inadequate eating habits, for example, the preference for quick meals, consisting mostly of high-calorie foods like snacks and soft drinks [9].

The purpose of the current study is to compare the associations of BMI and waist circumference with cardio respiratory fitness with regard to women belonging to both the graphical areas.

## Method and Materials

The study was conducted in Guntur and Vijayawada cities using a multistage cluster sampling method as described before, which was part of a national representative cross sectional study on Nutrition and Health, conducted in 2011 [18-23]. The study was approved by the Human Investigation Review Committee at the National Institute for Nutrition and Food Safety, Andhra Pradesh Center for Disease Control and Prevention. A written consent was obtained from the subject for

publication of the data collected. Three streets were randomly selected from each of the cities. In each town/street, two villages/neighborhoods were further randomly selected. In each village/neighborhood, 30 households were randomly selected. All members in the households were invited to take part in the study. Altogether, 1,537 out of 1,652 women with complete data were included in the survey. Energy and nutrient intake was calculated using three consecutive days of 24-h dietary recall in conjunction with the Indian Food Composition Table published in 2010 [24]. Anemia is defined as a hemoglobin concentration below 12 g/dl [1]. Women are classified by BMI categories as underweight (BMI  $< 18.5$ ), normal weight (BMI  $> 18.5 < 24$ ), overweight (BMI  $\geq 24 < 28$ ) and obesity (BMI  $\geq 28$ ) according to the Indian standard. Central obesity is defined as a waist circumference  $\geq 80$  cm [25]. Low socio-economic status (SES) is defined as an annual income of less than 1,500 INR, 'medium' as 1,500-4,999 INR and 'high' as more than 5,000 INR.

Variables are presented as percentage or means  $\pm$  standard deviations (SD) by BMI categories, with chi square test for categorical variables and ANOVA for continuous variables. Poisson regression is used to estimate the association as prevalence ratios (PRs) between BMI categories and central obesity and anemia controlling for confounders, including age, residence, SES, educational level, and daily energy and iron intake [26-28].

## Results

The mean age of the subjects is  $46.4 \pm 14.7$  yrs. The average BMI is  $23.6 \pm 3.7$ . Table 1 presents general characteristics of the study population by BMI categories. Compared with underweight subjects, obese/overweight women had higher iron intake. Energy intake and

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n (%)	Under weight 89 (5.8)	Normal weight 834 (54.3)	Over weight 424 (27.6)	Obese 190 (12.4)	P value
<b>Age (years) (%)</b>					
< 35	38.2	34.8	16.5	9.5	< 0.001
35-44	13.5	25.4	21.9	21.6	
45-54	13.5	25.4	33.7	26.3	
≥ 55	34.8	25.2	27.8	42.6	
<b>Residence</b>					
Urban city	23.6	22.1	27.4	31.1	0.03
Rural city	76.4	77.9	72.6	68.9	
<b>Socio-economic status</b>					
Low	26.1	32.4	33.9	34.0	0.39
Medium	38.6	31.0	34.8	33.0	
High	35.2	36.6	31.3	33.0	
<b>Education</b>					
Low	50.6	54.9	59.4	65.3	0.002
Medium	27.0	32.3	30.9	21.1	
High	22.5	12.8	9.7	13.7	
<b>Hemoglobin (g/L)</b>	125.0 (14.6)	124.9 (15.4)	128.4 (15.0)	131.9 (15.1)	<0.001
<b>Energy (kcal/d)</b>	1916 (563)	2124 (582)	2179 (639)	2198 (637)	0.001
<b>Iron (mg/d)</b>	20.0 (7.4)	23.4 (9.6)	24.2 (9.8)	23.8 (9.5)	0.003
<b>Vitamin C (mg/d)</b>	61 (33)	61 (38)	59 (39)	60 (36)	0.886

**Table 1:** General characteristics of the study population (n = 1,537) by BMI categories.

1Mean (SD), all such values; BMI, body mass index. Chi-square test for categorical variables and ANOVA for continuous variables

hemoglobin concentration increased over BMI categories. The overall prevalence of anemia is 31.1%. Women with high and medium SES have higher prevalence of anemia than women with low SES (35.4% and 35.9% vs. 21.5%,  $p < 0.001$ ). No difference in prevalence of anemia is found for age, urban/rural and educational level groups. Anemia showed a significant decreasing trend with increasing BMI. Compared to normal weight women, overweight and obese women have lower PRs for anemia (PR: 0.72, 95% CI: 0.62-0.89; PR: 0.59, 95% CI: 0.43-0.79). Central obesity is also inversely associated with anemia (PR: 0.75, 95% CI: 0.63-0.89).

## Discussion

In this representative cross-sectional study, it is found that both overweight/obesity and central obesity are inversely associated with anemia. The level of iron and vitamin C intake may partly explain the discrepancy. In this study, the average iron intake ranged from 20 to 24 mg/dl, which is in line with the Adequate Intake of 20 mg/dl for Indian women [26]. Although obese/overweight women had a higher intake of iron than underweight women, the average intake of underweight women was still adequate. In contrast, in the population of Andhra Pradesh, iron intake is reported to be in the range of 8-9 mg/d [5]. Intake of vitamin C, the most potent enhancer of non-hem iron absorption, is present in sufficient amounts in the diets of Guntur women (60 mg/d), whereas vitamin C intake in Krishna district women is low (30 mg/d). It may be that the dietary practices of Guntur area people consumption convey enough absorbable iron to lower the risk of anemia in contrast to the dietary practices of Krishna district people [6]. Although overweight or obesity in the population may not decrease with red-cell, survival or impair erythropoiesis, obesity might still result in hypoferrremia through hepcidin or other mediators [4].

Waist circumference reflects intra-abdominal fat mass, and is related to cardiovascular diseases in adults [27]. Limited studies have

assessed the relationship between central obesity and anemia. Gillum [8] reported a positive association between waist-hip-ratio and serum ferritin. In this study, women with central obesity are less likely to have anemia, consistent with the results with overall obesity. The main limitation of this study is that is used anemia as an indicator which only represents a part of the complex assessment of iron status. Therefore, it is truly difficulty to distinguish between anemia of chronic disease and anemia caused by iron deficiency. In conclusion, in this study it is found that inverse association between overweight/obesity, central obesity and anemia in Andhra Pradesh women from Krishna and Guntur cities. The study contributes to the existing knowledge base on the complex association between adiposity and anemia.

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