



Predictive Factors of Anaemia in Women in a Ghanaian Rural District

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Anaemia is a condition of public health concern worldwide especially in developing countries. Anaemia falls in the top ten causes of morbidity in Ghana with a nationwide prevalence of about 45%. A rural district (Shai-Osudoku District), close to the capital city in Ghana, recorded a progressive increase in prevalence of anaemia from the year 2011, with the incidence higher in older women than men of the same age group. This study sought to determine the factors associated with anaemia in women in a rural district in Ghana.

Methods: To identify the factors contributing to anaemia in older women at Shai-Osudoku District, a cross sectional study was carried out from May to June 2014. Two hundred and eighty three women, systematically sampled, were interviewed using a structured validated questionnaire, and data were obtained on the socio-demographics of the study respondents, lifestyle information and the dietary patterns with a food frequency table. Capillary blood was also obtained from respondents for haemoglobin check using a standardized Haemo Cue kit and the definition and categorization of anaemia done using the WHO Criteria. The data obtained were analysed.

Results: The ages of respondents ranged from 50-94years and their mean haemoglobin level was 11.5g/dL (CI: 11.30-11.64). The prevalence of anaemia in the population was 63% (CI: 0.57-0.68)

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at 95% confidence level. By logistic regression analysis, the following factors were found to be independently associated with anaemia at 95% confidence level at the study District: Respondents not working OR 2.60 95% CI(1.27-5.32); respondents who depended on family and friends or pension benefits as their main source of income OR: 1.94 95% CI (1.12-3.35); respondents who had change in eating pattern OR:0.55 95% CI (0.32-0.97); no loss of weight (OR:0.51(CI:0.29-0.90)) and occasional consumption of fruits OR:2.21 95% CI (1.07- 4.55)). Having adjusted for other variables, factors found to be significantly associated were; respondents not working ($p = 0.01$), respondents with no weight loss ($p = 0.03$) and the occasional consumption of fruits ($p = 0.04$).

Conclusion: The risk factors associated with anaemia among women in the study area were poor intake of fruits and non-working status. There is therefore the need to intensify education on healthy eating, including daily intake of fruits.

Keywords: Anaemia; fruits; women; rural district; Ghana.

1. INTRODUCTION

Anaemia is among the common public health problems of developing countries with important health, social and economic consequences [1]. Among the factors associated with anaemia are dietary and non-dietary factors. The main source of iron, which is a major component of blood cells, is from daily food intake of plant and animal sources. Vitamin C, which is known to promote the absorption of iron is also found in fruits and vegetables [2]. Therefore, a dietary deficiency of these nutrients is a major risk for anaemia. The non-dietary factors associated with anaemia include hookworm infestations, malaria and other infections [3,4]. Among children between ages 6 to 15 years in Ghana, a positive blood smear for malaria was significantly associated with anaemia [5]. The clinical manifestations of anaemia vary. Generally, the more rapid the development of anaemia, the more severe its symptoms and persons who develop it gradually experience few or no symptoms. The complications associated with severe anaemia include heart failure, parasthesia and confusion [6]. Though it may occur among the aged, anaemia is generally not seen as a problem of women who have passed their reproductive years since the natural processes of blood loss through menstruation and childbirth would have ceased. Anaemia falls in the top ten causes of morbidity in Ghana with a nationwide prevalence of 45% and 59% among women of age 15-49 years, which appears high as compared to some other West African countries. Considering the incidence of the condition by age and gender, anaemia appears higher in women (age, 50-years and above) 11.9%, 13.1% and 23% in 2011, 2012 and 2013 respectively as compared to men of the same age group with 2.7%, 4.5% and 11.3% in 2011, 2012 and 2013 respectively (District Health

Management Teams Report, 2011, 2012, 2013). This situation seems difficult to understand since this group of women do not lose blood through the major events of womanhood such as monthly menstruation, pregnancy or delivery. A clear understanding of the factors associated with anaemia in older women is critical to improving quality of life and decreasing morbidity and mortality in this segment of the population and should be a public health priority. The study therefore sought to determine the dietary and non-dietary factors associated with Anaemia among women.

2. METHODS

Ethical approval was obtained from the Ethical Review Committee of Ghana Health Service. A written consent was obtained from the individual respondents after the study had been explained to them.

The study involved a cross sectional survey of women resident in a rural district in Accra, Ghana between May and June 2014.

2.1 Study Setting

The study took place in the Shai-Osudoku District of the Greater Accra Region in Ghana. The district occupies 21% of Greater Accra Region land area and one of the purely rural districts in the region, which have not yet been caught up by the rapid urbanization of the peripheral areas surrounding the city of Accra. The district population as at 2013, was 72,525 with 34,473 males (48.2%) and 37,473 females (51.8%). Most of the inhabitants are subsistence farmers or fishermen. There are a handful of trained artisans, craftsmen and a few civil servants, mainly migrant employees of government ministries, departments and agencies.

2.2 Sample Size and Sampling

The study used data from Dodowa Health and Demographic Surveillance System (DHDSS) as a sampling frame to randomly select the study respondents. Using a prevalence of 23% (p) [7], with 5% precision (d) at 95% confidence interval, sample size (N) of 323 was obtained with the formula:

$$N = Z^2 \times p(q)/d^2$$

With a 5% allowance for non-response and recording error, a sample size of 283 was used.

Out of the 226 communities in the Shai-Osudoku District 86 communities were randomly selected (2 from each sub district). Proportionate method of sampling was used to pick respondents from each of the selected communities presented at the area council level as follows; Ayikuma (87) and Dodowa (99) in the Shai sub district whilst Osuwem(47) and Asutsuare (50) from the Osudoku sub District. Targeted women were identified from the data from the District Surveillance System was used to randomly select the women aged 50 years and above from the households in the selected communities. The nearest neighbour who was eligible replaced selected respondents who were unavailable at the time of the study.

2.3 Data Collection

A specially designed questionnaire was used. The structured questionnaire included items on socio demographic characteristics, tobacco and alcohol use, medical history and treatment of some medical conditions. The questionnaire also contained items on frequencies and sources of dietary intake. Haemo Cue 301 AB kit was used in testing the haemoglobin level of respondents. Data were collected by 5 trained interviewers (2 nurses and 3 non-medical trained interviewers). The questionnaire was translated into the local language (Dangme) and back translated into English by two different translators. Their versions were compared and reviewed by a language expert. Double entry verification of the data was done using Epidata 3.1 software by the principal investigator. Variables that required recoding were re-coded and the whole analysis was performed using STATA version 1.

Anaemia was determined by using haemoglobin level less than 12g/dL. Estimation of the prevalence of anaemia in the whole population (women 50years and above) was done by using proportions and for the various age groups.

Differences in the prevalence of anaemia by age groups were tested using Chi-squared or fisher's exact test for any cell that had a value less than 5. A value of $p < 0.05$ was established as statistically significant.

Factors associated with anaemia (haemoglobin < 12 g/dL) among the study respondents were investigated using logistic regression to estimate odds ratios (OR) and 95% confidence intervals. Factors that were associated with anaemia at $p < 0.05$ in the unadjusted analysis were put in a multivariable model.

3. RESULTS

Out of the 283 respondents, some (40.6%) were between 60 and 69years and more than 50% had no formal education. The characteristics of respondents are presented in Table 1.

Though more than half of the respondents, (53.0%) had one or more disease conditions in the last month of the study, only 12.2% gave the possible reason for a change in eating pattern to be the result of ill health (Table 2). The majority, (76.8%) reported of loss of appetite and the least proportion (6.1%) gave the lack of money as the reason for eating less. The majority (71.0%) of respondents had not identified any change in their body weight. Forty eight percent of respondents said they would avoid certain foods for reasons of allergy, cultural, religious, and medical, weight control and personal choices.

Table 1. Socio-demographic characteristics of respondents (N=283)

	Number (n)	Proportion (%)
Age (years)		
50-59	102	36.0
60-69	115	40.6
70-79	45	16.0
80+	21	7.4
Level of education		
None	149	52.7
Primary +	134	47.3
Source of income		
Business	195	68.9
Support	88	31.1
Wealth quintile*		
Poorest	39	15.1
Poorer	56	21.7
Poor	58	22.5
Less poor	53	20.5
Least poor	52	20.2

- * Wealth Quintile estimation excludes 25 missing values

Table 2. Prevalence of anaemia and risk factors

Factors	Respondents with anaemia	Total respondents	% with anaemia
Age (years)			
Pearson chi2 = 3.52 P Value = 0.32			
50-59	58	102	56.9
60-69	72	115	62.6
70-79	32	45	71.1
80 +	15	21	71.4
Marital status			
Pearson chi2 = 1.89 P Value = 0.17			
Married	72	124	58.1
Not Married	105	159	66.0
Level of education			
Pearson chi2 = 0.09 P Value = 0.77			
None	92	149	61.7
Primary+	85	134	63.4
Occupational status			
Pearson chi2 = 7.23 P Value = 0.01			
Working	136	231	58.9
Not Working	41	52	78.9
Source of income			
Pearson chi2 = 5.65 P Value = 0.02			
Business	113	195	58.0
Support	64	88	72.7
Wealth quintile			
Pearson chi2 = 5.65 P Value = 0.34			
Poorest	21	39	53.9
Poorer	33	56	58.9
Poor	38	58	65.5
Less Poor	39	53	73.6
Least Poor	32	52	61.5
Life style factors			
Alcohol			
Pearson chi2 = 0.04 P Value = 0.83			
Yes	64	101	63.4
No	113	182	62.1
Presence of disease condition			
Pearson chi2 = 1.06 P Value = 0.30			
Yes	98	150	65.3
No	79	133	59.4
Use of medication			
Pearson chi2 = 0.79 P Value = 0.40			
Yes	91	140	65.0
No	86	143	60.1

Table 2(continued). Prevalence of anaemia and potential risk factors

Factors	Respondents with anaemia	Total respondents	% with anaemia
Prescription of drug			
Pearson chi2 = 1.92 P Value = 0.17			
Yes	52	74	70.3
No	39	66	59.1
Change in eating pattern			
Pearson chi2 = 4.36 P Value = 0.04			
Yes	59	82	72.0
No	118	201	58.7

Factors	Respondents with anaemia	Total respondents	% with anaemia
Weight loss			
Pearson chi2 = 5.57 P Value = 0.02			
Yes	60	82	73.2
No	117	201	58.2
Food avoidance			
Pearson chi2 = 2.22 P Value = 0.14			
Yes	79	136	58.1
No	98	147	66.7
Dietary factors			
Consumption of meat products			
Pearson chi2 = 0.83 P Value = 0.66			
Often	82	135	60.7
Occasional	89	137	65.0
Never	6	11	54.6
Consumption of fish			
Pearson chi2 = 0.28 P Value = 0.87			
Often	171	274	62.4
Occasional	3	4	75.0
Never	3	5	60.0
Consumption of yellow/orange coloured vegetables			
Pearson chi2 = 0.54 P Value = 0.76			
Often	28	44	63.6
Occasional	79	131	60.3
Never	70	108	64.8
Consumption of green vegetables			
Pearson chi2 = 1.18 P Value = 0.28			
Often	143	234	61.1
Occasional	34	49	69.4
Never	-	-	-

Table 2(continued). Prevalence of anaemia and potential risk factors

Socio-demographic factor	Respondents with anaemia	Total respondents	% with anaemia
Consumption of chocolate drinks			
Pearson chi2 = 1.58 P Value = 0.45			
Often	69	109	63.3
Occasional	41	60	68.3
Never	67	114	58.8
Consumption of tea			
Pearson chi2 = 0.09 P Value = 0.95			
Often	87	139	62.6
Occasional	83	132	62.9
Never	7	12	58.3
Consumption of coffee			
Pearson chi2 = 0.10 P Value = 0.95			
Often	48	78	61.5
Occasional	97	153	63.4
Never	32	52	61.5
Consumption of fruits			
Pearson chi2 = 4.75 P Value = 0.03			
Often	141	236	59.8
Occasional	36	47	76.6
Never	-	-	-

3.1 Dietary Patterns of Respondents

The dietary factors studied were the food sources and frequency pattern of respondents. The food sources of interest were those, which contribute to iron building or its absorption: meat and fish products, orange/ yellow coloured vegetables, green leafy vegetables, fruits and beverages. The results showed that almost every participant (96.8%) took fish daily but as high as (82.7%) never ate snails (Table 3). All respondents consumed fruits and green vegetables with the majority, (83.4%) and

(82.7%) respectively eating them at often (daily to weekly) times. However, the consumption of yellow/orange (coloured vegetables) as well meat products was rare among most respondents (46.3% and 48.4% respectively). A daily to weekly intake of tea or chocolate was more among respondents rather than coffee.

3.2 Prevalence and Severity of Anaemia

The greater proportion of respondents, (63%) was found to be anaemic. The WHO criteria for describing the severity of the anaemia showed

Table 3. Regression of anaemic status associated with risk factors

Factor	Crude OR	Confidence interval at (95%)	P value
Age (years)			
50-59	1		
60-69	1.3	(0.7, 2.2)	0.39
70-79	1.9	(0.9, 4.0)	0.11
80 +	1.9	(0.7, 5.3)	0.22
Marital status			
Married	1		
Not Married	1.4	(0.9, 2.3)	0.17
Level of education			
None	1		
Primary+	1.1	(0.7, 1.7)	0.77
Occupational status			
Working	1		
Not Working	2.6	(1.3, 5.3)	0.01
Source of income			
Business	1		
Support	1.9	(1.1, 3.4)	0.02
Wealth quintile			
Poorest	1		
Poorer	1.2	(0.5, 2.8)	0.62
Poor	1.6	(0.7, 3.7)	0.25
Less Poor	2.4	(1.0, 5.7)	0.05
Least Poor	1.4	(0.6, 3.2)	0.46
Life style factors			
Alcohol			
Yes	1		
No	1.0	(0.6, 1.6)	0.83
Presence of disease condition			
Yes	1		
No	0.8	(0.5, 1.3)	0.30
Use of medication			
Yes	1		
No	0.8	(0.5, 1.3)	0.40
Prescription of drug			
Yes	1		
No	0.6	(0.3, 1.2)	0.17
Change in eating pattern			
Yes	1		
No	0.6	(0.3, 1.0)	0.04
Weight loss			
Yes	1		
No	0.5	(0.3, 0.9)	0.02

that most anaemic cases were severe (n=4,1%), mild (n=89,31%) or moderate (n=89, 31%) in severity. The prevalence of anaemia was highest (71.4%) among women of age 80years and older and of unmarried status (66.0%). Having a non-working status had a high prevalence of (78.9%) as well as dependence on family and friends' support or pension benefits as main source of income (72.7%). The study found that, the less poor (73.6%) and those who avoided certain foods, (66.7%) were anaemic. The presence of disease conditions, intake of medications (prescribed /un-prescribed) and the intake of alcohol did not show any significant difference in prevalence of anaemia. Majority of respondents (73.2%) who said they had lost some weight in the last month had anaemia. The prevalence of anaemia was high among respondents who reported that they only ate meat, fish, fruits and green vegetables occasionally. The same pattern was noticed for occasional drinkers of chocolate drinks and coffee.

3.3 Factors Associated with Anaemia

Data obtained from all 283 respondents were analysed to obtain the factors associated with anaemia. When factors were subjected to logistic regression, the following factors were found to be associated with anaemia at 95% level of confidence; respondents not working (OR: 2.6 (CI: 1.3-5.3)) respondents who depended on family and friends or pension benefits as main source of income (OR: 1.9 (CI: 1.1- 3.4)); respondents who had no change in eating pattern (OR:0. 6(CI:0. 3- 1.0)); respondents who reported no weight loss (OR:0. 51(CI:0. 3- 1.0)) and occasional consumption of fruits (OR: 2.2 (CI:1.1- 4.6)) (see Table 4).

The factors found significant in Table 4 were subjected to multivariable analysis. The factors that were not significant were removed from the model and the remaining factors were remodelled. This removal process was repeated until all factors were significant in the multivariable analysis. The factors that were found to be significant in the final model were; respondents not working at p=0.01, respondents with no weight loss at p= 0.03 and the occasional consumption of fruits at p= 0.04 as shown in Table 5.

4. DISCUSSION

The study sought to determine the factors associated with women with anaemia in a rural District close to the capital city of Ghana. The

prevalence of anaemia in the study population was 63% which compares to a community-based study carried out in rural areas of Chandigarh in India [8] and Uganda [9]. Using the WHO criteria [10] for describing the severity of anaemia, this study showed that most anaemic cases were either mild (31.0%) or moderate (31.0%) in severity. These types of anaemia are usually not given much clinical attention but could have serious health consequences and poor outcomes [11]. The prevalence of anaemia was highest among women of age 80years and older with comparatively lower prevalence as the age goes down to 50years. The increasing incidence of anaemia with age is supported by the decreased marrow reserve capacity with decreased hormonal responsiveness to haematologic stress [12].

In this study, anaemia was observed to be associated with respondents' non-working status and financial dependence on family and friends or pension benefits. Women who were not working were more than two times at risk of developing anaemia compared to those working. Similar studies have identified insignificant association of anaemia and reported financial independence [8]. Financial independence may affect the ability to afford healthy meals and therefore may be at a greater risk of anaemia. Factors associated with living in poverty such as an unhealthy environment are the cause of much ill-health and are compounded by ignorance, illiteracy, taboos and beliefs. The experience of ill-health in turn exacerbates household poverty due to loss of income and the cost of health care. This situation results in a vicious cycle.

Though the prevalence of anaemia was higher in respondents who were educated, (primary education and above), there was no association between anaemia and level of education.

Unlike other studies [9,13], this study found that the presence of disease conditions, intake of medications (prescribed /unprescribed) and the intake of alcohol did not show any significant difference in prevalence of anaemia. Mugisha et al. [9] had observed that the odds of anaemia were higher in those who had drunk alcohol in the past year compared to those who had not.

Fewer respondents who reported that they were eating less in the last month gave loss of appetite and general ill health as reasons for this change. Reports of possible weight loss in the last month were also reported with the majority having anaemia. Moreover a change in eating pattern

and weight loss were significantly associated with anaemia. Maintenance of healthy eating pattern and weight significant could serve as protective factors against anaemia. Consequently, women would benefit from strategies that could improve appetite and good health.

Risk of anaemia was significantly associated with the frequency of fruit intake. Women who ate

fruits occasionally (monthly or longer) were twice more likely of having anaemia as compared to those who took fruits often (at least weekly). Moreover, the consumption of fruits if less frequent put these women at 2.13 times at risk of anaemia compared to those who have at least weekly consumption. Vitamin C has been known to play an important role in the absorption of iron [14].

Table 4. Bivariate regression analysis of anaemia status and associated risk factor

Factor	Crude OR	95% C.I.	P-value
Food avoidance			
Yes	1		
No	1.4	(0.9, 2.3)	0.14
Dietary factors			
Consumption of meat products			
Often	1		
Occasional	1.2	(0.7, 2.0)	0.47
Never	0.8	(0.2, 2.7)	0.69
Consumption of fish			
Often	1		
Occasional	1.8	(0.2, 17.6)	0.61
Never	0.9	(0.2, 5.5)	0.91
Consumption of yellow/orange coloured vegetables			
Often	1		
Occasional	0.9	(0.4, 1.8)	0.70
Never	1.1	(0.5, 2.2)	0.89
Consumption of green vegetables			
Often	1		
Occasional	1.4	(0.7, 2.8)	0.28
Never	-	-	-
Consumption of chocolate drinks			
Often	1		
Occasional	1.3	(0.6, 2.4)	0.51
Never	0.8	(0.5, 1.4)	0.49
Consumption of tea			
Often	1		
Occasional	1.0	(0.6, 1.7)	0.96
Never	0.8	(0.3, 2.8)	0.77
Consumption of coffee			
Often	1		
Occasional	1.1	(0.6, 1.9)	0.78
Never	1	(0.5, 2.1)	1
Consumption of fruits			
Often	1		
Occasional	2.2	(1.1, 4.6)	0.03
Never	-	-	-

Table 5. Final multivariable analysis

Risk factors	Adjusted OR	95% C.I.	P value
Not working	2.49	(1.2, 5.1)	0.01
No Weight Loss	0.52	(0.3, 0.9)	0.03
Occasional consumption of fruits	2.13	(1.0, 4.5)	0.04

Iron, an important component of blood is known to be predominant in meat, poultry, fish, fruits, grains and vegetables. In this study however, the risk of anaemia was not different among respondents who ate some of the foods often and those who had them occasionally. It has been observed that anaemia-associated nutrient inadequacies are not uncommon in women regardless of race/ethnicity and added that single nutrient inadequacy is associated with a significant increase in risk of developing anaemia [15].

The maintenance of adequate body weight by respondents significantly prevented against anaemia compared to women who had lost weight. Beena et al. [16] supported encouraging women to eat adequately during age and avoid weight loss practices. Respondents in this study will benefit from nutrition counselling. They should be encouraged to resort to the available foodstuffs such as fish and green leafy vegetables that are abundant in such rural settings and are good source of iron.

The study was without limitations. The study would have benefited from a prospective cohort study in identifying the lifestyle factors associated with anaemia. However, this cross sectional study could provide useful background data for future research.

5. CONCLUSION

The risk factors associated with anaemia among women in the study area were poor intake of fruits and non-working status. There is therefore the need to intensify education on healthy eating, including daily intake of fruits.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. DeMaeyer E, Adiels-Tegman M: The prevalence of anaemia in the world. La prevalence de lanemie dans le monde. World Health Statistics Quarterly Rapport Trimestriel de Statistiques Sanitaires Mondiales. 1985;38(3):302-316.
2. Calis JC, Phiri KS, Faragher EB, Brabin BJ, Bates I, Cuevas LE, de Haan RJ, Phiri AI, Malange P, Khoka M: Severe anemia in Malawian children. New England Journal of Medicine. 2008;358(9):888-899.
3. Brooker S, Hotez PJ, Bundy DA. Hookworm-related anaemia among pregnant women: A systematic review. 2008;233(4):287-309.
4. Ronald LA, Kenny SL, Klinkenberg E, Akoto AO, Boakye I, Barnish G, Donnelly MJ. Malaria and anaemia among children in two communities of Kumasi, Ghana: A cross-sectional survey. Malaria Journal. 2006;5(1):105.
5. Humphries D, Mosites E, Otchere J, Twum WA, Woo L, Jones-Sanpei H, Harrison LM, Bungiro RD, Benham-Pyle B, Bimi L. Epidemiology of hookworm infection in Kintampo North Municipality, Ghana: Patterns of malaria coinfection, anemia, and albendazole treatment failure. The American Journal of Tropical Medicine and Hygiene. 2011;84(5):792-800.
6. O'Riordan E, Foley RN: Effects of anaemia on cardiovascular status. Nephrology Dialysis Transplantation. 2000;15(Suppl 3): 19-22.
7. Engmann C, Adanu R, Lu T-S, Bose C, Lozoff B. Anemia and iron deficiency in pregnant Ghanaian women from urban areas. International Journal of Gynecology & Obstetrics. 2008;101(1):62-66.
8. Tilak V, Tilak R: Geriatric anemia-a public health crisis in hematology. Indian J Prev Soc Med. 2012;43(2).
9. Mugisha JO, Baisley K, Asiki G, Seeley J, Kuper H, Shiff C. Prevalence, types, risk factors and clinical correlates of anaemia in older people in a rural Ugandan population. PloS One. 2013;8(10):e78394.
10. Organization WH. Iron deficiency anaemia: Assessment, prevention and control: A guide for programme managers; 2001.
11. Guralnik JM, Ershler WB, Schrier SL, Picozzi VJ. Anemia in the elderly: A public health crisis in hematology. ASH Education Program Book 2005. 2005;1:528-532.

12. Chambers SM, Shaw CA, Gatz C, Fisk CJ, Donehower LA, Goodell MA. Aging hematopoietic stem cells decline in function and exhibit epigenetic dysregulation. *PLoS Biol.* 2007;5(8): e201.
13. Ferrucci L, Maggio M, Bandinelli S, Basaria S, Lauretani F, Ble A, Valenti G, Ershler WB, Guralnik JM, Longo DL. Low testosterone levels and the risk of anemia in older men and women. *Archives of Internal Medicine.* 2006;166(13):1380-1388.
14. Nair KM, Iyengar V. Iron content, bioavailability & factors affecting iron status of Indians. *Indian J Med Res.* 2009; 130(5):634-645.
15. Thomson CA, Stanaway JD, Neuhauser ML, Snetselaar LG, Stefanick ML, Arendell L, Chen Z. Nutrient intake and anemia risk in the women's health initiative observational study. *Journal of the American Dietetic Association.* 2011; 111(4):532-541.
16. Sachan B, Idris MZ, Jain S, Kumari R, Singh A. Age at menarche and menstrual problems among school-going adolescent girls of a North Indian District. *Journal of Basic and Clinical Reproductive Sciences.* 2012;1(1-2):56-59.

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