Review Article

Iron status of the Pakistani population-current issues and strategies

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The present review aims to highlight the magnitude of iron status of Pakistani population and possible remedies to address iron deficiency among vulnerable groups. A computer-based search was carried out on “PubMed”, “Google Search” and “Sciencedirect.com” to retrieve relevant scientific literature published in the last two decades. The search yielded 193 articles, of which 64 were culled and further screening was performed based on the type of vulnerable population groups, age, sex and pregnancy. A thorough review of current literature reveals that iron deficiency (ID) and iron deficiency anemia (IDA) widely persist in Pakistan and necessitate immediate remedial actions. Females of reproductive age and children under 5 years have been shown to be the most IDA affected population segment. Fortification of wheat flour has been suggested as the most viable approach aptly matching Pakistan’s needs for combating IDA. The present review further stresses the need for global involvement to scale up efforts for mitigating ID and IDA to achieve Millennium Development Goals (MDGs) that are fundamentally based upon improving nutritional wellbeing of populations in developing economies by 2015.

Key Words: malnutrition, iron deficiency, iron deficiency anemia, Pakistan

INTRODUCTION

Iron deficiency anemia (IDA) is known to be the most common nutritional deficiency worldwide. It has shown to distress a larger segment of global population resulting in substantial health and economic loss. Iron deficiency anemia leads to innumerable mortalities, maternal hemorrhage, reduced school performance and decreased productivity in vulnerable populations,\(^4,5\) and is more damaging during pregnancy especially in the countries of under developed world.\(^6\) Complications in pregnancy among anemic mothers result in mortality and morbidity with low birth weight, leading to increased infant mortality rate.\(^6,7\) Cut-off values defined by WHO for children <5 years of age and pregnant women, non-pregnant women and men are 11, 12 and 13 g/dL respectively. Considering hemoglobin level as a standard for IDA, 7-10.9 and <7 g/dL Hb represent moderate and severe anemia respectively.\(^8\)

Iron deficiency anemia affects nearly 700 to 800 million people worldwide and severely distress 60 to 70 million people in resource constrained countries. Similarly, 56% of pregnant women in developing countries are anemic. South Asia and Africa are the most vulnerable regions showing the highest prevalence (40%) of ID in all age groups except for adult males and pregnant women. Around 65% of pregnant women in South Asia suffer from IDA and in Indian subcontinent alone; the rate of developing IDA during pregnancy is 88%.\(^9,11\)

Pakistan, with its vital geopolitical importance, is still a long way off from its goal to overcome IDA among vulnerable population groups. An overwhelming majority of Pakistani population suffers from IDA. Predictably, all pregnant women and nursing mothers in Pakistan are affected by IDA. Prevalence of IDA among females of reproductive age exists up to 50%,\(^12\) therefore, maternal mortality rate is high and a growing concern has been raised by the local and international organizations to control IDA in Pakistan. According to Pakistan Demographic and Health Survey 2006-07, maternal mortality was shown to be high with 276 deaths per 100,000 live births as compared to 1 in 8,000 in the developed world. Amongst 89 Pakistani women, one dies of childbirth complications.\(^13\)

Several strategies such as fortification, supplementation and dietary diversification have been attempted
to combat ID and IDA; however, fortification of wheat flour is recognized as a potential approach to reduce ID in Pakistan. A number of success stories of iron fortification of wheat flour have been reported in the literature from countries of Middle East, North Africa, Azerbaijan, Kazakhstan, Kyrgyz Republic, Mongolia, Tajikistan, and Uzbekistan successfully implemented iron fortification of wheat and corn flour.11 Pakistan stands amongst several South East countries that have signed the consensus statement on wheat flour fortification,12 however, more concerted efforts are needed to implement wheat flour fortification for the control of ID and IDA.

IRON DEFICIENCY ANEMIA IN PREGNANCY

A substantial body of literature reveals that IDA is the most prevalent nutritional deficiency in Pakistan. Numerous small studies showed a great variation in the extent of prevalence of IDA in Pakistan eg 48.2% of the pregnant women were shown to be anemic while 90.5% of the total tested pregnant women suffered from IDA.16 Poor nutrition in repeated pregnancies and unhealthy food habits have been predominantly associated with the onset of IDA among vulnerable population fractions.17-19 National data showing the prevalence of IDA in pregnant and non-pregnant mothers in Pakistan are presented in Table 1.20

One representative study carried out in Multan, the fourth biggest city of Pakistan, demonstrated a correlation between the prevalence of anemia, dietary habits and the socio-economic status of the mothers. Multiparity was reported to persist among such groups and 86% to 96% of these women had Hb <11.0 g/dL. The mean income of the subject families was reported to be ~ 3.96 thousand rupees (~40 US$) per month which appeared to be insufficient. Other determinants for the development of IDA included intrauterine growth retardation, illiteracy and lack of supplement.21-23

IRON DEFICIENCY ANEMIA AMONG INFANTS AND ADULTS

Malnutrition among children <5 years has been a potential cause of 50% deaths every year in Pakistan. Evidently, the infant mortality rate remained around 65 deaths per 1000 live births and 78 deaths per 1000 births under the age of five.24-25 Anemic mothers usually give birth to children with moderate to severe anemia.26 Numerous reports have demonstrated 65-78 % of the children <5 years to be suffering from ID, with their Hb levels below 11 g/dL.27-28 According to another survey, the prevalence of anemia was estimated to be 83%, 78%, 85% and 82.9% among pregnant women, lactating women, adolescent girls and children respectively.29-30 Studies, from semi urban areas of Peshawar29 and Abbottabad,31 to ascertain IDA prevalence among children <2 years exhibited IDA prevalences of 68% and 69 % respectively. Similarly, prevalence of IDA was assessed to be 61% (Hb<11 g/dL) in children aged 6-60 months in urban slums of Karachi.27 Rural based preschool children of Karachi showed high prevalence of anemia (78.7%) and low hematocrit (63.8%).31 Available data pertaining to the prevalence of IDA in Pakistan exhibit that ID is the leading cause of all types of anemia in children. Several other determinants have been identified including poverty, consumption of cereal based diets with low bioavailability of iron, inappropriate dietary habits, personal hygiene and lack of sanitation that heighten the development of anemia among vulnerable populations in Pakistan.17,32

Growth retardation, impaired cognition and reduced physical activity have been widely reported in Pakistani children.29,33 Approximately 39% of adolescents, 30% boys and 54% girls,32 47% of the children, 30% of the adult females,31 40-50 % of preschool and primary school children,34 and 69% children <2 years,32 were reported to be affected by IDA in Pakistan. According to a World Health Organization surveys, IDA was shown to be a sever public health problem in pre-school children followed by pregnant and non-pregnant women of reproductive age in Pakistan (WHO, 2008).36

ETIOLOGY OF IRON DEFICIENCY ANEMIA

The etiology of IDA has been known for many years. Several determinants have been identified for the onset of IDA in developing countries including early marriage, poor diet and socio-economic conditions, low literacy rate and high consumption of cereals, legumes, and plant-based diets.37

Menstrual blood loss has been considered to be a

Table 1. Iron deficiency anemia (IDA) in pregnant and non-pregnant mothers in Pakistan

<table>
<thead>
<tr>
<th>Province/Region</th>
<th>Residence</th>
<th>Punjab</th>
<th>Sindh</th>
<th>KPK</th>
<th>Baluchistan</th>
<th>FATA</th>
<th>AJK</th>
<th>Gilgit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6873</td>
<td>2728</td>
<td>4145</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe IDA, %</td>
<td>0.8</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate IDA, %</td>
<td>19.1</td>
<td>18</td>
<td>19.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non anemic, %</td>
<td>80.1</td>
<td>81.5</td>
<td>79.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron deficiency anemia - Pregnant mothers</td>
<td>949</td>
<td>334</td>
<td>615</td>
<td>502</td>
<td>315</td>
<td>32</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>Severe IDA, %</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.6</td>
<td>2.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moderate IDA, %</td>
<td>24.9</td>
<td>24.6</td>
<td>25</td>
<td>26.4</td>
<td>22.5</td>
<td>15.3</td>
<td>31.1</td>
<td>0</td>
</tr>
<tr>
<td>Non anemic, %</td>
<td>74.1</td>
<td>74.4</td>
<td>73.9</td>
<td>73</td>
<td>75.4</td>
<td>84.7</td>
<td>68.9</td>
<td>0</td>
</tr>
</tbody>
</table>

FATA=federally administrated tribal areas; KPK=Khyber Pakhtoonkhwa; N= total no. of subjects

potent cause of developing IDA among women of reproductive age. Repeated pregnancies considerably exacerbate the risk factors leading to IDA especially in those conditions where balanced diets and bioavailability diets, supplementation are not available. Regular blood donation, consumption of low and certain pathological conditions are attributed to cause IDA among vulnerable populations. However data are scant to precisely gauge the level of IDA prevalence relevant to these determinants in Pakistan. Recommended Dietary Allowances for iron in infants, children, and adults needs special consideration to meet iron requirements in these age groups (Table 2).

ECONOMIC IMPACT OF IRON DEFICIENCY ANEMIA

IDA has been widely debated as one of the principal nutritional causes that hinders the national progress on account of its adverse health consequences and economic loss of billions of dollars annually in the developing countries. Estimates show that the number of people globally suffering from IDA is 293 million (47%) children <5 years and 468 million (30%) non-pregnant women. The cost to cure these vulnerable population segments might be exceeding billions of dollars annually.

Nearly 5% of Gross Domestic Product (GDP) of many countries is expended through death and disability. However, these losses might be curtailed by modulating micronutrient malnutrition to a consequential level e.g. drop in GDP allocation could be achieved effectively from 5% to around 0.3% through strategic implementation of food fortification programs.

According to UNICEF, child mortality due to malnutrition is about 33% of the total deaths especially in more serious illness. Next to tuberculosis, cost of IDA stands out to be the highest in the world. Undernourishment during conception, infancy and childhood severely affects cognitive development, affecting individual’s learning ability and imposes a burden on the country to spend more in education, health, productivity and development. Moreover, undernourished children are more predisposed to severe sickness and death. Direct cost on health care and disease control obviously is much less than the indirect cost i.e loss of productivity. IDA in childhood is typically reflected as reduced wages (up to 2.5% in adulthood).

Pakistan, as a developing nation has been a potential victim of the disease burden and the loss in GDP, merely owing to micronutrient deficiencies. Approximately, US$ 3 billion are spent each year for the treatment of diseases associated with micronutrients deficiencies which suggests a timely micronutrient intervention to restrict the cost to US$ 83 million. Gestation and early years of life are important and require more cautious approaches to limit permanent economic and health losses due to malnutrition in Pakistan. Another study reported high disease burden (15% of deaths of children <5 years) signifying hidden hunger to be critically damaging in terms of health and wellbeing of population in Pakistan.

Nation-wide comparative economic losses incurred each year to address malnutrition in various regions are significantly alarming, for example Egypt losses 0.44% of GDP, Bangladesh and Pakistan spend around 0.5 billion dollars, India is expected to be expending $3.8 billion, and Nepal and Sri Lanka are allocating $5 billion each year. These data confirm the magnitude of economic losses associated with IDA thus suggesting global efforts for materializing a sustainable healthier world by recognizing micronutrients deficiencies as an issue of public health significance.

Several measures have been suggested to curtail IDA and its health and economic consequences that include improvement in infant and child nutrition, breastfeeding, good nutrition for women during pregnancy for safer birth outcomes. Combating IDA among infants and adults would save several billions of dollars annually in the shape of better cognitive performance and productivity.

STRATEGIES TO COMBAT IRON DEFICIENCY ANEMIA

Prevention of ID and IDA through adequate nutritional and/or therapeutic applications is important during critical periods of the life cycle. Several preventive approaches to deliver bioavailable iron have been efficiently attempted e.g. iron fortification of foods, dietary modification and supplementation. However, no single strategy seemed to work effectively and multiple ways to improve iron nutrition have shown promise to overcome this nutritional deficiency especially in developing societies. Three potential approaches to prevent ID and IDA have been suggested and are discussed with their merits and demerits.

| Table 2. Recommended Dietary Allowances for iron for infants (7 to 12 months), children, and adults |
|---|---|---|---|---|
| Age | Men (mg/day) | Women (mg/day) | Pregnancy (mg/day) | Lactation (mg/day) |
| 7 to 12 months | 11 | 11 | N/A | N/A |
| 1 to 3 years | 7 | 7 | N/A | N/A |
| 4 to 8 years | 10 | 10 | N/A | N/A |
| 9 to 13 years | 8 | 8 | N/A | N/A |
| 14 to 18 years | 11 | 15 | 27 | 10 |
| 19 to 50 years | 8 | 18 | 27 | 9 |
| 51+ years | 8 | 8 | N/A | N/A |

Source: (Anon 2001)
Fortification

During the last decade, a growing concern was raised on malnutrition and a wave of awareness spurred among the policy makers to tackle this issue with grave seriousness. Resultantly, international organizations had to take a plunge to redress the losses associated with malnutrition. World Health Organization has recommended four basic approaches for the prevention and control of ID which include dietary change to increase iron intake, supplementation, food fortification and the control of infection.

Approximately, 540 million people gained access to fortified flour in 2007. These data show a worldwide increase of 9% in wheat flour fortification with twenty one countries practicing mandatory wheat flour fortification. Wheat flour fortification has shown promising results as a strategy to reduce IDA in developing countries. Addition of iron fortificants have exhibited an extended shelf life of the flour suggesting that fortificants exert inhibitory effects against microbial growth under hot and humid conditions which is apparently another added advantage of flour fortification. Therefore, choice of iron fortificants, appropriate levels of fortification, suitability of vehicle, and viability of plans are the predominant constraints to make any fortification program a success in Pakistan.

Iron fortified flour is being marketed in Pakistan, however rural areas in Pakistan are not benefiting from this intervention program on account of illiteracy and conventional food habits. Pakistan has been currently fortifying wheat flour as a planned strategy with an average fortified flour consumption of 248 g/day and fortification level of 10 ppm with FeEDTA. Since, wheat flour is the major dietary staple in the sub-continent, exhibiting a more consequential effect as compared to other vehicles for fortification. However, numerous limitations need to be overcome for successful implementation of wheat flour fortification programs in Pakistan eg storage stability of fortified flour with modern storage facilities, acceptability among the consumers through excessive awareness campaigns and the bioavailability by using novel iron sources in the presence of phytic acid in wheat flour. With an objective to substantially reduce IDA in women and children under five and to enhance fortified wheat flour consumption until 2013, a vital step has been taken by GAIN (Global Alliance for Improved Nutrition) through awarding a considerable financial support for commercial wheat flour fortification and to ensure that the fortified flour reaches 45 percent of the population in Pakistan. Recommended iron fortification levels (ppm) for wheat flour according to iron compound and daily flour consumption were reported by Hurrell et al (2010), suggesting higher fortification levels with decreased flour consumption.

Fortification of food may be mandatory by legislation or voluntary on the part of the manufacturer; however addition of iron fortificants to the flour needs to be carefully monitored for optimum results and to avoid certain risk factors. Food vehicle and the fortificants must be used such that it ensures stability, acceptability, bioavailability of the iron compound in the final product. Additionally, extensive care has to be exercised to preserve color, flavor and appearance of food. Any critical alteration as a result of fortification in the basic composition of the flours must be carefully monitored.

Supplementation

Supplementation as a strategy to curtail IDA in Pakistan is generally practiced among pregnant women. Oral iron supplementation is recommended under conditions where IDA becomes quite visible among children owing to dietary ID or parasitic infections. Success of supplementation however, depends solely on the level of coverage and compliance. Iron supplementation as a planned strategy is yet to be done since no concerted effort has been made so far to eliminate IDA in Pakistan. Iron supplementation has been found to be an unsuccessful strategy in the form of tablets and syrups in developing countries. Women of reproductive age are the most vulnerable group to be targeted for supplementation since they need sufficient reserves for themselves and for the fetus during pregnancy.

Multiple micronutrient supplementation as compared to iron-folate during pregnancy has been recommended by a group of researchers in Pakistan. Contrarily, daily iron supplementation has been suggested during pregnancy instead of intermittent iron supplementation in developing countries to avoid complications in pregnancy.

Iron supplementation with and without folate on IDA in mothers demonstrated no difference in rates of anemia at term with intermittent iron-folate vs daily iron-folate supplementation. However, there is a 73% decrease in anemia with supplementation of daily iron alone or with the combination of iron/folate vs control.

Dietary modification

Consumption of a variety of foods denotes the supply of required nutrients to ensure normal health. Similarly, illiteracy and low socio economic conditions deter the vulnerable population from buying expensive foods. Therefore, it appears to be quite rational to encourage addition of essential food components to add value to such foods to meet the nutritional requirements of the target population.

Dietary modification may be a practical approach to combat IDA. However, changing eating behavior obviously seems hard in situations where training and awareness are lacking and populations predominantly rely on the limited information and food sources. In developing counties, animal foods are expensive and scarce which result in limited access. Programs to change eating behavior are difficult to implement and sustain by government because traditions remain entrenched.

Selection of a diet to promote iron ingestion and absorption requires that the fate of iron in the food is well understood eg meat proteins and vitamin C improve non-heme iron absorption. Contrarily, tea containing tannins and legumes with calcium, polyphenols, and phytates decrease absorption of non-heme iron. Similarly, absorption of non-heme iron is also retarded by certain anti-nutrients in soybeans.
Deworming
Hookworm infection is common in developing countries especially among children dwelling in poorer settings. The association of parasitic infection with anemia related to helminthiasis is a major issue of public health significance for iron deficiency. It is estimated that 1,500 million people are affected by geohelminths of whom ~300 million has severe morbidity including that of anemia. Hookworm is a substantial determinant of anemia among children in developing economies. It is also linked to anemia in pregnant women in poor countries.

There is insufficient literature available on iron deficiency and hook worm infection in Pakistan. However, a few recent studies demonstrate the health risks associated with the occurrence of IDA in relation to hook worm infection, among children. Increased intestinal nematode and hookworm infection risk among wastewater farmers and their children has been reported in Faisalabad city in Pakistan. Hookworm infection is higher among wastewater farmers compared with farming households using regular irrigation water. Similarly, intestinal parasitic infestation in children aged 5-12 years has been reported in Abbottabad Pakistan. Around 230 children were found to have parasitic infection among subjects (283 tested) suggesting a very high prevalence of parasitic infection (81%) among vulnerable groups. Eight different species of helminthes and protozoa have been detected in fecal specimens with A. lumbricoideus 48% of the parasitic population.

Poor sanitation and hygiene contribute to the high prevalence of worm infestation in Pakistan and hookworm considerably contributes to produce anemia among children. Enough evidence is available to suggest that efficient and continuous deworming be an integral part of health programs for schoolchildren at high risk of hookworm infection. An integrated, long-term and concerted effort is needed for the elimination of hookworm infestation in developing regions like Pakistan.

CONCLUSIONS AND FUTURE DIRECTIONS
Available evidence suggests that IDA is the most pervasive of all nutritional deficiencies affecting pregnant women and women of child bearing age. Iron deficiency anemia contributes to maternal mortality and morbidity in Pakistan. Several factors account for the high prevalence of IDA in Pakistan including poverty, malnutrition, illiteracy, inadequate infrastructure and lack of policy and legislation. Millions of pregnant women, women of reproductive age and children are predisposed to the health consequences of IDA in Pakistan. This situation warrants a multi-pronged approach to alleviate IDA especially among women and children. Iron fortification of wheat flour, supplementation, consumption of diversified foods, sagacious selection of foods focusing on dietary inhibitors (eg, phytates) and enhancers (eg, vitamin C) and improved socioeconomic conditions in the region, may be measures to curtail the magnitude of IDA in Pakistan. But hygiene, deworming, nutritional education, campaigning and training of target population groups, may be more effective ways in Pakistan to improve iron status. More studies to ascertain the roles of various commonly consumed and cost effective foods are needed to control ID and IDA in Pakistan. Biofortification and home gardening also show promise to attenuate this hidden hunger.

ACKNOWLEDGEMENTS
We, the coauthors highly appreciate and acknowledge the significant contribution and the substantial amount of time and efforts by the author Saeed Akhtar in the preparation of this manuscript.

AUTHOR DISCLOSURES
Authors declare no conflict of Interest in the manuscript

REFERENCES


57. FAO. Food and Agriculture Organization/World Health Organization, FAOSTAT, Food supply, crops primary equivalent. 2009; Available at: http://faostat.fao.org/site/609/default.aspx#anchor


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巴基斯坦人的鐵營養狀況-目前的議題及策略

此篇文章回顧巴基斯坦族群鐵營養狀況幅度的重點及可能的補救方針，以解決那些弱勢族群的鐵缺乏。從電腦網站- PubMed、Google Search 及 Sciencedirect.com 檢索近 20 年刊登的相關科學文獻。共搜尋出 193 篇文章，再從中挑選出 64 篇，進一步篩選是根據弱勢族群、年齡、性別及懷孕狀態。透過對現今文獻的詳盡回顧，發現鐵缺乏(ID)及鐵缺乏貧血(IDA)普遍存在巴基斯坦，且必須立即採取補救措施。大部分鐵缺乏貧血影響的族群為生育年齡女性及 5 歲以下的兒童。麵粉強化已經被建議為最可實行及最適合巴基斯坦對抗 IDA 的對策。本次回顧更進一步強調需要全球的高規格努力，減輕鐵缺乏及鐵缺乏貧血狀況，以達到千禧年發展目標(MDGs)的根本，在 2015 年前改善發展中經濟體族群的營養安適。

關鍵字：營養不良、鐵缺乏、鐵缺乏貧血、巴基斯坦