Original Article

Dietary Intake, Prevalence, and the Effect of Anemia on Various Morphophysiological Variables of Postmenopausal Women of North India

Maninder Kaur

Department of Anthropology, Panjab University, Chandigarh, India

Abstract

Context: Anemia has a high prevalence among postmenopausal Indian females. **Aim and Objective:** The aim of this study was to evaluate dietary intake, prevalence, and the effect of anemia on various morphophysiological variables among postmenopausal women. **Setting and Design:** This was a community-based sample survey. **Materials and Methods:** A total of 250 postmenopausal women aged 45–80 years from various parts of North India participated in the study. Anthropometric measurements, hemoglobin concentration, and bone mineral density (BMD) (using dual-energy X-ray absorptiometry) of each participant were assessed. A 24-h dietary recall method for three consecutive days was employed. **Statistical Analysis:** The Statistical Package for the Social Sciences version 20 was used for statistical considerations. **Results:** An age-associated decline in the mean values of hemoglobin concentration and the prevalence of anemia was reported to be 85.2% among postmenopausal women. Anemic women were lighter and had lesser circumferential measurements as well as lower BMD than their nonanemic counterparts. The intake of nutrients such as protein, calcium, and iron and energy was lower among anemic women than nonanemic women. Binary logistic regression analysis identified age (odds ratio = 1.04, 95% confidence interval = 1.00–1.09)* as the possible predictor of anemia. **Conclusions:** Anemia was not only the result of aging process but also inadequate and unbalanced dietary intake.

Keywords: *Bone mineral density, hemoglobin concentration, postmenopausal*

Introduction

Anemia is a growing public health burden associated with a range of detrimental effects across all age groups. The World Health Organization (WHO)[1] observed that anemia is one of the 10 most important global health concerns and is a major factor for enhancing morbidity and mortality particularly in preschool children and pregnant women. Findings of Chaves *et al*.[2] also reported poor mobility, increased frailty, and decreased executive functions among women having low levels of hemoglobin concentration. With the rising number of aged and elderly people at the global level, anemia is becoming focus of interest in gerontology, because it is associated with a number of clinical[3-7] and socioeconomic burden. Nutrition has a strong influence in the maintenance or development of anemia. The WHO[8] recognized anemia as the most prevalent nutritional problem in the world today. In a developing country such as India, nutritional scenario is not very encouraging. The reports of National Family Health Survey-3[9] observed an increasing prevalence of anemia in women since the National Family Health Survey-2. There are ample data on nutritional status as well as the prevalence of anemia among adolescence,[10,11] pregnant women,[12,13] and on elderly people,[14,15] but the studies on dietary intake and

Address for correspondence: Dr. Maninder Kaur, Department of Anthropology, Panjab University, Chandigarh, India. E-mail: maninderkaur_1@yahoo.in

How to cite this article: Kaur M. Dietary intake, prevalence, and the effect of anemia on various morphophysiological variables of postmenopausal women of North India. J Mid-life Health 2018;9:72-8.

Access this article online

Quick Response Code:

Website: www.jmidlifehealth.org

DOI: 10.4103/jmh.JMH_20_18

the effect of anemia on various morphophysiological variables among postmenopausal women of North India have been insufficiently recognized. Given the wide range of negative consequences of anemia across all age levels, this escalating problem needs a thorough investigation. Hence, the present study is an attempt to assess the dietary intake, prevalence, and effect of anemia on various morphophysiological variables among postmenopausal women of North India.

Materials and Methods

The present cross-sectional study was based on a sample of 250 postmenopausal women ranging in age from 45 to 80 years. The data were collected by purposive sampling method from March 2009 to October 2010 from two neighboring states, that is, Punjab and Haryana of North India and the union territory of Chandigarh.

Inclusion criteria

Women having at least 1 year natural amenorrhea[16] were randomly selected in the present study.

Exclusion criteria

The women who had undergone hormone replacement therapy, hysterectomy, or having physical deformity were not included in the study.

The present study is a part of the research project and got ethical approval from by the Ethical Committee of Kurukshetra University, Kurukshetra (Haryana). A total of four anthropometric measurements height (mm), weight (kg), waist circumference (mm), and hip circumference (mm) were taken on each participant following the standard techniques recommended by Weiner and Lourie.[17] Height (mm) and weight (kg) were measured by anthropometer and weighing machine, respectively. Waist circumference (cm) and hip circumferences (cm) of each participant were measured with Freeman's steel tape. Waist circumference (mm) was taken midway between umbilicus and xiphoid. Hip circumference (mm) was measured at the maximum protuberance of the buttocks. Body mass index (BMI) was calculated as body weight divided by height squared (kg/m^2). Handgrip strength (N) of all the postmenopausal women was gauged with dynamometer (Analog model, range 0–100 kg, made in Japan). The participants were encouraged to exert their maximal grip with both dominant and nondominant hand. All the participants performed three handgrip tests, out of which the best result was chosen for analysis. Bone mineral density (BMD) was assessed using dual-energy X-ray absorptiometry (GE Healthcare Lunar enCORE, Madison, USA). Cyanmethemoglobin method using a photoelectric colorimeter with green filter (500–570 nm wavelength) was employed to ascertain the hemoglobin concentration of the participants. According to the WHO,[18] criteria hemoglobin level <12 g/dl in women were designated as anemic. The various categories of anemia were mild (10–11.9 g/dl), moderate (8.0–9.9 g/dl), and severe (<8 g/dl) anemia.

To assess the approximate quantity of dietary intake of all the participants, a 24 h dietary recall method for 3 consecutive days was employed. The amounts of food consumed were measured using standardized spoons, glasses, and bowls for measurement of the foodstuffs and compared with the recommended dietary allowances (RDAs)[19] values for Indian women females. Nutritive value tables for Indian foods were employed to assess nutrient intake.[20] Nutritional status was evaluated on the basis of BMI guidelines[21] with following cutoff points: undernutrition: BMI <18.5 (kg/m^2); normal: BMI 18.5–24.9 (kg/m^2); and overweight: BMI ≥25.0 (kg/m^2). Additional information on frequency (ate two times/day or three times/day) and type (vegetarian or nonvegetarian; intake of fruits) of food consumption as well as awareness about anemia (meaning, symptoms, and effects of anemia) was also recorded.

Statistical analysis

The Statistical Package for the Social Sciences version 20 (SPSS, Inc., Chicago, IL) was used for data analysis. Descriptive statistics including means, standard deviations (SDs) were determined for each variable. Comparisons between the anemic and nonanemic groups were made by Student's *t*-test. Chi-square test was employed to compare categorical variables. One-way analysis of variance (ANOVA) was obtained to gauge statistical significance of the differences for different variables on the basis of their hemoglobin concentration. Binary logistic regression analysis was performed to identify risk factors for anemia among the postmenopausal women.

Results

General characteristics of the sample

In the present study, the prevalence of anemia was found to be 85.2% among postmenopausal women of North India. General information and dietary habits of the participants are presented in Table 1. Hemoglobin concentration of 37 nonanemic participants was 12.36 + 0.32 g/dl, whereas for 213 anemic participants it was 9.78 + 1.08 g/dl. Out of the total postmenopausal women, 44.4% and 55.6% females ate two times/day and three times/day, respectively. Among nonanemic participants, 64.86% women were vegetarian and 35.13% nonvegetarian, whereas 86.3% and 13.69% anemic females were vegetarian and nonvegetarian, respectively.

Most of the anemic females (79.34%) demonstrated irregular intake of fruits. Only 37.6% females were aware of the causes, symptoms, and effects of anemia, while rest of the females (62.4%) were not aware of it. Chi-square test displayed significant differences for the intake of fruits ($P < 0.00$) and diet ($P < 0.00$) only.

Hemoglobin concentration as stratified by age

Means, SD values, and ANOVA of hemoglobin levels of the postmenopausal women on the basis of their age are documented in Table 2. The prevalence of anemia was lowest in the younger age groups 45–55 (78.8%) and highest in the oldest age groups 66–80 (89.7%). Maximum mean value for hemoglobin concentration (10.54 g/dl) was in the age group 45–55 followed by a decline in their mean values till 66–80 years. One-way ANOVA demonstrated highly significant age differences for hemoglobin concentration as reflected by their *F*-value (4.852***).

Table 1: General information and dietary habits of the participants

Particulars	Normal (*n*=37), *n* (%)	Anemic (*n*=213), *n* (%)	Total (*n*=250), *n* (%)
Frequency of consumption*			
Two times/day	16 (43.24)	95 (44.6)	111 (44.4)
Three times/day	21 (56.75)	118 (55.39)	139 (55.6)
Intake of fruits**			
Irregular	15 (40.54)	169 (79.34)	184 (73.6)
Regular	22 (59.45)	44 (20.65)	66 (26.4)
Diet***			
Vegetarian	24 (64.86)	183 (86.3)	204 (81.6)
Nonvegetarian	13 (35.13)	30 (13.69)	46 (18.4)
Awareness about anemia****			
Yes	14 (37.83)	80 (37.55)	94 (37.6)
No	23 (62.16)	133 (62.44)	156 (62.4)
As per BMI (WHO, 1995)			
<18.5 kg/m^2	1 (2.7)	18 (8.45)	19 (7.6)
18.5-24.9 kg/m^2	19 (51.3)	87 (40.8)	106 (42.4)
≥25 kg/m^2	17 (45.9)	108 (50.7)	125 (50)

*Chi-squared test: P>0.05, **Chi-squared test: P<0.01, ***Chi-squared test: P<0.01, ****Chi-squared test: P>0.05. BMI: Body mass index, WHO: World Health Organization

Table 2: Age wise means, standard deviation values, and analysis of variance of hemoglobin levels of the postmenopausal women

Age group	*n*	Prevalence of anemia, *n* (%)	Mean±SD	*F*
45-55	71	56 (78.8)	10.54±1.25	4.852***
56–65	91	78 (85.7)	10.18±1.18	
66–80	88	79 (89.7)	9.93±1.20	
Total	250	213 (85.2)	10.19±1.23	

SD: Standard deviation. *$P < 0.05$, **$P < 0.01$,***$P < 0.001$

Morphophysiological variables in different categories of hemoglobin concentration

Table 3 demonstrated means, SD values, and ANOVA for various morphophysiological variables in different categories of hemoglobin concentration. Severely anemic females (<8 g/dl) were lighter and shorter than participants in all other categories of hemoglobin levels. Females having normal hemoglobin concentration were heavier than females from moderate (8.0–9.9 g/dl) and mild categories (10.0–11.9 g/dl). Women with normal hemoglobin concentration had highest circumference for waist (844.3 mm) than women in mild (827.9 mm), moderate (819.8 mm), and severe (816.8 mm) categories. Similar trend was witnessed for dominant, nondominant handgrip strength, and BMD, where maximum mean value was reported in normal women and minimum in severely anemic females. Results of one-way ANOVA performed on each variable showed no significant differences except for dominant (14.27***), nondominant handgrip strength (12.67***) as is evident from their *F*-ratio. Table 4 presented mean, SD, and odds ratio (OR) of various morphophysiological variables of anemic (mild, moderate, and severe categories combined) and nonanemic postmenopausal females. Anemic women were lighter (61.26 vs. 64.86 kg), and had lesser circumferential measurements (waist 823.9 vs. 844.3 mm; hip 910.8 vs. 936.7 mm) than their normal counterparts. Grip strength of both dominant (173.87 vs. 145.33 N, $P < 0.01$) and nondominant hand (150.23 vs. 125.13 N, $P < 0.01$) as well as BMD (0.87 vs. 0.83 g/cm^2, $P < 0.05$) of anemic women was significantly lower than the participants having normal hemoglobin concentration. Binary logistic regression analysis revealed that odds of having anemia was 1.00 (95% confidence interval [CI]: 0.94–1.06) for weight, 1.03 (95% CI: 0.97–1.10) for height, and 0.18 (95% CI: 0.09–1.06) for BMD at total femur. Age (OR = 1.04, 95% CI = 1.00–1.09)* was recognized as the risk factor for anemia.

Dietary intake of the postmenopausal women

Anemic and nonanemic females have been classified in their normal, underweight, and overweight categories depending on the WHO criteria of BMI [Table 1]. Among nonanemic participants, about 51.3% of the participants were in the normal range of BMI, 2.7% in underweight, and 45.9% in overweight category. The anemic females have 40.8% of the participants in normal range, 8.45% in underweight, and 50.7% as overweight. As is evident from Table 1 that the overall prevalence of underweight and overweight was

Table 3: Means, standard deviations, and analysis of variance of various morphophysiological variables on the basis of different categories of hemoglobin concentration

Variables	<8 g/dl (severe *n*=5)	8.0–9.9 g/dl (moderate *n*=103)	10–11.9 g/dl (mild *n*=105)	12 g/dl/above (normal *n*=37)	*F*
Weight (kg)	58.80±9.52	60.46±10.18	62.17±12.55	64.86±12.05	1.49
Height (mm)	1494.0±13.4	1572.1±67.2	1571.0±79.6	1568.6±79.3	1.79
Waist circumference (mm)	816.8±66.8	819.8±87.0	827.9±93.1	844.3±74.5	0.71
Hip circumference (mm)	909.8±117.5	910.3±92.1	940.8±144.8	936.7±104.9	0.75
Dominant handgrip strength (*n*)	103.95±16.37	128.56±43.05	163.77±52.17	173.87±51.58	14.27***
Nondominant handgrip strength (*n*)	96.10±8.13	110.12±36.67	141.21±49.52	150.23±49.42	12.67***
Total femur BMD (g/cm^2)	0.81±0.10	0.83±0.11	0.83±0.13	0.87±0.15	1.53

BMD: Bone mineral density.*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$

Table 4: Mean, standard deviation, and odds ratio of various morphophysiological variables of anemic and nonanemic postmenopausal females

Variables	Nonanemic	Anemic	OR (95% CI)
Age (years)	59.46±7.87	62.69±8.58	1.04 (1.00-1.09)*
Weight (kg)	64.86±12.05	61.26±11.39	1.00 (0.94-1.06)
Height (mm)	1568.6±79.3	1569.7±73.7	1.03 (0.97-1.10)
Waist circumference (mm)	844.3±74.5	823.9±89.4	1.00 (0.92-1.09)
Hip circumference (mm)	936.7±104.9	910.8±106.2	0.97 (0.91-1.04)
Dominant handgrip strength (*n*)	173.87±51.58	145.33±50.79**	0.93 (0.77-1.12)
Nondominant handgrip strength (*n*)	150.23±49.42	125.13±45.89**	0.97 (0.79-1.18)
Total femur BMD (g/cm^2)	0.87±0.15	0.83±0.12*	0.18 (0.09-1.06)

*P<0.05, **P<0.01,***$P < 0.001$. BMD: Bone mineral density, OR: Odds ratio, CI: Confidence interval

higher among anemic participants. Nutrient (energy, protein, fat, calcium, and iron) intake of the anemic and nonanemic participants and their comparison with RDA for Indian women are portrayed in Figure 1. The intake of energy (nonanemic 1544.17 kcal; anemic 1416.1 kcal), protein (nonanemic 44.6 g/d; anemic 42.71 g/d), calcium (nonanemic 311.44 mg/d, anemic 275.28 mg/d), and iron (nonanemic 23.06 mg/d; anemic 22.04 mg/d) was lower among anemic participants as compared to nonanemic participants. Except for fat both the anemic and nonanemic groups exhibited inadequate nutrient intake when compared to the RDA.

Discussion

In the present study, the prevalence of anemia was found to be 85.2% among postmenopausal women. The current cross-sectional study reported an age-associated increment in the prevalence of anemia. Binary logistic regression analysis also identified age (OR = 1.04, 95% CI = 1.00–1.09)* as the possible predictor of anemia. Guralnik *et al*.[22] also stated that the prevalence of anemia in women doubles from 10% to 20% from 75–84 years to 85 years and older age groups. Kim and Lee[23] also observed the lowest prevalence of anemia in age group 60–69 (10.0%) followed by age group 70–79 (15.5%) and the highest among age over 80 (20.7%). The prevalence of anemia was significantly higher in the older age groups as compared to their younger age groups have reported by a number of previous reports.[15,24-26] The age-related decline in the level of hemoglobin concentrations might be due to a lower erythropoietin secretion[3] or a reduced hematopoietic reserve.[27]

In the present study, severely anemic females were lighter, shorter and had lower circumferential measurements than the participants from all other categories of hemoglobin concentration. Kim and Lee[23] also observed that anemic participants showed lower anthropometric status as compared to their nonanemic counterparts. Considerable literature[28-33] also documented that participants with anemia showed statistically lower values in weight, height, and BMI than those with normal hemoglobin levels. Manual strength (both dominant and nondominant handgrip strength) was highest in the females with normal hemoglobin concentration as compared to females with mild, moderate, and severe categories of anemia. Kaur and Kochar[31] also witnessed lower handgrip strength of both dominant and nondominant hand of anemic participants as compared to their nonanemic counterparts. Penninx *et al*.[34] displayed a decreased physical performance and strength among anemic residents of Chianti area of Italy. This is in accordance with the previous reports[35,36] that participants with hemoglobin level less than normal had less grip strength than participants with normal hemoglobin concentration.

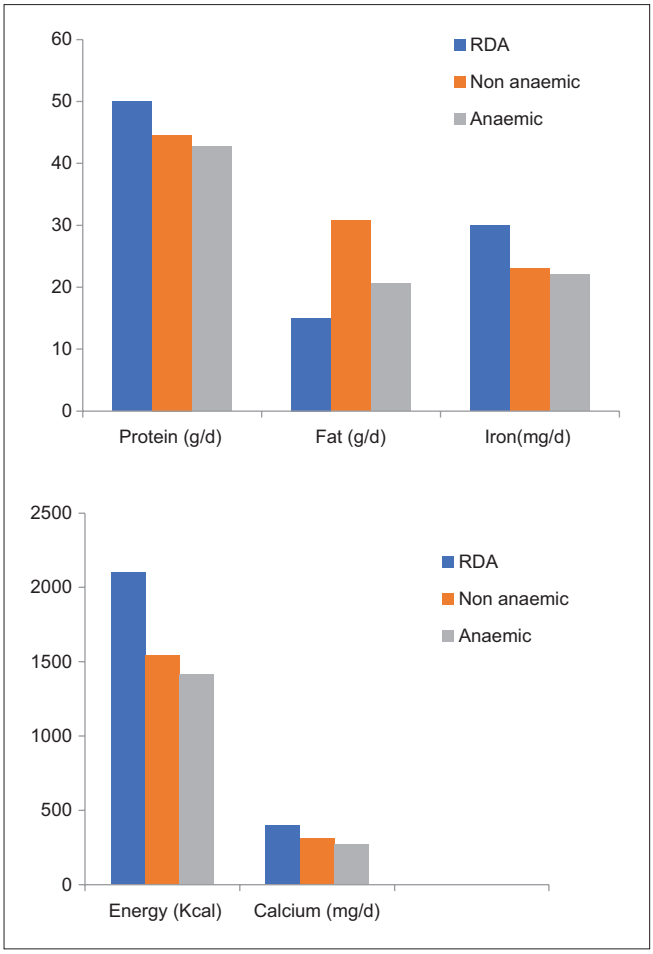

Figure 1: Nutrient intake of anemic and nonanemic females with reference to recommended dietary allowances

This may be attributed to lower levels of hemoglobin were able to influence oxygen delivery to skeletal muscle and consequently negatively impact muscular strength.[37,38] The present study emphasized that anemic females revealed significantly ($P < 0.05$) lower BMD than the females with normal hemoglobin concentration. Findings of Cesari *et al*.[29] were also compatible with the present study as they presented that anemic women were also more likely to have lower levels of total bone density than their nonanemic counterparts. A few other studies[39,40] also suggested a direct relationship of hemoglobin concentration with BMD. Fujimoto *et al*.[4] studied the relationship of anemia and hemoglobin levels with bone density and observed that hypoxemia can affect mineral density and participants with low PaO_2 demonstrated a decreased BMD.

Previous studies indicated nutrition is an important factor for controlling anemia.[32] In the present study, about 44.4% participants of the present study ate twice a day, and 73.6% had irregular intake of fruits. Out of the total 37 nonanemic postmenopausal women, 64.86% were vegetarian and 35.13% were nonvegetarian, whereas 86.3% and 13.69% anemic females were vegetarian and nonvegetarian, respectively. Intake of energy (nonanemic 1544.17 kcal and anemic 1416.1 kcal), protein (nonanemic 44.6 g/d and anemic 42.71 g/d), calcium (nonanemic 311.44 mg and anemic 275.28 mg), and iron (nonanemic 23.06 mg/d and anemic 22.04 mg/d) was higher in nonanemic participants than their anemic counterparts. Except for fat both the anemic and nonanemic groups of the present study showed inadequate dietary intake as compared to the RDA values.[19] Thomson *et al*.[32] also described that inadequate nutrient intakes were a significant risk factor for anemia in older women. They further elaborated that among anemic postmenopausal women enhanced access to nutrient-rich foods particularly iron, B-12, and/or folate intake may be required to correct nutritional anemia. As per the WHO[21] criteria of BMI for assessing nutritional status, 51.3% nonanemic and 40.8% anemic participants were in the normal range of BMI while rest were in underweight and overweight categories. In the present study, less women fall in the undernutrition category than women were in overweight category. Similar trend was observed by Kaur[41] among elderly females and reported among rural and urban Brahmin females 11.76% and 1.65% fall in the underweight category, respectively, whereas 39.32% rural and 45.58% urban women were in the overweight category. National Family Health Survey-3[9] also reported a very high burden of nutritional deficiency among Indian women, but the prevalence of overweight and obesity is also on the rise. A study carried out in Chicago by Yan *et al*.[42] discussed lower quality of life, worse physical performance, and less physical well-being among participants with both overweight and low-weight values as compared to participants within normal range. The postmenopausal women of the present study predominantly had cereal-pulse-based diet with low animal protein as well as fruit intake and this monotonous diet may be attributed to lower nutrient intake.

Conclusions

The postmenopausal women of the present study demonstrated age-associated decline in hemoglobin levels accounting for lighter individuals with reduced grip strength as well as BMD among anemic participants. The magnitude of anemia has been further compounded by insufficient nutrient intakes among postmenopausal women. Hence, the present study highlighted that anemia among postmenopausal women was not only associated with aging process but also further enhanced by inadequate dietary intake.

Acknowledgment

Author (Maninder Kaur) is thankful to the Department of Science and Technology (New Delhi) for the financial support under Women Scientist Scheme (SR/WOS-A/LS-60/2005) to carry out this work.

Financial support and sponsorship

This study was financially supported by the Department of Science and Technology, New Delhi, India.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. The World Health Report 2002: Reducing Risks, Promoting Healthy Life; 2002. Available from: http://www.who.int/whr/2002/en/whr02_en.pdf. [Last Retrieved on 2014 Jul 31].
2. Chaves PH, Carlson MC, Ferrucci L, Guralnik JM, Semba R, Fried LP, *et al.* Association between mild anemia and executive function impairment in community-dwelling older women: The Women's Health and Aging Study II. J Am Geriatr Soc 2006;54:1429-35.
3. Kario K, Matsuo T, Kodama K, Nakao K, Asada R. Reduced erythropoietin secretion in senile anemia. Am J Hematol 1992;41:252-7.
4. Fujimoto H, Fujimoto K, Ueda A, Ohata M. Hypoxemia is a risk factor for bone mass loss. J Bone Miner Metab 1999;17:211-6.
5. Lipschitz D. Medical and functional consequences of anemia in the elderly. J Am Geriatr Soc 2003;51:S10-3.
6. Denny SD, Kuchibhatla MN, Cohen HJ. Impact of anemia on mortality, cognition, and function in community-dwelling elderly. Am J Med 2006;119:327-34.
7. Komajda M, Anker SD, Charlesworth A, Okonko D, Metra M, Di Lenarda A, *et al.* The impact of new onset anaemia on morbidity and mortality in chronic heart failure: Results from COMET. Eur Heart J 2006;27:1440-6.
8. WHO. Worldwide Prevalence of Anaemia 1993–2005. WHO Global Database on Anaemia. Geneva, Switzerland: World Health Organization; 2008.
9. National Family Health Survey 2005-06 (NFHS 3); 2010. Available from: http://www.mohfw.nic.in/nfhsfactsheet.htm. [Last Retrieved on 2014 Mar 26].
10. Kara B, Cal S, Aydoğan A, Sarper N. The prevalence of anemia in adolescents: A study from turkey. J Pediatr Hematol Oncol 2006;28:316-21.
11. Chaudhary SM, Dhage VR. A study of anemia among adolescent females in the urban area of Nagpur. Indian J Community Med 2008;33:243-5.
12. Kalaivani K. Prevalence and consequences of anaemia in pregnancy. Indian J Med Res 2009;130:627-33.
13. Lokare PO, Karanjekar VD, Gattani PL, Kulkarni AP. A study of prevalence of anemia and sociodemographic factors associated with anemia among pregnant women in Aurangabad city, India. Ann Nigerian Med 2012;6:30-4.
14. Landi F, Russo A, Danese P, Liperoti R, Barillaro C, Bernabei R, *et al.* Anemia status, hemoglobin concentration, and mortality in nursing home older residents. J Am Med Dir Assoc 2007;8:322-7.
15. Maninder K, Kochar GK. Burden of anaemia in rural and urban Jat women in Haryana state, India. Malays J Nutr 2009;15:175-84.
16. World Health Organisation. Scientific Group, Research on the Menopause. World Health Organization Technical Report Series 670; 1981.
17. Weiner JS, Lourie JA. Practical Human Biology. London: Academic Press; 1981.
18. World Health Organization. The Prevalence of Anaemia in Women: A Tabulation of Available Information. Geneva: World Health Organization; 1992.
19. Indian Council for Medical Research. Nutrient Requirement and Recommended Dietary Allowance for Indians. A Report of Expert of ICMR. Hyderabad: NIN; 1999.
20. Gopalan C, Ramasastry BV, Balasubramanyam SC, Narasinga Rao BS, Deosthale YG, Pant KC. Nutritive Value of Indian Foods. Hyderabad: National Institute of Nutrition; 1990.
21. World Health Organisation. Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. Geneva: WHO; 1995.
22. Guralnik JM, Eisenstaedt RS, Ferrucci L, Klein HG, Woodman RC. Prevalence of anemia in persons 65 years and older in the United States: Evidence for a high rate of unexplained anemia. Blood 2004;104:2263-8.
23. Kim HS, Lee BK. Cross-sectional study on the prevalence of anemia among rural elderly in Asan. Nutr Res Pract 2008;2:8-12.
24. Anía BJ, Suman VJ, Fairbanks VF, Rademacher DM, Melton LJ 3rd. Incidence of anemia in older people: An epidemiologic study in a well defined population. J Am Geriatr Soc 1997;45:825-31.
25. Smith DL. Anemia in the elderly. Am Fam Physician 2000;62:1565-72.
26. Tettamanti M, Lucca U, Gandini F, Recchia A, Mosconi P, Apolone G, *et al.* Prevalence, incidence and types of mild anemia in the elderly: The "Health and anemia" population-based study. Haematologica 2010;95:1849-56.
27. Lipschitz DA, Mitchell CO, Thompson C. The anemia of senescence. Am J Hematol 1981;11:47-54.
28. Choi CW, Lee J, Park KH, Yoon SY, Choi IK, Oh SC, *et al.* Prevalence and characteristics of anemia in the elderly: Cross-sectional study of three urban Korean population samples. Am J Hematol 2004;77:26-30.
29. Cesari M, Pahor M, Lauretani F, Penninx BW, Bartali B, Russo R, *et al.* Bone density and hemoglobin levels in older persons: Results from the InCHIANTI study. Osteoporos Int 2005;16:691-9.
30. Baig-Ansari N, Badruddin SH, Karmaliani R, Harris H, Jehan I, Pasha O, *et al.* Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan. Food Nutr Bull 2008;29:132-9.
31. Kaur MK, Kochar GK. Impact of anemia on morpho-physiological variables of rural Haryanvi Jat females. J Life Sci 2010;2:17-20.
32. Thomson CA, Stanaway JD, Neuhouser ML, Snetselaar LG, Stefanick ML, Arendell L, *et al.* Nutrient intake and anemia risk in the women's health initiative observational study. J Am Diet Assoc 2011;111:532-41.
33. Song P, Li L, Man Q, Wang C, Meng L, Zhang J, *et al.* Case-control study of anaemia among middle-aged and elderly women in three rural areas of China. BMJ Open 2014;4:e004751.
34. Penninx BW, Guralnik JM, Onder G, Ferrucci L, Wallace RB, Pahor M, *et al.* Anemia and decline in physical performance among older persons. Am J Med 2003;115:104-10.
35. Colín-Ramírez E, Castillo-Martínez L, Orea-Tejeda A, Asensio Lafuente E, Torres Villanueva F, Rebollar González V, *et al.* Body composition and echocardiographic abnormalities

associated to anemia and volume overload in heart failure patients. Clin Nutr 2006;25:746-57.
36. Penninx BW, Pahor M, Cesari M, Corsi AM, Woodman RC, Bandinelli S, *et al.* Anemia is associated with disability and decreased physical performance and muscle strength in the elderly. J Am Geriatr Soc 2004;52:719-24.
37. Cerretelli P. Muscle energetics and ultrastructure in chronic hypoxia. Respiration 1992;59 Suppl 2:24-9.
38. Dodd SL, Powers SK, Brooks E, Crawford MP. Effects of reduced O2 delivery with anemia, hypoxia, or ischemia on peak VO2 and force in skeletal muscle. J Appl Physiol (1985) 1993;74:186-91.
39. Espallargues M, Sampietro-Colom L, Estrada MD, Solà M, del Rio L, Setoain J, *et al.* Identifying bone-mass-related risk factors for fracture to guide bone densitometry measurements: A systematic review of the literature. Osteoporos Int 2001;12:811-22.
40. Kenny AM, Dawson L, Kleppinger A, Iannuzzi-Sucich M, Judge JO. Prevalence of sarcopenia and predictors of skeletal muscle mass in nonobese women who are long-term users of estrogen-replacement therapy. J Gerontol A Biol Sci Med Sci 2003;58:M436-40.
41. Kaur M. Age related changes in height, weight, and body mass index of Brahmin females: A rural-urban comparison. Internet J Geriatr Gerontol 2008;4(1).
42. Yan LL, Daviglus ML, Liu K, Pirzada A, Garside DB, Schiffer L, *et al.* BMI and health-related quality of life in adults 65 years and older. Obes Res 2004;12:69-76.