Effect of Selected Dietary Supplements on Haemoglobin Status of Female Military Recruits

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Abstract

Background: During General Military Training, female military recruits undergo vigorous physical stress. A significant proportion of individuals experience the medical condition known as anaemia which further deteriorates due to training activities.

Objective: To determine the effectiveness of selected dietary supplements in improving the haemoglobin status of female military recruits in the Army Medical Corps Centre and School.

Methods: The study was experimental, following one sample pre-test and post-test design. It was conducted among 48 female military recruits undergoing General Military Training at the Army Medical Corps Centre and School. Selected dietary supplements were administered among the participants for six and half months in addition to the standard menu. Their haemoglobin status was determined by three consecutive laboratory tests.

Results: In the initial test, 66.7% of female recruits were found anaemic and the mean haemoglobin level was 11.477 ±1.099. After administering selected dietary supplements, 33.3% and 27.1% were found anaemic after three months and six and half months and the mean haemoglobin levels were 12.215±0.917 and 12.538±0.937 respectively. Statistically significant differences were found among the mean haemoglobin level of the three consecutive tests (P<0.05).

Conclusion: Considering the health condition of newly enrolled female military recruits, the daily menu can be revised by adding selected diets and dietary supplements during General Military Training. Periodic screening for haemoglobin status may be recommended.

Keywords: Female military recruits, Anaemia, Hemoglobin level, Dietary supplements.

Introduction

Bangladesh is a Southeast Asian developing country. Anaemia is a common public health issue that impacts about 27 million women, children and adolescents in Bangladesh.[1] A high prevalence of anaemia was also observed among this population of rural Bangladeshi pregnant women.[2] According to the World Health Organization[3], the prevalence of anaemia is estimated to be 40% among children aged 6-59 months, 37% among pregnant women and 30% among women aged 15-49 years globally in 2023.

In the Bangladesh Army, female recruits undergo 9 months of intense military training. It encompasses physical training, including running, push-ups, reach-ups, chin up, drill, small arms firing and long marches. They take the standard diet as per the supply protocol. The military recruits join Bangladesh army following structured recruiting procedures, including health check-ups. However, it has been observed in the last few years that many female recruits develop anaemia during their training period.

The training of female military recruits demands substantial physical and mental endurance. Iron deficiency was identified as being extremely prevalent among female recruits.[4] Iron deficiency anaemia reduces the physical fitness of trainees during military training.[5] Similarly, women serving in active military units and female athletes might face heightened vulnerability to iron deficiency and its associated adverse consequences.[6,7] A significant concern for females in the military is iron deficiency, which may be facilitated by insufficient iron consumption and the iron loss that occurs during menstruation.[4] Poor iron status was associated with delayed run times, which indicated impaired aerobic fitness during Basic Combat Training.[8] Ensuring sufficient amounts of dietary iron intake, absorption, storage, and cellular uptake is of paramount importance for the enhancement of endurance performance.

Inadequate nutrition significantly contributes to vitamin and mineral deficiency and consequently, anaemia.[9] Iron deficiency is the predominant dietary factor contributing to anaemia.[3] Other than iron, Mn, Ca, Mg, Na, K, Co, iodine, P, Se, Cu, Li, and Zn also have an essential role in hematopoiesis.[10] Micronutrients such as folates, vitamin B12 and vitamin A have also been linked to anaemia.[11] The correct formation of haemoglobin necessitates the presence of folate riboflavin, and a lack of micronutrients might result in anaemia due to insufficient red blood cell synthesis.[9] Iron is a crucial micronutrient that plays a vital role in oxidative metabolism and is of utmost importance for optimal exercise performance.

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The presence of low iron levels has been demonstrated to have adverse effects on both general well-being and physical capabilities.[12] There exist two distinct categories of dietary iron, namely heme and nonheme. Nonheme iron is present in plant-based diets and fortified food products. Heme iron is obtained from animal sources such as meat, poultry and fish.[13] Regardless of the type of iron consumed, the minimum daily dietary requirement for this mineral among women aged 19 to 30 years is 18 mg/d. Foods or beverages high in bran, dietary fiber, calcium, tannins (in tea and coffee), oxalates, phytates, and polyphenols (in certain plant-based foods) can interfere with absorption. Foods rich in ascorbic acid (vitamin C), such as citrus fruit, broccoli, mango, pineapple and guava, in contrast, will facilitate the absorption of iron.[13]

Folic acid has a crucial role in the promotion of erythropoiesis, the process of red blood cell production.[14] It is found in citrus juices, dark green leafy vegetables, legumes and fortified cereals. Foods with high levels of vitamin B-12 include meat and dairy.[14]

Haemoglobin is crucial in transporting oxygen to various tissues and organs inside the human body. Anaemia is a medical disorder distinguished by a reduced haemoglobin concentration inside the bloodstream. It is classified as mild, moderate or severe based on the haemoglobin concentrations in the blood. Mild anemia corresponds to a level of haemoglobin 10.0-11.9 g/dl for non-pregnant women. For all tested groups, moderate anaemia corresponds to a level of 7.0-9.9 g/dl while severe anaemia corresponds to a level less than 7.0 g/dl.[15] Myhre et al[16] found that the prevalence rates of borderline, moderate and severe anaemia among female US Air Force basic trainees were 12.6%, 10.9% and 1.9% respectively.

Diets and dietary supplements can play a significant role in preventing and treating anaemia. The banana is widely consumed in several locations with a high prevalence of iron deficiency, making it a promising candidate for iron fortification.[17] They are considered to be a valuable dietary source of several essential vitamins and minerals, with notable concentrations of potassium, vitamin B6 and vitamin C.[18] Animal liver is considered to be a very nutritious meal due to its substantial content of iron, riboflavin, vitamin B12, vitamin A and copper.[19] Plantain (raw banana) and beef liver are two dietary supplements available in the present context. They contain food ingredients (Table-I) which might help improve the haemoglobin status of female military recruits.

Materials and Methods

The study was experimental, following one sample pre-test and post-test design. The plan of study is shown in Figure-1.
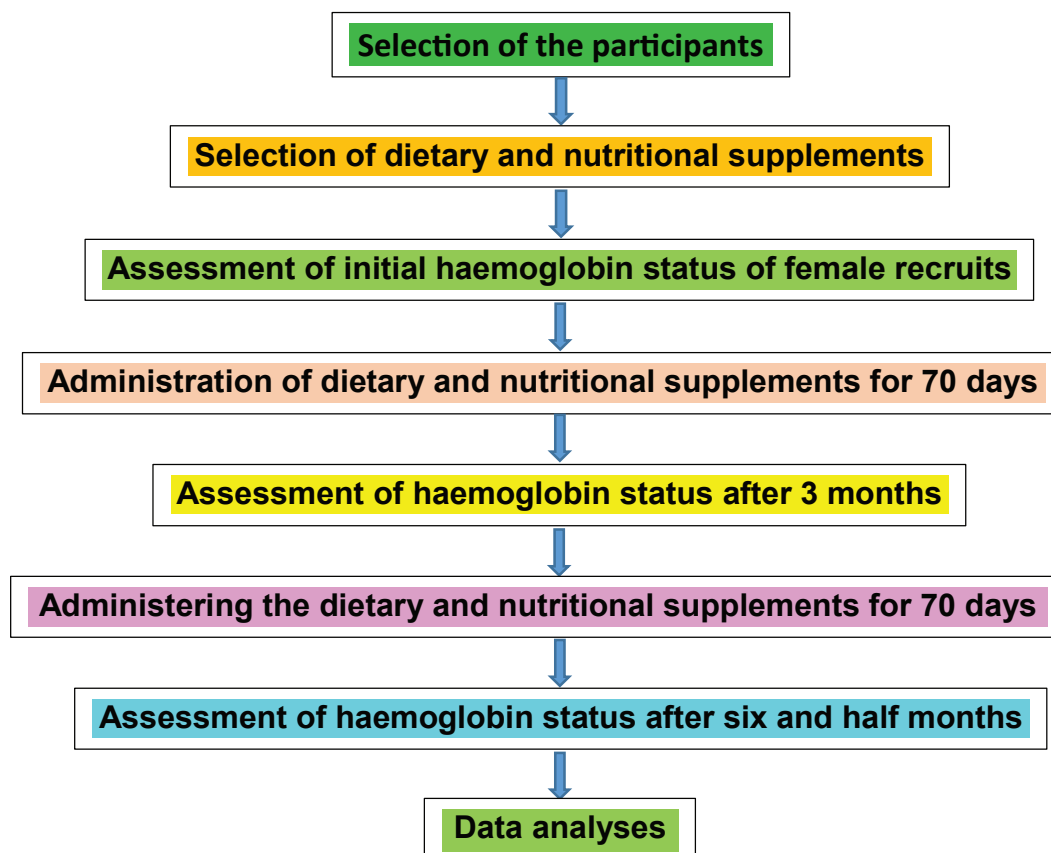

Figure-1: Flow-chart showing the sequence of events of the study.

Table-I: Food composition of beef liver and plantain (raw banana)

Food Name	Edible portion co-efficient	Energy (Kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Total Dietary Fibre (g)
Beef Liver, Raw	1.00	547	70.8	20.4	3.6	3.9	0
Plantain Raw	0.66	327	78.9	2.0	0.3	15.5	2.3

	Ash (g)	Ca (mg)	Fe (mg)	Mg (mg)	P (mg)	k (mg)	Na (mg)	Zn (mg)	Cu (mg)
Beef Liver, Raw	1.3	4	3.5	18	387	313	69	3.71	1.50
Plantain, Raw	1.0	22	0.6	28	21	242	4	0.14	0.08

	Vit-A (mcg)	Retinol (mcg)	Beta Carotene Equivalent (mcg)	Vit-D (mcg)	Vit-E (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)
Beef Liver, Raw	4968	4948	244	1.2	0.38	0.19	2.76	13.2
Plantain, Raw	56	0	676	0	0.14	0.09	0.06	0.9

	Vit- B6 (mg)	Folate (mcg)	Vit- C (mg)	
Beef Liver, Raw	1.083	290	1.3	Source: Food Composition Table for Bangladesh, Institute of Nutrition & Food Science, Centre for Advance Research in Science, University of Dhaka.
Plantain, Raw	0.299	22	7.3	

In 2023, female recruits joined the Army Medical Corps Centre and School in February 2023 for General military training. They have been termed as female military recruits for the present study. Forty-eight female recruits willing to participate were selected as study participants. Ethical clearance for the study was taken from Combined Military Hospital, Ghatail. After explaining the purpose of the study, written informed consents were obtained from the female recruits. In the consent form, it was mentioned that the data obtained from them would be used anonymously, and they could withdraw from the study at any point in time. In this study, plantain (raw banana) and beef liver (in exchange of beef) were administered during the study period (six and half months) as a supplementary diet. One plantain (as vorta/ vegetable) was administered daily and 226 gm beef liver twice a week. Tablets containing Iron (150 mg) and folic acid (0.5 mg) in combination, and Vitamin C (Ascorbic Acid, 250 mg) were also administered in single doses each daily. For the present study, all these administered items were collectively termed as selected dietary supplements.

Five (5) ml of Intravenous blood samples of 48 female recruits were collected (as shown in Figure-2) on March, June, and September 2023 consecutively. Haemoglobin level was estimated via Sysmex XN-550 Hematology Auto Analyzer (Figure-2). The data were analyzed with SPSS v25. The normality of data was tested, and ANOVA was done to determine the differences between the means of the haemoglobin level in three consecutive laboratory tests. P value below 0.05 was considered significant.

Figure-2: Photographs showing intravenous blood sample collection procedure from the participant's hematology Auto Analyzer.

Results

All the participants were female recruits within the age group of 18-19 years. They underwent general military training during the period of study. They were from different parts of the country, as shown in Table-II. Most of them (85%) had regular menstrual cycles and all of them took anthelmintic tablets within the last six months. None of them had a known hereditary blood disorder or mentionable history of illness.

In the first laboratory test, the mean Hb level was 11.477± 1.099 and in the final test, the mean Hb level was 12.538± 0.935. Descriptive statistics of Hb status are shown in Table-III. One way ANOVA was done to determine the difference between means of 3 estimates and found significant.

Table-II: Demography of the participants

Age	18-19 years
Location (Division)	Dhaka- 16 (33.3%)
	Chittagong- 7 (14.6%)
	Rajshahi- 4 (8.3%)
	Khulna- 9 (18.8%)
	Barishal- 5 (10.4%)
	Sylhet- 4 (8.3%)
	Rangpur- 3 (6.3%)
Residence	Rural area- 95%
	Urban area-5%
Mean Body Mass Index (BMI)	15.7±1.861kg/m²
Menstrual History	Regular

Table-III: Mean, SD and Confidence Interval of Haemoglobin levels in 3 consecutive tests and difference of means by ANOVA

Variable	S	Mean±SD	95% Confidence Interval		Significance (P Value)
			Lower Bound	Upper Bound	
Hb level (g/dl)	1	11.477±1.099	11.158	11.796	
	2	12.215±0.917	11.948	12.481	0.000
	3	12.538±0.937	12.265	12.899	

Discussion

The study was conducted among 48 female military recruits. All the participants were below 21 years old and unmarried (According to the Policy of enrollment of Army Training and Doctrine of Command). In the initial test, their mean Hb level was 11.4 g/dl. According to World Health Organization[20] report in the year 2019, the mean Hb level of women of childbearing age (15-49 years) in Bangladesh is 12.3 g/dl. Yanovich et al[21] commented that during heightened physical activity and tension among combatants, certain hematological variables are negatively influenced. It can be assumed that General military training had an adverse influence on the Hb level of female military recruits of the present study. A high incidence of anaemia and iron deficiency is usually found among persons who engage in extended periods of strenuous training.[22]

Most of the female recruits of the present study came from rural areas. About one-third of the participants were from the Dhaka division. In the initial test of the present study, the mean Hb level was highest among the participants from Dhaka (12 g/dl) and lowest among the participants from Rajshahi division (10.2 g/dl). Since the number of participants was small, it might not represent the overall scenario of the country. This low haemoglobin level may be due to low socioeconomic background and lack of awareness among females in the country.

Anaemia is a significant public health problem among children below five years of age in Bangladesh due to recurrent intestinal parasite infections. In adolescence, deworming pills and hand-washing help prevent anaemia.[1] Welch et al[23] found that implementing mass deworming initiatives is likely to decrease the occurrence of soil-transmitted helminth infections. However, its impact on anaemia and iron-deficiency among teenage girls and non-pregnant women may be minimal or inconsequential.[24] However, all the participants of the present study had anthelmintics within 6 months.

In the initial test before administering the selected dietary supplements, 66.7% of female recruits were found anaemic. Of them, 60.4% were mildly anaemic and 6.3% moderately anaemic. According to Spring-Nutrition[25], in the year 2011, 39.9% of women of childbearing age in Bangladesh were found to be anaemic. Among them, 34.4%, 5.2% and o.2% had mild, moderate and severe anaemia, respectively. From the findings, it is evident that the prevalence is higher among female military recruits.

Dietary sources and supplements are crucial for promoting optimal health and enhancing physical performance.[12] The provision of nutritionally enhanced lunches and Iron Folic Acid supplements has yielded the most significant reductions in anaemia among female garment employees through workplace nutrition programs.[26] Beef liver and plantain (raw banana) were selected as supplements because they rich in iron, Vitamin B12, Folic acid, Vitamin A, copper and other constituents required for haemoglobin synthesis. Mostly, nutritional deficiency is caused by iron deficiency, folate, Vitamin B12 and Vitamin A deficiency.[3] Vitamin C Tablet was administered to fortify their immunity and increase iron absorption. Plantain is readily available and inexpensive. Beef liver is also available and can be given from the Government issue of fresh ration.

In the initial test before administering the supplement, the mean Hb level was below 12 g/dl. At the end of six and a half months, the mean Hb level improved significantly. A gradual improvement in haemoglobin levels was observed over the study period.

Limitation

Larger sample would have yielded a better result. For convenience, female military recruits of one Military Training Centre and School were selected as participants. Iron status of the participants was not addressed in the study. There was no control group for the study.

Conclusion

In light of the health status of newly enrolled female military recruits, it is advisable to modify the daily menu by incorporating specific diets and nutritional supplements throughout General Military Training. Plantain (raw banana), beef liver, Iron folic Acid and Vitamin C supplements, enhanced the haemoglobin status of female recruits. Including these dietary supplements in the regular menu may be advisable for female military recruits. Periodic screening for haemoglobin status as a means of detecting the presence of anaemia may be considered.

References

1. Institute of Public Health Nutrition (IPHN). National Strategy for Anaemia Prevention and Control in Bangladesh. Available from: https://www.nnsop.gov.bd › storage › files

2. Hyder SZ, Persson LÅ, Chowdhury M, Lönnerdal BO, Ekström EC. Anaemia and iron deficiency during pregnancy in rural Bangladesh. Public Health Nutrition. 2004; 7(8):1065-70.

3. WHO. Anemia; 2023 [updated 2023, cited 10 Nov 23]. Available from: https://www.who.int/health-topics/anaemia#tab=tab_

4. Israeli E, Merkel D, Constantini N, Yanovich R, Evans RK, Shahar DA, Moran DS. Iron deficiency and the role of nutrition among female military recruits. Med Sci Sports Exerc. 2008; 40(11 Suppl):S685-90.

5. Wilson C, Lynn A. Training and Health Outcomes of Women Diagnosed with Iron Deficiency Anemia During Basic Military Training. Uniformed Services University of the Health Sciences, USA (59th MDW). 2012:1-20.

6. Alaunyte I, Stojceska V, Plunkett A. Iron and the female athlete: A review of dietary treatment methods for improving iron status and exercise performance. JISSN. 2015; 12(1):38.

7. McClung JP, Gaffney-Stomberg E, Lee JJ. Female athletes: A population at risk of vitamin and mineral deficiencies affecting health and performance. J Trace Elem Med Biol. 2014; 28(4):388-92.

8. Martin NM, Conlon CA, Smeele RJ, Mugridge OA et al. Iron status and associations with physical performance during basic combat training in female New Zealand Army recruits. Br J Nutr. 2019; 121(8):887-93.

9. Abbaspour N, Hurrell R, Kelishadi R. Review on iron and its importance for human health. Journal of research in medical sciences: The Official Journal of Isfahan University of Medical Sciences. 2014; 19(2):164.

10. Oliveira DC, Nogueira-Pedro A, Santos EW, Hastreiter A, Silva GB, Borelli P et al. A review of select minerals influencing the haematopoietic process. Nutrition Research Reviews. 2018; 31(2):267-80.

11. Loechl CU, Datta-Mitra A, Fenlason L, Green R, Hackl L, Itzkowitz L et al. Approaches to address the anemia challenge. The Journal of Nutrition. 2023; 153(Suppl 1):S42-S59.

12. DellaValle DM. Iron supplementation for female athletes: Effects on iron status and performance outcomes. Current Sports Medicine Reports. 2013; 12(4):234-9.

13. Wilson C, Brothers M. Iron deficiency in women and its potential impact on military effectiveness. Nursing Clinics. 2010; 45(2):95-108.

14. American Society of Hematology. Washington DC: Anemia, 2021 [updated 2023; cited 2023 Nov]. Available from: https://www.hematology.org/education/patients/anemia.

15. Kariyeva GK, Magtymova A and Sharman A. Anemia. 2002:1-7. Available from https://api.semanticscholar.org/CorpusID:14745980.

16. Myhre KE, Webber BJ, Cropper TL, Tchandja JN, Ahrendt DM, Dillon CA et al. Prevalence and impact of anemia on basic trainees in the US air force. Sports Medicine-Open. 2016; 2(1):1-7.

17. García OP, Martínez M, Romano D, Camacho M et al. Iron absorption in raw and cooked bananas: A field study using stable isotopes in women. Food & Nutrition Research. 2015; 59(1):25976.

18. AShill KB, Karmakar P, Kibria MG, Das A, Rahman MA, Hossain MS et al. Prevalence of iron-deficiency anaemia among university students in Noakhali region, Bangladesh. Journal of Health, Population and Nutrition. 2014; 32(1):103.

19. Healthline. Bananas 101: Nutrition Facts and Health Benefits. Healthline Media LL; 2023 [updated 2023, cited 2023 Nov 10]. Available from: https://www.healthline.com/nutrition/foods/bananas.

20. WHO. Mean hemoglobin level of women of reproductive age (aged 15-49 years); 2019 [updated 2023, cited 2023 Nov 10]. Available from: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/mean-hemoglobin-level-of-women-of-reproductive-age-(aged-15-49-years).

21. Yanovich R, Merkel D, Israeli E, Evans RK, Erlich T, Moran DS. Anemia, iron deficiency and stress fractures in female combatants during 16 months. JSCR. 2011; 25(12):3412-21.

22. Epstein D, Borohovitz A, Merdler I, Furman M, Attali E, Sorkin A et al. Prevalence of iron deficiency and iron deficiency anemia in strenuously training male army recruits. Acta Haematologica. 2018; 139(3):141-7.

23. Welch VA, Ghogomu E, Hossain A, Awasthi S, Bhutta ZA et al. Mass deworming to improve developmental health and wellbeing of children in low-income and middle-income countries: A systematic review and network meta-analysis. The Lancet Global Health. 2017; 5(1):e40-50.

24. Ghogomu ET, Suresh S, Rayco-Solon P, Hossain A, McGowan J et al. Deworming in non-pregnant adolescent girls and adult women: A systematic review and meta-analysis. Systematic Reviews. 2018; 7(1):1-6.

25. Spring-Nutrition. National Anemia Profile. Available from: https://www.spring-nutrition.org/publications/series/national-anemia-profiles/bangladesh.

26. Hossain M, Islam Z, Sultana S, Rahman AS, Hotz C, Haque MA et al. Effectiveness of workplace nutrition programs on anemia status among female readymade garment workers in Bangladesh: A program evaluation. Nutrients. 2019; 11(6):1259.