Risk factors and interventions for anemia among Adolescent Girl

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Abstract

Background: Iron deficiency anemia is a problem that affects many adolescent girls. Objective: To determines the risk factors for and intervention efforts against anemia among adolescent girls. Setting and Design: A literature review. Methods and Materials: Journals searched from various literature indexes with the keywords anemia, risk factors, interventions, and adolescent girls. The 160 journals obtained were then sorted under the following criteria: featuring Hb measurements by blood tests, being intervention research with pre- or quasi-experimental designs, published in 2014-2020, being in the full-text pdf format, and being free. A total of 52 selected journals were reviewed, analyzed narratively, and constructed according to the research objective. Results: Direct risk factors include nutritional status, eating behaviors, food intake which does not contain substances that the body needs, menstrual patterns, and parasitic infections. Indirect risk factors include knowledge, attitudes, and socio-demographic factors, including household income, low parent education, residency in rural areas, and food insecurity. There are three types of interventions, including education, administration of specific foods/supplements, and their combinations. Administering Fe in combination with iron rich-foods increased Hb by 3.03 g/dL, and applying SeTiA youth movement as comprehensive nursing care increased Hb by 3.73 g/dL. Conclusion: The risk factors for anemia are composed of direct and indirect risk factors. The existence of various risk factors for anemia is the basis for developing comprehensive interventions. All of the
Interventions aim to prevent anemia in adolescent girls as prospective mothers. Elucidation on the interventions is provided via integrated service posts, schools, and health centers.

**Keywords:** anemia, behavior, education, food, supplementation.

**Key message:**
Iron deficiency anemia is a problem that affects many adolescent girls. Serious efforts are needed to overcome this problem so that young women grow healthily without anemia, can achieve optimal academic performance, and in time give birth to healthy children without low birth weight and/or stunting.

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**Introduction**

The main nutritional problems of adolescents are micronutrient deficiencies, iron deficiency anemia in particular. Iron deficiency and anemia are the main problems of adolescents worldwide. Improving their nutrition before they enter pregnancy, and delay it could help to reduce maternal and infant mortality, and contribute to breaking the vicious cycle of intergenerational malnutrition, poverty, and even chronic disease.\(^1\) Anemia is a condition that occurs when the blood lacks red blood cells or hemoglobin. If the red blood cells or hemoglobin are low or abnormal, then the cells in the body have not got enough oxygen.\(^2\) According to the WHO, adolescents are in the age range of 10-19 years. Meanwhile, according to the Minister of Health Regulation No. 25/2014, adolescents are 10-18 years old and according to the Indonesian National Family Planning Coordinating Board, 10-24 years old and unmarried.\(^3\)

The prevalence of anemia at the age of 15-24 years in Indonesia in 2018 was 32%.\(^4\) Anemia in adolescent girls contributes to maternal and fetal mortality and morbidity later in life.\(^5\) Anemia is one of the causes of maternal mortality due to bleeding in pregnant women. Females are a very vulnerable group of iron deficiency anemia. The main factors that cause anemia are inadequate intake of iron in the body.\(^6\) Serious efforts are needed to overcome this problem so that young women grow healthily without anemia, can achieve optimal academic performance, and in time give birth to healthy children without low birth weight and/or stunting.
Teenage girls are at risk for anemia due to an imbalance in nutritional intake and unhealthy consumption habits. Nutritional status during adolescence plays an important role in the human life cycle that affects growth and development and during this period nutritional needs are the greatest. Adolescence is a very unique time in life because it is a time of intense physical, psychosocial, and cognitive development. The nutritional needs of adolescent girls increase due to physical activity and increased growth rates. Adolescence is a period of rapid transition with high nutritional needs. Anemia in adolescent girls develops due to the increasing need for iron which is getting faster, coupled with poor food intake, plus the high incidence of menstruation and some cases of worms. Micronutrient deficiencies, including iron deficiency, are common. The effects of anemia on public health include decreased intellectual and school performance. Other factors that affect adolescent girls are rapid physical growth and the occurrence of menstruation.

The number of various possible risk factors for anemia in adolescents encouraged the researchers to review the literature on risk factors for anemia in adolescents. Besides, numerous interventions have been researched in various parts of the world. The researchers considered it necessary to map the results of these studies to be used as consideration for choosing an anemia problem-solving intervention. The research objective was to determine the risk factors for anemia in adolescent girls and what interventions have been researched or carried out so far. It is hoped that the results of the study will provide broader insights about anemia in adolescent girls as well as become material for policymakers and competent authorities in efforts to prevent and manage anemia problems in adolescent girls.

Subjects and Methods

The study was conducted with a literature review design. Search for research articles was carried out through the following journal databases: Garuda portal for research in Indonesia, BMC Public Health, and added searches on Google Scholar, Elsevier, and Research Gate. The search results are depicted in a PRISMA flow diagram. The search for articles guided by the keywords anemia, risk factors, interventions, and adolescent girls. The article inclusion criteria were as follows: 1) the studies investigated the risk factors for anemia where the measurements of anemia were determined by blood tests; 2) the intervention research was conducted as pre-experiment or quasi-experiment research with or without control; 3) a quantitative design was used for statistical analysis; 4) full-text pdf articles were available and obtained free of charge.

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according to what were already available during the Internet search or upon request to the researchers; and 5) the language used was the Indonesian and/or English language at least in the abstracts. The article exclusion criterion was research articles published before 2014. Research data extraction was carried out by reading journals that were read separately by two researchers. Then, the results were put together in tabular form, then analyzed narratively and constructed according to the research objective. The following is the article search flowchart.

**Figure 1. PRISMA flow diagram indicating the study selection process for inclusion in the literature review**

![PRISMA flow diagram](image)

**Results**

The following is a summary table of the extracted data.

**Table 1: Recapitulation of factors associated with anemia in adolescent girls**

<table>
<thead>
<tr>
<th>No.</th>
<th>Authors</th>
<th>Methods (designs, samples, statistical methods)</th>
<th>Results</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SabujKanti Mistry et al. [12]</td>
<td>Cross-sectional survey; 1,314 adolescent girls – Bangladesh; multiple logistic regression analysis</td>
<td>A total of 51.6% of the subjects suffered from anemia, with households in the bottom wealth quintile being the significant risk factor and status malnutrition the non significant risk factor. Anemia prevalence ranged from 24 to 38% averaged at 29%. The risk of anemia was higher among adolescent girls in their early adolescence period (10–14 years) with AOR of 1.98 and among adolescent girls who lived in moderately food insecure households.</td>
<td>Related: Sosiodemographic factors. Non-related: Nutritional status.</td>
</tr>
<tr>
<td>2</td>
<td>Gebreyesus, Bilal ShikurEndris, GetahunTekaBeyene, Alnoor Mohamed Farah, Fekadu Elias, and Hana Nekatebeb Bekele [13]</td>
<td>Community-based cross-sectional design, both in from and out of school; 1,323 adolescent girls, sampled by random sampling – Ethiopia; tables, graphs, and summary figures</td>
<td></td>
<td>Related: Sosiodemographic factors</td>
</tr>
<tr>
<td>No.</td>
<td>Authors</td>
<td>Methods (designs, samples, statistical methods)</td>
<td>Results</td>
<td>Risk Factors</td>
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<td>3</td>
<td>Ely Agustina, and Warni Fridayanti [14]</td>
<td>Case-control design; 120 adolescent girls-Kebumen Indonesia; Chi-square test, logistic regression analysis</td>
<td>There was no significant relationship between knowledge of anemia and worm infection to anemia. There were significant relationship of energy nutrient of energy ($p = 0.047$), protein ($p = 0.000$), and iron ($p = 0.002$), menstrual pattern ($p = 0.001$), and anthropometric nutritional status ($p = 0.021$) to anemia, and the the most dominant variable was protein intake with CI OR of 4.255.</td>
<td>Related: nutritional status, intake of energy, iron, and protein, menstrual pattern, Non related: knowledge, worm infection</td>
</tr>
<tr>
<td>4</td>
<td>Arisanty Nurseti a Restuti, and Yoswenita Susindra [15]</td>
<td>Cross-sectional design; 71 girls aged 14–18 years who were not menstruating and consuming Fe - Jelbuk Indonesia; Gamma test</td>
<td>There were no significant relationships of nutritional status and intake of energy, carbohydrates, protein, fat, and vitamin C to anemia prevalence.</td>
<td>Non-related: nutritional status, intake of energy, protein, and fat</td>
</tr>
<tr>
<td>5</td>
<td>Much. Nur Hasan Syahand Alfia Fairuz Asna [16]</td>
<td>Cross-sectional design; 46 female students aged 19 years; Bekasi, Indonesia; Chi-square test</td>
<td>As many as 21.7% of the subjects had anemia and 26.1% were at risk of eating disorders. Twenty percent of the subjects with anemia had an eating disorder risk. There was no significant relationship between the risk of eating disorders and anemia.</td>
<td>Non-related: eating behavior</td>
</tr>
<tr>
<td>6</td>
<td>Dwihandayani, Eti Poncorini Pamungkasari, and Endang Sutansuna Sulaeman [17]</td>
<td>Case-control design; 117 female adolescents, divided into case (n=39) and control (n=78) groups – Sukoharjo Indonesia; path analysis</td>
<td>Eating behavior had a significant relationship with and direct effect between eating behavior on anthropometric status and anemia. Attitude had an indirect effect on but no relationship with anemia. Eating behavior had a strong effect on anemia through anthropometric status.</td>
<td>Related: eating behavior, Non-related: attitude</td>
</tr>
<tr>
<td>7</td>
<td>Cynthia Almaratus Sholicha, and Lailatul Muniroh [18]</td>
<td>Cross-sectional design; 60 female students of grades X and XI, sampled by proportional random sampling – Gresik Indonesia; Chi-square and Spearman tests</td>
<td>There were significant correlations between intake of iron ($r = 0.635$), protein ($r = 0.663$), and vitamin C ($r = 0.780$) and Hb level and between menstrual pattern and anemia.</td>
<td>Related: menstrual pattern</td>
</tr>
<tr>
<td>8</td>
<td>Rudolf Boyke Purba, I Made Djendra, Reza Z. Kindangen, Irza N. Ranti, Olga Paruntu, Grace K. Langi, and Joice M. Laoh [19]</td>
<td>Cross-sectional design; 55 subjects, sampled by stratified random sampling – Southeast Minahasa Indonesia; Chi-square test</td>
<td>As many as 52.7% of the subjects suffered from anemia, 61.8% had poor eating behavior, and 60% had behavior less protein intake. There were significant relationships of eating behavior and protein intake to incidence of anemia.</td>
<td>Related: Protein intake; eating behavior</td>
</tr>
<tr>
<td>No.</td>
<td>Authors</td>
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<td>Results</td>
<td>Risk Factors</td>
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<tr>
<td>9</td>
<td>Arnovemisa F. Arinendya, Lailatul Muniroh, and Annas Buanasita</td>
<td>Cross-sectional design; 78 female students, 40 from grade X, 38 from grade XI - Surabaya Indonesia; Chi-square test</td>
<td>Protein adequacy level and vitamin C had significant relationships with anemia. Iron adequacy level, zinc adequacy level, and menstrual cycle did not have any significant relationships with anemia.</td>
<td>Related: protein; Vit. C Non-related: iron; zinc; menstrual pattern</td>
</tr>
<tr>
<td>10</td>
<td>Asmaa Hamed Mohamed, Mahassen Ahmed Abd El-Wahed, Dalia Ibrahim Tayel, Abeer Abd El-Aziz Mohamed Madian, and Neama Yousef Mohammed</td>
<td>Case-control design; 240 girls from anemia and non-anemia groups (120 in the case group, and 120 in the control group) - Damahour city Egypt; multivariate logistic regression analysis</td>
<td>Low parent education, rural residence, and intestinal parasite infection were identified as predictors of Iron Deficiency Anemia. Poor eating habits and menstrual history had a significant role in the development of anemia; The relationship between academic performance and anemia was very significant.</td>
<td>Related: sociodemographic factors, eating behavior, menstrual pattern, parasite infections</td>
</tr>
<tr>
<td>11</td>
<td>Jayant V. Upadhye, and Jayshree J. Upadhye</td>
<td>Cross-sectional survey; 300 girls (12-18 years old) – India; Chi-square test, t-test</td>
<td>There were significant associations of anemia to socio-economic status and literacy status of parents. The mean height and weight of girls with anemia were significantly less than those of girls without anemia. A high prevalence of anemia was found among girls whose parents were less educated.</td>
<td>Related: knowledge, sociodemographic factors, nutritional status</td>
</tr>
<tr>
<td>12</td>
<td>Titi Mursiti</td>
<td>Cross-sectional design; 91 girls, sampled by stratified random sampling – Kendal, Indonesia; t-test</td>
<td>A total of 25.6% of the subjects had anemia, 44.4% had poor eating behavior, and 65.6% had poor knowledge. The eating behavior of subjects with no anemia was better than those who had anemia.</td>
<td>Related: eating behavior</td>
</tr>
<tr>
<td>13</td>
<td>Muammar MA Shaheen, and Islam Hassouneh</td>
<td>Cross-sectional design; 200 healthy university students on campus – Palestine; One-Way ANOVA test</td>
<td>A total of 22% of the subjects were with anemia; Students’ dietary habits had a moderate effect on anemia. There was a 1.3 - 2.1 fold increase in the risk of anemia for students with poor dietary habits. There was a significant difference in anemia prevalence between underweight and overweight groups.</td>
<td>Related: nutritional status, eating behavior</td>
</tr>
<tr>
<td>14</td>
<td>Herta Masthalin a, Yuli Laraeni, and Yuliana Putri Dahlia</td>
<td>Cross-sectional design; 67 Madrasah Aliyah Al-Aziziyyah female students, sampled by random sampling – Lombok Barat, Indonesia; Chi-square test</td>
<td>A total of 47.6% of the anemic subjects usually consumed iron-inhibitors-source foods and 76.2% sometimes consumed iron-enhancer-source foods. There was a significant relationship between iron inhibitor and anemia.</td>
<td>Related: iron inhibitor Non-related: iron enhancer</td>
</tr>
<tr>
<td>No.</td>
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<td>Methods (designs, samples, statistical methods)</td>
<td>Results</td>
<td>Risk Factors</td>
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<tr>
<td>15</td>
<td>Alhidayati, Christine Vita Gloria Purba, and Tri Murti[25]</td>
<td>Cross-sectional design; 82 female Senior High School students – Indragiri Hilir, Indonesia; Chi-square test</td>
<td>There were relationships of knowledge, attitude, eating habits, and nutritional status to the incidence of anemia. Related: knowledge, attitude, nutritional status</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Is Rinieng Nur Sya`Bani, and Sri Sumarmi[26]</td>
<td>Cross-sectional study; 106 female students aged 12 – 15 at The Muzamza Chosyiah Dormitory Islamic Boarding School – Jombang, Indonesia; Chi square test</td>
<td>A total of 18.9% of the female students were underweight, 52.8% were of normal weights, 28.3% were overweight, and 57.5% were with anemia. In term of food consumption, 80.9% of the students lacked of energy, 42.5% lacked of protein, 86.8% lacked of vitamin C, and 86.8% lacked of iron. There were no significant relationships of energy, protein, and vitamin C intake and anemia status, but there was between iron intake and anemia status. Related: iron. Non-related: energy, protein, vitamin C, nutritional status</td>
<td></td>
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<tr>
<td>17</td>
<td>FresthyAstrikaYunita, Sri AnggariniParwatiningsih, Hardiningsih, AgusEkaNurmaYuneta, and M. Nur DewiKartikasariRopitasari[27]</td>
<td>Cross-sectional design; students of SMP 18 Surakarta, Indonesia; sampled by random sampling; Chi-square test</td>
<td>The majority of the respondents (66.67%) had high knowledge of iron consumption and more than a quarter had anemia (26.67%). Knowledge of iron consumption had a significant relationship with the incidence of anemia. Respondents who had low knowledge about iron consumption had a 13.5 times greater risk of anemia. Related: knowledge</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Uji Utami, and Mutik Mahmudah[28]</td>
<td>Cross-sectional design; 38 female adolescents Senior High School students, sampled by purposive sampling – Karanganyar, Indonesia; Chi-square test</td>
<td>There was a relationship between eating pattern and the incidence of anemia among female adolescents. Related: eating behavior</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Desri Suryani, Riska Hafiani, and Rinsesti Junita[29]</td>
<td>Cross-sectional design; 1,200 junior and senior high school students in the city of Bengkulu, Indonesia; Chi-square test</td>
<td>The prevalence rate of anemia among adolescent female students was 43% and 79.2% of the students had poor eating behavior. There was no significant relationship between knowledge and the incidence of anemia and neither was there a significant relationship between eating behavior and the incidence of anemia. Non-related: knowledge, eating behavior</td>
<td></td>
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<tr>
<td>No.</td>
<td>Authors</td>
<td>Designs</td>
<td>Samples</td>
<td>Intervention</td>
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<tr>
<td>1</td>
<td>Silvia Dewi Styaningrum, Zenni Puspitarini, and Siska Puspita Sari</td>
<td>Pre-experimental one-group pretest-posttest design</td>
<td>66 female students of a boarding school in Yogyakarta, Indonesia</td>
<td>Integrated education in boarding school</td>
</tr>
<tr>
<td>2</td>
<td>Arini Pradita Roselyn, Ari Khusuma, and Annissa Agata</td>
<td>Quasi-experiment with non-equivalent control group design</td>
<td>50 female adolescents of grade XI of SMA Natar, Indonesia</td>
<td>Administration of 400 gr of date for 6 days (66.7 g/day)</td>
</tr>
<tr>
<td>3</td>
<td>Nurul Qamariah Rista An daruni, and BQ Nurbayet</td>
<td>Experimental study with pretest-posttest control group design</td>
<td>30 female students with Hb &lt;12 g/dL divided into 3 groups – Mataram, Indonesia</td>
<td>Supp. of Fe tablet + guava juice Supp. of Fe + Vit. C tablets Supp. of Fe tables</td>
</tr>
<tr>
<td>4</td>
<td>Desmon Wirawati, Astuti Yuni Nursasi and Sigit Mulyono</td>
<td>Experimental research with pretest-posttest design</td>
<td>103 young girls in of grades X and XI of a junior high school in Depok, Indonesia</td>
<td>SeTiA youth movement</td>
</tr>
<tr>
<td>5</td>
<td>Yulina Dwi Hastuty, and Dodoh Khodijah</td>
<td>Experimental research with randomized control trial and pretest-posttest control group design</td>
<td>105 female senior high school students divided into 3 treatment groups – Batubara, Indonesia</td>
<td>Supp. of Fe Supp. of Fe+vit. C Supp. of Fe+vit. A</td>
</tr>
<tr>
<td>6</td>
<td>Pagdya Haninda Nusantri Rusdi, Fadi Oenzil, and Eva Chundrayetty</td>
<td>Quasi-experiment with simple random sampling</td>
<td>34 anemic adolescents divided into 2 groups in Padang Panjang, Indonesia</td>
<td>Guava juice</td>
</tr>
<tr>
<td>7</td>
<td>Hesti Permata Sari, Yovita Puri Subardojo, and Ibnu Zaki</td>
<td>True experimental research with randomized pretest-posttest control group design</td>
<td>31 treatment group members and 39 control group members – Banyumas, Indonesia</td>
<td>Nutrition education</td>
</tr>
<tr>
<td>8</td>
<td>Sofia Mawaddah, and Vopy</td>
<td>Quasi-experiment, one-group pretest-posttest design</td>
<td>35 adolescent girl, sampled by consecutive sampling – Palangkaraya, Indonesia</td>
<td>Date juice in 360gram / bottles taken by 2x1 spoon for 2 weeks</td>
</tr>
<tr>
<td>9</td>
<td>Sajiman Syahwal, and Zufliana Dewi</td>
<td>Experimental design</td>
<td>Adolescent girl with Hb &lt;12 g/ DL divided into 3 groups, each consisting of 15 people – Banjarbaru, Indonesia</td>
<td>Supp. of Fe Snack Bar &amp; Fe Snack Bar</td>
</tr>
<tr>
<td>10</td>
<td>Khalida Thamrin, Budu</td>
<td>Experimental design with</td>
<td>32 midwivery students divided</td>
<td>Dragon fruit</td>
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</tbody>
</table>

<table>
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<tr>
<th>No.</th>
<th>Authors</th>
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<th>Samples</th>
<th>Intervention</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>11</td>
<td>Yuli Laraeni, Irianto, Abdul Salam, Komang Agusjaya Mataram, and Ni Putu Agustinii</td>
<td>Pretest-posttest control group design</td>
<td>20 subjects divided into 10 in treatment group and 10 in control group – Mataram, Indonesia</td>
<td>Breakfast time</td>
<td>An increase of Hb by 1.5 g/dL Significant for energy, fat, and folic acid intake</td>
</tr>
<tr>
<td>12</td>
<td>Werna Nontji, and Suchi Avnalurini Shariff</td>
<td>Quasi-experimental research, randomized control group, pretest-post test</td>
<td>Intervention study</td>
<td>30 moderately anemic girls in experimental group and 30 in control group – Makassar, Indonesia</td>
<td>Laddu</td>
</tr>
<tr>
<td>13</td>
<td>T. Kamalaja, M. and Prashanthi</td>
<td>Intervention study</td>
<td>30 moderately anemic girls in experimental group and 30 in control group – Akola, India</td>
<td>Supp. of Fe + iron-rich foods diet</td>
<td>An increase of Hb by age: 13- 3.03 g/dL 14- 2.82 g/dL 15- 2.88 g/dL 16- 2.98 g/dL</td>
</tr>
<tr>
<td>14</td>
<td>Azizah Nur Rohim, Siti Zulaekah, and Yuli Kusumawati</td>
<td>Quasi-experiment, pretest-posttest control group design</td>
<td>75 female teenagers – Surakarta, Indonesia</td>
<td>Storybook lecture</td>
<td>Increase in knowledge</td>
</tr>
<tr>
<td>15</td>
<td>Baiq Fitria Rahmia ti Wayan Canny Naktiyan, and Junendri Ardiana</td>
<td>Quantitative experimental research with pretest-posttest design</td>
<td>Adolescent girls of senior high school level – West Nusa Tenggara, Indonesia</td>
<td>Nutrition counseling</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>16</td>
<td>Lu’u’atul Khodijah, S.A Nugraheni, and Apoina Kartini</td>
<td>Quasi-experimental research with pretest-posttest control group design</td>
<td>Intervention group and control group, 40 students</td>
<td>Peer-education</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>17</td>
<td>Sutrio Syaki</td>
<td>Pre-experimental one-group pretest-posttest design</td>
<td>300 high school teenage girls in Bandar Lampung, Indonesia</td>
<td>Animation media</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>18</td>
<td>Husnul Khotimah, Martinus Ginting, and Iman Jaladi</td>
<td>Experimental one-group pretest-posttest design</td>
<td>35 girls in the village of Tebas Kuala as intervention group, Indonesia</td>
<td>Face-book</td>
<td>Increase in knowledge and protein, iron, and vitamin C intake</td>
</tr>
<tr>
<td>19</td>
<td>Hiya Alfi Rahmah, and Setiyowati Rahardjo</td>
<td>Intervention study</td>
<td>34 students of SMPN Kembaran, 12 with the highest increases of scores of whom to go through selection to be health ambassadors</td>
<td>Reading corner</td>
<td>Increase in knowledge</td>
</tr>
<tr>
<td>20</td>
<td>Reni Zuraida, Nur Indrawati Lipoto, Masrul Masrul, and Judhiastuty Febru</td>
<td>Quasi-experimental.</td>
<td>55 students in intervention group and 47 in control group selected among senior high</td>
<td>Free club session</td>
<td>Increase in knowledge and attitude</td>
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<tr>
<td>No.</td>
<td>Authors</td>
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<td>21</td>
<td>Maida Pardosi</td>
<td>Experimental pre-test-posttest design</td>
<td>78 girls in intervention group and 78 in control group, Deli, Indonesia</td>
<td>Anemia booklet</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>22</td>
<td>Monika Singh, Raghavendra A.Honnakamble, and Om Prakash Rajoura</td>
<td>Intervention study</td>
<td>106 adolescent school girls of grade XI in Delhi, India</td>
<td>Intensive health education</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>23</td>
<td>Dewi Kusumawati, Rimbawan, and Ikeu E kayani</td>
<td>Experimental pre-test-posttest design</td>
<td>54 female students at a boarding school in Bogor, Indonesia</td>
<td>Addition of fruit + protein in lunch, nutrition education</td>
<td>Increase in knowledge, attitude, intake of all nutrients, and intake of fiber</td>
</tr>
<tr>
<td>24</td>
<td>Nadimin</td>
<td>Pre-test-posttest without control group design</td>
<td>Girlsof a Makassar boarding school, 15 groups, 10 students each, 1 being an counsellor</td>
<td>Peer-education</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>25</td>
<td>Marwan O. Jamalbo, Razinah Sharif, Ihab A. Naser, and Norimah A. Karim</td>
<td>Intervention study, data Baseline, and after 6 months</td>
<td>89 females aged 15–19 randomly, intervention and control groups - Gaza Strip</td>
<td>Nutrition education</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>26</td>
<td>Seyed Nematollah Roshan F., Navipor H., and Alhani F.</td>
<td>Semi-experimental practical research</td>
<td>60 female HS students, random cluster (30 in test group, 30 in control group) - Iran</td>
<td>Small group discussion</td>
<td>Increase in knowledge, attitude and perceived susceptibility, perceived severity, and self-efficacy</td>
</tr>
<tr>
<td>27</td>
<td>Nandita Kapadi-Kundu, Douglas Storey, Basil Safi, Geetali Trivedi, Rama Tupe, and G. Narayana</td>
<td>RCT to improve nutrition, hygiene, and reproductive health behaviors</td>
<td>30 schools in rural Uttar Pradesh (UP), India</td>
<td>Instruction modules</td>
<td>Increase in knowledge and attitude, 13 prevention behaviors</td>
</tr>
<tr>
<td>28</td>
<td>Ghada M. Salem and Randa M. Said</td>
<td>Intervention study</td>
<td>108 girls aged 15-17 years of a secondary school in Zagazig, Egypt.</td>
<td>Education based on Health Belief Model</td>
<td>Increase in knowledge and attitude, Health Belief Model construct</td>
</tr>
<tr>
<td>29</td>
<td>Hossein Ashtarian, Behnaz Marzbani, Afshin Almasi, Behjat Marzbani, Mehdi Khezeli, and Sara Shahabadi</td>
<td>Quasi-experimental study, a questionnaire based on Planned Behavior Theory</td>
<td>174 girls sampled by multistage random sampling devise into 3 groups: students (n= 58), students with mother (n= 58) and control (n= 58) - Iran</td>
<td>Education based on Planned Behavior Theory</td>
<td>Increase in nutritional status and iron intake</td>
</tr>
<tr>
<td>30</td>
<td>Nurma syita, Bagoes Widjanarko, and Ani Margawati</td>
<td>Quasi-experimental research with pretest-posttestcontrol</td>
<td>73 overweight HS students, sampled by purposive sampling, 36 in treatment group</td>
<td>Nutrition education</td>
<td>Increase in knowledge and attitude</td>
</tr>
<tr>
<td>No.</td>
<td>Authors</td>
<td>Designs</td>
<td>Samples</td>
<td>Intervention</td>
<td>Results</td>
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<td>---------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>31</td>
<td>Nooshin Peyman, and Monireh Abdollahi</td>
<td>Quasi-experimental pretest-posttest control group, IMB skills model intervention study carried out over six months</td>
<td>120 Iranian high school girls divide into experimental and control groups. Adolescents girls in rural and urban Khulna, Bangladesh 71 girls aged 16–19 years sampled by randomized sampling from schools and colleges in Sheffield, the UK</td>
<td>Workshop based on IMB skills model</td>
<td>Increase in iron intake</td>
</tr>
<tr>
<td>32</td>
<td>Md. Shofikul Islam et al.</td>
<td>Intervention study carried out over six months</td>
<td>37 in control group – Pontianak and 37 in control group</td>
<td>Nutrition education</td>
<td>Increase in nutritional status</td>
</tr>
<tr>
<td>33</td>
<td>Hilary J. Powers, Mark Stephens, Jean Russell, and Marilyn H. Hill</td>
<td>A randomized, double-blind, placebo-controlled intervention trial</td>
<td>120 Iranian high school girls divide into experimental and control groups. Adolescents girls in rural and urban Khulna, Bangladesh 71 girls aged 16–19 years sampled by randomized sampling from schools and colleges in Sheffield, the UK</td>
<td>Fortified cereal</td>
<td>Increase in micronutrient intake</td>
</tr>
</tbody>
</table>

### Discussion

The results of the study illustrate that two main factors are risk factors or are associated with the incidence of anemia in adolescent girls, namely, direct and indirect risk factors. The interventions are divided into three types, namely, nutrition education, certain substance supplements, action or provision of certain types of foods, and a combination of the two. Direct factors include nutritional status, nutritional intake of certain substances, eating behavior, menstrual patterns, and worm and parasite infections. Indirect factors include knowledge, attitudes related to anemia, and socio-demographic factors.

The first intervention type is nutrition education using various methods to improve knowledge, attitudes, nutritional status, wrong eating habits, and habits of intake of certain nutrients. Other interventions are providing certain types of foods, giving certain supplements, and/or a combination of the two interventions. Figure 2 illustrates the results of the research review.
Figure 2. Diagram of review about risk factors and interventions for anemia among adolescent girl

Risk Factors

Indirect Risk Factors
- Workshops based on IMB skills (+ for Fe)
- Facebook (+ for protein, Fe, and vit C)
- Education based on planned behavior theory (+ for Fe)

Direct Risk Factors
- Nutritional Status
  - Related
  - Non-related
- Eating Behavior
  - Related
  - Non-related
- Intake of certain substances:
  - Energy: Related
  - Non-related
  - Iron: Related
  - Non-related
  - Protein: Related
  - Non-related
  - Fat: Non-related
  - Vitamin C: Related
  - Non-related
  - Fiber: Related
  - Non-related
  - Zinc: Non-related
  - Iron inhibitor
  - Related
  - Non-Related
- Menstrual patterns
  - Related
  - Non-related
- Infection
  - Related
  - Non-related

Interventions

Interventions for knowledge
- Nutrition education
- Story-book lectures
- Facebook
- Reading corner for school health efforts

Interventions for knowledge and attitude
- Small group discussion
- Instructional modules
- Peer-education
- Education based on HBM
- Nutrition counseling
- Peer-education
- Animation media
- Free club session
- Anemia booklet
- Intensive HE
- Nutrition education
- Education based TPB

Incidence of anemia in Adolescent Girls
- Range: 21.7 - 57.5%; Average: 37.73%

Incidence of anemia in the blood
- Range: 0.47 – 3.73 g/dL; Average: 1.35 g/dL

Academic Performance and IQ level
- Related

Eating Behavior

Interventions

Nutrition education
- Workshop based on IMB skills (+ for Fe)
- Facebook (+ for protein, Fe, and vit C)
- Education based on planned behavior theory (+ for Fe)

Nutritional Status

Knowledge/literacy
- Related
- Non-related

Social Factors
- Socio-economic status: Related
- Households in bottom wealth quintile: Related
- Rural residence Related
- Low parent education: Related
- Food insecure households: Related

Intake of certain substances:
- Energy: Related
- Non-related
- Iron: Related
- Non-related
- Protein: Related
- Non-related
- Fat: Non-related
- Vitamin C: Related
- Non-related
- Fiber: Related
- Non-related
- Zinc: Non-related
- Iron inhibitor
- Related
- Non-Related

Menstrual patterns

Infection

Give certain foods
- Breakfast time for energy, fat, and folic acid
- Fortified cereal for micronutrient
- Addition of fruit and protein in lunch, nutrition education, for all nutrient + fiber

Intervention with Hb measurement results

Give Certain Foods/supplements
- Dragon fruit increased Hb by 0.47 g/dL
- Guava juice increased Hb by 1.96 g/dL
- Date grain increased Hb by 1.93 g/dL, date juice increased Hb by 1 g/dL
- Breakfast time increased Hb by 1.5g/dL
- Laddu increased Hb by 0.66 g/dL

Give a mix of supplements & foods
- Supp. Fe tablet + guava juice increased Hb by 2.13 g/dL
- Supp. Fe + vit. C tablets increased Hb by 1.23 g/dL
- Supp. Fe tablets increased Hb by 0.83 g/dL
- Supp. Fe +vit. C increased Hb by 0.6 g/dL
- Supp. Fe +vit. A increased Hb by 0.8 g/dL
- Supp. Fe +in Fe increased Hb by 1.08 g/dL
- Snack Bar & Fein Fe increased Hb by 1.75 g/dL
- Snack Bar increased Hb by 1.04 g/dL
- Supp Fe + Iron rich food diet increased Hb by 3.03 g/dL (13 years old)

Education
- Integrated education in boarding-based schools increased Hb by 0.6 g/dL
- SeTIA youth movement increased Hb by 3.73 g/dL
- Nutrition education increased Hb by 0.51 g/dL

Interventions for knowledge

Interventions for knowledge and attitude
The mean height and weight of adolescent girls with anemia were significantly smaller than those of girls without anemia.\textsuperscript{[14]} Underweight, overweight, and obesity were significantly higher in the anemia group than in their non-anemia counterpart.\textsuperscript{[13]} There was a significant difference in the prevalence of anemia between underweight and overweight adolescent girls. Adolescent girls with abnormal nutritional status are 3 times more likely to suffer from anemia than adolescent girls with normal nutritional status. Also, they were more prone to anemia than children and adults because they were still growing and in need of higher levels of nutrients, including iron, and because they started menstruating. Girls usually also pay attention to body shape, thereby limiting their food consumption and abstaining from large meals.\textsuperscript{[25]}

Nutritional status was not related to anemia because anemias caused not only by food intake, but also genetic factors or disease. Wrong eating habits of adolescent girls also affected the fulfillment of nutritional needs and nutritional status. Adolescent girls often consumed junk food which contains a lot of energy but has very little vitamins and minerals. Hence, adolescent girls with normal nutritional status were not necessarily safe from iron or mineral deficiency.\textsuperscript{[15]} Another study explained that respondents who suffered anemia mostly had normal BMI. The test results showed that there was no relationship between nutritional status and anemia. Inadequate nutritional status was not a risk factor for anemia. However, malnutrition was a risk factor for deficiency and depreciation of iron reserve or store in the body.\textsuperscript{[26]}

As many as 15.83\% of adolescent girls had less energy input, even though this energy is vital for the body's metabolic processes. School activities were exhausting, but adolescent girls usually did not have adequate food intake. Those with low-energy substance intake had 2.8 times the risk of suffering from anemia of those who had sufficient energy intake.\textsuperscript{[14]} As many as 31.66\% of adolescent girls lacked protein intake. Protein functions as a builder, regulator, and fuel for the body's metabolism. Protein is a provider of amino acids that are components of all cells in the body. Protein is used for growth processes and energy reserves if energy intake is less. Individuals with adequate protein intake were 4.25 times less likely to suffer from anemia than those with insufficient protein intake.\textsuperscript{[14]} Protein plays an important role in the absorption of iron in the body. If protein intake is insufficient, iron absorption is inhibited leading to iron deficiency.\textsuperscript{[18]} Lack of protein intake can lead to disorders of iron transport as well as formation of hemoglobin and red blood cells that can ultimately lead to iron deficiency anemia.\textsuperscript{[15]}

Iron is the main component of hemoglobin which functions to synthesize hemoglobin. Lack of iron intake mostly occurred in junior high school girls because most of them had never taken iron supplements. Individuals with adequate iron intake were 3.18 times less likely to
develop anemia than those with low iron intake. Another reason was that they often consumed non-heme sources of iron, such as potatoes, beans, green vegetables (spinach, mustard greens, broccoli, etc.), and iron absorption inhibitors, such as tea and coffee. Iron derived from beef, liver, poultry, and fish can be absorbed better than non-heme iron. If iron intake is insufficient, and if the frequency of consumption of absorption inhibitors is higher, the iron levels in the body will be low, which can lead to iron deficiency anemia. Most of the adolescent girls had never taken iron supplements or blood-booster tablets during menstruation. Fiber is associated with anemia, as shown by research on feeding lunch and nutrition education based on balanced nutrition guidelines for 15 weeks.

It was found that the rate of poor eating behavior was 61.8%. The eating behavior of girls who were not anemic was significantly better than that of girls who were. The low habit of consuming green vegetables among adolescents was due to their lifestyles which made them feel greater prestige and confidence in interacting when consuming fast foods such as meatballs, instant noodles, etc. Regarding the adolescent girls’ diet, there was a significant difference between anemic and non-anemic students in terms of frequency of eating (3 times/day), breakfast, types of snacks, consumption of tea after meals, consumption of fresh vegetables, and consumption of fast food. The diet of anemic students was worse than those who were not.

Student eating habits had a moderate effect on iron deficiency anemia. There was an increased risk of iron deficiency anemia by 1.3 to 2.1 times for students with a poor diet. There was no significant association between the risk of eating disorders and anemia. The study did not look at food intake but the risk of eating disorders that occurred in adolescent girls. The risk of this eating disorder would have an impact on diet and intake, which were closely related to the incidence of anorexia and bulimia. Individuals suffering from anorexia were associated with a lack of protein and energy intake, which could lead to impaired red blood cells formation. Diet provides an overview of the frequency, type, and model of food consumed every day. The recommended diet is a nutritionally balanced diet for adolescents. These adolescents are recommended to have breakfast with complete nutrition, especially carbohydrates, fats, and protein, which accounts for one-third of the lunch portion. We recommend eating with balanced frequency, amount, and composition of food contents.

Types of adolescent menstrual disorders include hypermenorrhea, hypomenorrhea, polimenorrhea, and oligomenorrhea. Anemia was significantly associated with menstrual cycle length and the presence of dysmenorrhoea and premenstrual syndrome, but not with the...
age of menarche and duration of blood flow. Significantly more adolescent girls who suffered anemia had irregular menstrual cycles, dysmenorrhea, and premenstrual syndrome.[14] The proportion of adolescent girls who had abnormal menstrual patterns and anemia is 70%, while respondents who had normal menstrual patterns and suffered anemia only made up 16.7%.[16] Furthermore, regarding menstrual symptoms, 95.4% of anemic students and 91.8% of non-anemic students felt dysmenorrhea pain with insignificance difference.[21] There was no relationship between menstrual patterns and anemia. Theoretically, menstrual cycles in the abnormal category allowed blood loss to be followed by loss of iron and eventually anemia. However, the statistical test results showed no significant association.[20]

There was a significant difference between anemic students (70.00%) and non-anemic students (22.5%) reporting a history of parasitic infestations. Besides, there was a significant difference between anemic students (20.2%) and non-anemic students (48.2%) reporting that parasites made them eat more than usual.[21] Another study showed that there was no significant relationship between worm infection and anemia, in which case anemic group (47.5%) and non-anemic group (52.5%) did not suffer from worms.[14]

There was a significant difference, in which case well-informed teens were 3 times less likely to suffer anemia than those with less knowledge.[25] There was a positive relationship between the knowledge of young women about iron consumption with the incidence of anemia, as knowledge of nutrition was an essential foundation for good diet habits. Individuals with better nutritional knowledge had a more positive attitude toward healthy eating. Conversely, lack of knowledge was a risk factor for malnutrition, including the risk of suffering from anemia.[27] The low understanding of knowledge about anemia in junior high school adolescents was also evident from the incomplete questionnaire filling. This could be because the School Institution Nutrition Improvement Program on anemia had never been implemented. When it comes down to socioeconomic and geographic backgrounds, junior high school adolescents mostly came from rural areas. This caused varying levels of ease of access to information from the mass media for adolescents from different research locations.[14]

As many as 65.4% of respondents with a negative attitude and 30% who had a positive attitude had anemia. Adolescent girls who had a negative attitude had 4 times the risk of suffering anemia of those who had a positive attitude.[25] As many as 45.2% of adolescent girls disagreed with the assumption that increasing consumption of iron supplements would prevent anemia, 4.2% said anemia is not a problem, and 18.8% ignored the fact that anemia can interfere with school activities.[17]
It was found that there was a significant relationship of the socioeconomic status and literacy status of parents to anemia. A high prevalence of anemia in adolescent girls was found in those whose parents were low educated. Many girls suffering from anemia in Bangladesh came from households in the bottom wealth quintile, who were likely to be at 1.54 times the risk of suffering from anemia of those from families outside the bottom wealth quintile. Long-term and sustainable public health interventions are urgently needed to address this situation. The risk of anemia was higher among adolescent girls who lived in households with food insecurity with AOR of 1.48. Low parent education, living in rural areas, and being infected with intestinal parasites were identified as predictors of iron deficiency anemia among female students. The relationship between academic achievement and anemia was very significant. The food fortification program is expected to include iron for school-age groups, implement a school breakfast program, conduct laboratory tests for anemia, develop school nutrition education programs in the curriculum, and conduct a national nutritional analysis survey.

Furthermore, anemia interventions were carried out on risk factors for anemia, both indirect and direct risk factors. The following are some nutrition education interventions. The first intervention using nutrition education was carried out six times for 1.5 months with one meeting per week. Educational materials were conveyed to participants through a combination of lecture methods, presentations, and educational games. Another type of nutrition education intervention was carried out for 3 months for the intervention group, while the control group did not receive the same intervention. The intervention group received nine sessions (one and a half hours/session), consisting of lectures, wall writings, videos, booklets, and brochures. The intervention program also included basic concepts on how to obtain a balanced diet, anemia in general, iron deficiency as a serious public health problem, growth and development according to what we eat, and iron-rich sources of foods. Next, a nutrition education intervention to the treatment group was given once a week for 3 months, while to the control group only once in 3 months. Nutrition education referred to delivery of nutritional messages through the learning process in class using the lecture method. The next intervention was a reading corner for school health efforts in the form of activities to increase the ability of adolescent girls related to knowledge about anemia, the causes of anemia, overcoming body image, and caring for adolescent health. The knowledge gained became a provision in providing assistance to other adolescent girls integrated into school health activities, Youth Red Cross and Scouts. Participatory methods were used by involving partners as resource persons and facilitators.
The next interventions were those which influenced knowledge and attitude. The first of the interventions was small group discussion. A study group was divided into six equal, researcher-led group discussions held in four sections of approximately 45 minutes per session to increase knowledge of perceived severity, perceived susceptibility, and self-efficacy, and to increase awareness of the disease, treatments, and complications. There was no intervention for the control group. Final evaluation was carried out one week after the intervention.\(^{[54]}\)

The next type was learning module that could increase knowledge, coupled with thirteen preventive behaviors. The intervention included ten intervention sessions at school based on compassion, self-efficacy, emotional well-being, peers, and parental support. The material was packaged in the form of a learning module that was short and easy to use.\(^{[55]}\)

The next was health education which was based on the Health Belief Model (HBM). Health education was carried out based on the results of the pre-test which were compiled with the HBM concept.\(^{[56]}\)

The next intervention was nutrition counseling for female high schoolers of XI in the form of provision of knowledge related to programs for giving iron nutrition and preventing iron nutrition anemia. The intervention began with screening students for their health status, 24-hour food recall, and anthropometry. Fe tablets and compliance cards were given to students at the beginning of the intervention by the researchers with the help of school health personnel. A total of 30 Fe tablets were given along with an explanation that they should consume one tablet per week and ten tablets during menstruation.\(^{[44]}\)

Next type is peer education.\(^{[45],[52]}\) The intervention group was given nutrition education using the peer education method for one week.\(^{[45]}\) Anemia prevention training for fifteen prospective peer-group motivators was carried out for a day with lectures and discussions. The training materials include understanding and how determining anemia, symptoms of anemia, causes of anemia, the effects of anemia, the prevention of anemia, anemia prevention foods, and how to consume Fe tablets. It was followed by the formation of a counseling group called peer groups, each consisting of ten students with a trained motivator who became the supervisor of the anemia prevention group. Peer counseling in each group was conducted every week through face-to-face meeting, and brochures about anemia were distributed.\(^{[52]}\)

Another intervention was the use of animate media. The use of animated media in a nutrition education intervention not only produced an effective way of learning in a short time but also resulted in the conclusion that something that is received through audiovisual means will be longer and better retained in memory because it involves more of the five senses. The form of the intervention was not explained in detail.\(^{[46]}\)

The next was club sessions. The intervention
group attended 12-week anemia-free club session-based nutrition education, while the control group did not. This model developed as role teachers would play in providing information on efforts to prevent iron deficiency anemia and monitoring adolescent health. Mothers were given information on how to prepare good diets containing iron and how to arrange them proportionately, how to prepare menu items according to nutritional needs, and nutritional status according to anthropometric measurements (body mass index/age). During the 12 weeks of implementing this model, the teachers acted as facilitators and the mothers acted as meal companions. Adolescent girls received nutrition education related to efforts to prevent iron deficiency anemia.\textsuperscript{[49]}

The next was anemia booklet. It was stated that the anemia booklet was effective in changing the behavior of senior high school girls in Kutalim Baru, Deli Serdang Regency. It was not explained what the booklet contained and how long it would take.\textsuperscript{[50]} Other interventions were, intensive health education on weekly iron-folic acid supplementation and intensive counseling provided for six months through Powerpoint presentations, pamphlets, and visual displays of iron-rich foods such as green leafy vegetables, germinated grains, citrus fruits, and jaggery.\textsuperscript{[10]}

The next was nutrition education.\textsuperscript{[51],[53]} Interventions were given to add protein and fruit to lunch and to provide nutrition education for 15 weeks. Nutrition education was delivered by teachers, and material refreshments were carried out by nutrition students.\textsuperscript{[51]} Nutrition education interventions consisted of lectures, presentations, interactive discussions using posters, and distribution of information booklets and brochures on proper nutrition, for three months.\textsuperscript{[53]} Next, education was based on the theory of TPB. The study was divided into three groups, namely, students, students with mothers, and control group. Questionnaires based on the TPB were used to collect data, then the results were used to develop educational interventions. This intervention was carried out by holding three training sessions for 90 minutes, each for students in two intervention groups which only included students and students with mothers. A 30-minute training session was conducted for teachers and trainers in both intervention groups. A 45-minute session was also given to mothers in the intervention group with mothers.\textsuperscript{[57]}

There were several interventions found from the literature review which measured Hb levels at the end of the interventions. Figure 3 shows the types of interventions and the increases in Hb levels after the interventions.
The SeTiA youth movement was a form of intervention to prevent and overcome the problem of anemia in adolescents by providing nursing care to individuals, families, groups, and communities, especially young women to overcome health service management problems and nursing problems.[33]

In summary, the interventions against anemia among adolescent girls were in the form of health education with materials on good nutrition, provision of certain foods/supplements, and their combinations. It is hoped that the interventions can improve the proper anemia preventive behavior (knowledge, attitude, eating behavior practice, and proper supplementation) so that in the end adolescent girls have normal Hb levels or do not suffer from anemia.

The following are some research results related to the opportunities for delivering nutrition messages to the public, including constraints and obstacles. In some areas, some people have not received nutrition messages. Some of the obstacles that arise include low awareness, inaccurate perceptions of iron tablets because they are considered a contraceptive tool, the influence of religion and culture that is unsupportive, and a lack of trust in the value of iron tablet supplementation. Health posts and health centers are the preferred health facilities for iron supplementation for girls who are not in school, and schools are the preferred facilities for iron supplementation for girls who are in school.[62] Other studies have found that student exposure to the program objective of increasing nutrition was satisfactory, but the delivery and accuracy of educational materials and training sessions were inadequate. Methods of delivery and educational materials and training sessions were inadequate and need to be improved.[63]
Empowering adolescent girls with the appropriate knowledge to make sound and healthy decisions will be the key to sustainable behavior change throughout their life journeys. Although some micronutrient deficiencies are known to occur in adolescent girls due to low resources, recommendations for pre-conception (before entering pregnancy) multiple micronutrient supplementation are warranted. The provision of interventions in the form of health education and supplements for young women is carried out over a long period of time within the frameworks of existing public health programs.\textsuperscript{[64]}

**Conclusion**

The risk factors for anemia can be grouped into direct and indirect risk factors. Direct risk factors include nutritional status, eating behavior, poor diet where the food intake does not contain substances that the body needs, menstrual patterns, and worm/parasite infections. Indirect risk factors include knowledge, concern for anemia, and several socio-demographic factors, including socioeconomics such as household income, low parental education, residency in rural areas, and food insecurity. Anemia is associated with decreased school performance and lower IQ test scores. Interventions against anemia among adolescent girls include interventions on risk factors. There are three groups of types of interventions including educational interventions to increase knowledge, attitudes, and practices of anemia prevention, specific food/supplement interventions, and their combinations. Interventions were carried out on various occasions, in various durations of interventions, under different methods of implementations, and at various locations. The existence of various risk factors for anemia is the basis for developing comprehensive interventions. All of them aim to prevent anemia in young women as prospective mothers by utilizing integrated service posts, schools, and health centers.

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