ORIGINAL ARTICLE

Risk factors associated with anaemia among adolescent girls: a cross sectional study in District Peshawar, Pakistan

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Abstract

Objective: To assess the risk factors associated with anaemia among adolescent girls.

Methods: The cross-sectional study was conducted at 10 schools in district Peshawar, Khyber Pakhtunkhwa, Pakistan, and comprised adolescent girls aged 10-14 years who were divided into two equal groups on the basis of haemoglobin levels; group 1 had those with haemoglobin <12, and group 2 ≥12gm/dl. Anthropometric measurements were taken and haemoglobin concentration was determined by the Hemo'cue method. Physical activity was determined by Modified Harvard step test, cognitive functions were assessed by Raven's Coloured Progressive Matrices. SPSS 16 was used for data analysis.

Results: Of the 100 subjects, 50(50%) each were in the two groups. Illiteracy rate was significantly higher among the fathers and mothers of group 1 girls ($p \leq 0.05$). Mean haemoglobin in group 1 was 10.28±1.33 g/dl and group 2 12.73±0.58 g/dl. Mean number of steps climbed by group 1 girls were 154.6±54.6 and a longer period of time was taken to recover the basal pulse rate by them compared to group 2 counterparts ($p \leq 0.05$). The mean resting pulse rate in group 1 was significantly higher compared to group 2 ($p \leq 0.05$). Also, group 1 scored significantly lower in the cognitive function test($p \leq 0.05$).

Conclusion: Socio-economic status, parent education, body mass index, physical work capacity, cognitive function of anaemic girls was significantly lower than non-anaemic girls.

Keywords: Anaemia, Cognitive function, Physical work capacity, Raven's Coloured Progressive Matrices. (JPMA 69: 1591; 2019). **doi: 10.5455/JPMA.295006.**

Introduction

The adolescents represent a nutritionally vulnerable segment of population, as adolescence is a period of rapid physical and psychological growth. Increased nutrient requirements combined with the marginal nutrient intake place this group at a risk of various deficiency diseases.[1] Among nutritional deficiencies, anaemia affects a large fraction of female population, particularly adolescents and pregnant women.[2] Anaemia is globally considered a serious public health issue which affects 1.62 billion people, including 25.5% of school-going adolescent girls worldwide.[3] In the developing countries, 27% adolescent girls are found to be anaemic compared to only 6% in the developed countries.[4] In Pakistan, 39% adolescent girls and 20% adolescent boys are anaemic with a haemoglobin (Hb) level <10mg/dl.[5]

Anaemia in adolescents is mainly caused by iron deficiency due to the increased iron demand for pubertal growth, increased blood volume, and menstrual losses. Limited iron intake in the diet is another reason.[6] Reduction in the physical work capacity is due to the reduced Hb concentration, which leads to less oxygen availability to the tissues and cardiac output.[7] Decreased Hb is in turn due to the reduction in iron store affecting physical performance, and results in minimal oxygen consumption among anaemic subjects during exercise.[8] Cognitive function is affected due to the alteration in iron content of the brain and neurotransmitters.[9] Moreover, anaemia can cause the impairment of iron-dependent enzymes such as noradrenalin, serotonin, and dopamine that are important for normal functioning of the neurotransmitters.[10]

The risk factors associated with anaemia during

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adolescence justify the need for interventions, as most of the programmes are usually designed to prevent anaemia in infants, young children, lactating and pregnant women, but not necessarily in adolescents whose needs remain neglected despite them being at a high risk of facing detrimental health effects. The current study was planned to determine risk factors associated with anaemia among school-going adolescent girls.

Subjects and Methods

The cross-sectional study was conducted at 10 high schools in district Peshawar, Khyber Pakhtunkhwa (KP), Pakistan, from October 2016 to June 2017, using convenience sampling and giving consideration to the fact that the selected sample should cover the geographical, ethical and economic variability of the study region. Those included were school-going adolescent girls aged 10-14 years. Those with blood Hb level <12 g/dl were taken as cases, and those with Hb ≥12 g/dl acted as controls.[2] Girls with terminal illness, physical disability, chronic diseases, and metabolic disorders were excluded, and so were those who failed to provide informed consent.

A pre-designed and pre-tested questionnaire was used for data collection regarding socio-demographic, anthropometry, dietary intake pattern, physical work capacity and cognitive function of the subjects.

Data regarding age, gender, socioeconomic status, family size, family education, family occupation and family type were collected by interviewing the subjects, and were recorded. Water/Sanitation, Assets, Maternal education and Income (WAMI) index was used to measure socio-economic status (SES). This includes four variables, i.e., access to improved water and sanitation, mother's year of schooling up to 16 years, presence of 8 priority assets, and monthly household income. Each variable was scaled ranging 0-8. The scores were summed up and divided by 32 to obtain WAMI index range 0-1; 0 denoting poor SES, and 1 denoting high SES. All score were converted into quintiles.[11]

Nutritional status of the subjects was assessed by measuring their weight, height, and body mass index (BMI) using standard procedures. Height for age and weight for age z-score was determined using World Health Organisation (WHO) growth standards.[12] Blood Hb concentration was determined by using Hemocue method, while the dietary intake pattern was assessed using a 24-hour recall method.

Physical work capacity of the subjects was assessed using Modified Harvard's Step test with slight modification.[13] Pulse rate of the subjects was first checked at rest, and they were asked to climb up and down a set of five steps for up to three minutes as fast as they could. The total number of steps climbed up and down was counted.[13] Pulse rate of the subjects was measured after the physical activity and was recorded after every minute up to 3 minutes.[14] A specially-designed intelligence quotient (IQ) questionnaire, Raven's Coloured Progressive Matrices, obtained from the Psychology Department of the University of Peshawar, was used for this purpose. Time for the test was 30-60 minutes. It is a very simple and easy test which is culture-free, language-free, nationality-free, and usually covers a wide range of age and ability. It is used to assess a person's immediate capacity for observation, clear thinking and accurate intellectual work.[15]

Data was analysed using SPSS 16.[16] Descriptive statistics like mean and standard deviation (SD) were used for quantitative variables, and frequencies and percentages for qualitative variables. Association between categorical

Table-1: Socioeconomic and demographic status of the school-going adolescent girls.

Variables		Non-anaemic (%)	Anaemic (%)	p-value[1]
Mean Age (years)		11.66±1.23	11.86± 1.52	
Family Type	Joint	27 (54.0%)	25 (50.0%)	0.689
	Nuclear	23 (46.0%)	25 (50.0%)	
Family size[2]	<5	1 (2.0%)	1 (2.0%)	1.00
	>5	49 (98.0%)	49 (98.0%)	
Father occupation	Government	17 (34.0%)	24 (48.0%)	0.191
	Private job	33 (66.0%)	26 (52.0%)	
Father education	Illiterate	1 (2.0%)	10 (20.0%)	0.001*
	<intermediate	18 (36.0%)	26 (52.0%)	
	≥intermediate	31 (62.0%)	14 (28.0%)	
Mother occupation	Government	3 (6.0%)	0 (0.0%)	0.173
	Private job	2 (4.0%)	1 (2.0%)	
	House wife	45 (90.0%)	49 (98.0%)	
Mother education	Illiterate	19 (38.0%)	28 (56.0%)	0.265
	<intermediate	28 (56.0%)	21 (42.0%)	
	≥intermediate	3 (6.0%)	1 (2.0%)	
Socioeconomic Status	(WAMI Index)<0.4	13(26.0%)	39 (78.0%)	0.000*
	0.4-0.5	17 (34.0%)	7 (14.0%)	
	>0.5	20 (40.0%)	4(8.0%)	

Plus-minus values is mean± SD; [1]p-value was calculated using a Chi-square test using 2-sided method (accepted level is 0.05); [2]Fisher's exact test was used for categories with cell/cells having expected coun less than 5;*the samples from the two groups are significantly different (p-value <0.05); WAMI: Water/Sanitation, Assets, Maternal education and Income. Quintiles (<0.4=40 (Low SES), 0.4-0.5=60 (Med SES), ≥0.5=80 (high SES).

Table-2: Anthropometric, haemoglobin (Hb) concentration, and daily dietary intake of school-going adolescent girls.

Variables		Anaemic (n=50)	Non-anaemic (n=50)	*p*-value
Body Mass Index **(BMI)**				
Underweight (Body Mass Index Z- score <-2)		18(36.0)	14(28.0)	0.391*
Normal (-2 Body Mass Index Z- score <2)		32(64.0)	36 (72.0)	
Anaemia classification				
Mild anaemia (11.0-11.9 g/dl)		21 (42.0)	NA	
Moderate anaemia (8.0-10.9 g/dl)		27 (54.0)	NA	
Severe anaemia (<8.0 g/dl)		2 (4.0)	NA	
Haemoglobin level (g/dl)		10.28 ± 1.33	12.73 ± 0.58	0.000**
Dietary intake	**RDA**			
Carbohydrates	275 gm	189.6 ± 32.93	249.6 ± 23.45	0.000**
Protein	55 gm	43.0 ± 10.10	56.9 ± 12.18	0.000**
Fats	97gm	39.2 ± 14.77	51.8 ± 10.71	0.000**
Total energy (Kcal)	2200 Kcal	1234.4 ± 216.11	1867.6 ± 216.64	0.000**
Iron	15mg	13.15 ± 4.02	20.2 ± 7.76	0.000**
Vitamin C	45mg	20.4 ± 38.55	38.0 ± 22.32	0.006**

BMI, Body mass index; numbers in parentheses are numbers and percentages; plus-minus values are means ± SD. RDA: Recommended Dietary Intake. *p-value was calculated using a Chi-square test using 2-sided method (accepted level is 0.05) **Independent sample t test significant at p ≤ 0.05; 10th Edition of the RDAs, Food and Nutrition Board, Commission on Life Sciences. 1994.

variables was tested with Chi-square test. Independent t-test was applied to compare the means between cases and controls for physical work capacity and cognitive functions. Correlation of different variables with anaemia was determined using Pearson's correlation test.[17] All tests were performed at a significance level of 0.05.

Results

Of the 100 subjects, 50(50%) each were in the two groups. Illiteracy rate was found significantly higher (p≤0.05) among the cases 10(20%) compared to the controls 1(2%) (Table 1). Anaemia was more prevalent in adolescent girls whose families scored less than 0.4 om the WAMI index 34(78%). Among the families of the control group, 20(40%) scored >0.5.

There were 17(34%) underweight girls among the cases compared to 14(28%) controls.[12] Mean Hb concentration of the cases was 10.28±1.33 gm/dl, which was significantly lower (p≤0.05) compared to the controls 12.73±0.58mg/dl. The cases had significantly lower (p<0.05) intake of carbohydrates, protein and fats than the Recommended Dietary Allowance (RDA) (Table 2).

Mean number of steps climbed by the cases were 154.6±54.6 and a longer period of time was taken to recover the basal pulse rate by them compared to the controls (p≤0.05). The mean resting pulse rate in the cases was significantly higher compared to the controls (p≤0.05). Also, the cases scored significantly lower in the cognitive function test (p≤0.05).

Bivariate regression analysis showed a significant positive correlation (r =.685; p<0.05) between Hb level and total intelligence scores of the school-going adolescent girls.

Table-3: Physical work capacity and cognitive function test score of school-going adolescent girls.

Variables	Anaemic Mean ± S.D	Non-anaemic Mean ± S.D	t -value	*p* -value
Modified Harvard's Step test				
Time taken for activity(minutes)	1.1± 0.42	1.7±0.44	5.880	0.000*
Number of steps covered	154.6 ± 54.6	251.6± 79.9	7.085	0.000*
Pulse rate taken at rest (Beats/minutes)	95.0±12.9	87.5±6.27	-.423	0.000*
Pulse rate after 1min of activity (beats/minutes)	123.7 ±15.8	134.1 ±16.2	3.257	0.002*
Pulse rate after 2min of activity(beats/minutes)	109.0±14.7	115.6±15.9	2.150	0.034*
Pulse rate after 3min of activity(beats/minutes)	102.1±13.3	101.4±12.6	-.108	0.914*
Cognitive function test score				
A***	7.3±1.96	10.3 ± 0.83	9.983	0.000*
AB****	4.5±1.98	9.7±1.08	16.218	0.000*
B*****	3.7±1.66	8.00±1.46	13.763	0.000*
Total score	15.5±4.75	28.00±2.38	16.626	0.000*
Percentile	5th %-10th %	Above 75%		
Grade	IV,V, intellectual defective	II, Definitely above the average in intellectual capacity		
Correlation of haemoglobin level and total intelligence score				
		Total intelligence score		**p-value**
Haemoglobin		r =.685		0.000**

*Independent sample t-test significant at p ≤ 0.05; **Correlation at p ≤ 0.01; ***A means child's ability to complete the continuing patterns, ****AB means child's ability to perceive the separate forms as one gestalt on the basis of spatial relations and *****B means depends on the development of the child's ability in abstract thinking.

Discussion

The current study is the first to assess the risk factors associated with anaemia in school-going adolescent girls in KP province of Pakistan. Illiteracy rate was found to be higher among the parents of anaemic girls. In contrast, higher education level was found in fathers of non-anaemic girls (62%). A study conducted on adolescent girls reported that fathers and mothers' education was positively associated with Hb

level of low as well as high SES.[17,18] Anaemia was more prevalent in adolescent girls, who belonged to low SES families (78%). The result was supported by a previous study.[19] Majority of anaemic girls were underweight (34%) and no obesity was reported.[12] Furthermore, mostly anaemic girls had moderate anaemia (54%) followed by 42% mild and 4% severe anaemia.[2] Similar results have been reported earlier.[14] Macronutrient intake of the anaemic girls was lower than RDA, micronutrient intakes, such as iron and vitamin C of the anaemic girls were statistically lower than the mean intake of non-anaemic, indicating that anaemia was associated due to low dietary intake of iron and vitamin C. These findings were in line with a previous study.[13] One study previously reported average energy and protein intake of the subjects as 1513.5±6.94 kcal and 45.5±9.8g, respectively.[19] The values were very much lower than those recommended by Indian Council of Medical research (ICMR).[20] However, improving dietary intake could prevent anaemia; anaemic subject whose mean Hb level was 8mg/dl significantly improved to 9mg/dl through dietary intake of iron and vitamin C-rich fruits and vegetables.[21]

The current study found that anaemia was likely to compromise physical work capacity of school-going adolescent girls. Physical work capacity test revealed that the mean time spent (1.1±0.42 minutes) in activity by anaemic girls was shorter, and they got tired easily while having climbed less number of steps (154.6±54.6) compared to the non-anaemic girls who climbed significantly higher ($p \leq 0.05$) number of steps over a long period of time. The results are parallel with a study which determined that the time taken by adolescent anaemic girls for physical activity was shorter (1.30 minutes) compared to the non-anaemic (1.92 minutes) due to fatigue in anaemic girls.[22] Moreover, mean resting pulse rate of the anaemic girls was significantly higher ($p \leq 0.05$) compared to the non-anaemic. A similar study done with Indian school girls also reported that anaemic girls covered fewer steps (143) compared to the non-anaemic girls (174) ($p<0.05$).[23] It determined that anaemia affected the physical activity of adolescent girls and could reduce performance of anaemic girls in activity due to low supply of oxygen to the tissues and cells.[24] Post-activity, longer time was taken by anaemic girls to recover to the basal pulse rate. A study on adolescent girls reported that anaemic girls had significantly high pulse rate immediately after 1-2 minutes of activity compared to non-anaemic because of low supply of oxygen to blood and tissue.[14]

Anaemia can compromise the cognitive function of school-going adolescent girls. Raven's Coloured Progressive Matrices test results showed that anaemic girls scored significantly ($p \leq 0.05$) lower in sections A, AB, and B compared to the non-anaemic girls. Similarly, total score of the anaemic girls was 15.5±4.75, which was significantly lower ($p<0.05$) compared to the non-anaemic girls (28.00±2.38). The anaemic girls fell in the range 5th to 10th percentile, which comes in grades IV and V, which confirmed that the anaemic girls were intellectually deficient.[15] Cognitive function was affected due to the alteration in iron content of the brain and neurotransmitters.[9] Further, anaemia can cause the impairment of iron-dependent enzymes, such as noradrenalin, serotonin and dopamine that are important for normal functioning of the neurotransmitters.[2] The results of the current study were in line with a previous study which revealed that mean total score of Raven's test of anaemic girls (25.3 ±7.07) was significantly ($p>0.05$) lower than that of the non-anaemic girls (28.6 ±6.88).[25] However, iron supplementation showed a positive impact on cognitive function of the anaemic girls with a low IQ score. After iron therapy, Hb level and intelligence scores improved.[26]

In terms of limitation, this study was conducted at a single district with small sample size, which limits the statistical power and generalization of its findings. However, these results are considered good enough in understanding the risk factors associated with anaemia in adolscent girls.

It is recommended that awareness programme should be initiated for parents and teachers to sensitise them about consequences and prevention of anaemia. Also, fortification and supplementation programmes should be started for school-going adolescent girls.

Conclusions

The major risk factors associated with anaemia were low SES, high illiteracy of parents, poor intake of macro- and micro-nutrients. Moreover, anaemia compromised the cognitive function and physical work capacity of school-going adolescent girls. Hb and IQ levels were found to be positively correlated.

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Conflict of interest: None.

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