Review Article

# Iron status of the Pakistani population-current issues and strategies

Saeed Akhtar PhD[1], Anwaar Ahmed PhD[2], Asif Ahmad PhD[2], Zulfiqar Ali PhD[3], Muhammad Riaz PhD[1], Tariq Ismail MSc[1]

[1]*Department of Food Science and Technology, Bahauddin Zakariya University Multan -Pakistan, Pakistan*
[2]*Department of Food Technology, PMAS-Arid Agriculture University, Rawalpindi, Pakistan*
[3]*Department of Agriculture and Food Technology, Karakoram International University, Gilgit-Baltistan, Pakistan*

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,[1-4] and is more damaging during pregnancy especially in the countries of under developed world.[5] 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

**Corresponding Author:** Dr Saeed Akhtar, Department of Food Science and Technology, Bahauddin Zakariya University Multan, Pakistan.
Tel: +9261 92100269; Fax: +92619210098
Email: saeedbzu@yahoo.com
Manuscript received 21 February 2013. Initial review completed 22 April 2013. Revision accepted 11 May 2013.
doi: 10.6133/apjcn.2013.22.3.17

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 ie countries of Middle East, North Africa, Azerbaijan, Kazakhstan, Kyrgyz Republic, Mongolia, Tajikistan, and Uzbekistan successfully implemented iron fortification of wheat and corn flour.[14] Pakistan stands amongst several South East countries that have signed the consensus statement on wheat flour fortification,[15] 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 supplements.[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.[23]

Studies, from semi urban areas of Peshawar[29] and Abbottabad,[30] 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,[34] 40-50 % of preschool and primary school children,[35] and 69% children <2 years,[29] 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

| | | Iron deficiency anemia – Non-pregnant mothers | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Residence | | Province/Region | | | | | | |
| | | Urban | Rural | Punjab | Sindh | KPK | Baluchistan | FATA | AJK | Gilgit |
| Total | | | | | | | | | | |
| N | 6873 | 2728 | 4145 | 3519 | 1887 | 292 | 440 | 37 | 401 | 297 |
| Severe IDA, % | 0.8 | 0.6 | 0.9 | 0.6 | 1.3 | 0.1 | 1.5 | 0 | 0.3 | 0.3 |
| Moderate IDA, % | 19.1 | 18 | 19.6 | 19.4 | 21.8 | 5.2 | 14.6 | 15.9 | 18.4 | 9.7 |
| Non anemic, % | 80.1 | 81.5 | 79.5 | 80 | 77 | 94.6 | 83.9 | 84.1 | 81.3 | 90 |
| Iron deficiency anemia - Pregnant mothers | | | | | | | | | | |
| N | 949 | 334 | 615 | 502 | 315 | 32 | 37 | 0 | 39 | 24 |
| Severe IDA,% | 1 | 1 | 1 | 0.6 | 2.1 | 0 | 0 | 0 | 0 | 0 |
| Moderate IDA, % | 24.9 | 24.6 | 25 | 26.4 | 22.5 | 15.3 | 31.1 | 0 | 28.4 | 30.4 |
| Non anemic, % | 74.1 | 74.4 | 73.9 | 73 | 75.4 | 84.7 | 68.9 | 0 | 71.6 | 69.6 |

FATA=federally administrated tribal areas; KPK=Khyber Pakhtoonkhwa; N= total no. of subjects
Source; National Nutrition Survey Report NNS (2011) [20]

**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) [39]

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.[38] 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).[39]

## 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.[40,41]

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.[42] According to UNICEF, child mortality due to malnutrition is about 33% of the total deaths especially in more serious illness.[43] 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 ie loss of productivity. IDA in childhood is typically reflected as reduced wages (up to 2.5% in adulthood) .[44,9]

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.[45-47]

Nation-wide comparative economic losses incurred each year to address malnutrition in various regions are significantly alarming, for example Egypt loses 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.[48]

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.[49]

## 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.[50] Three potential approaches to prevent ID and IDA have been suggested and are discussed with their merits and demerits.

***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.[51] 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.[52]

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.[53] 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.[51,54] 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.[55]

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.[56,57]

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.[58,59] Recommended iron fortification levels (ppm) for wheat flour according to iron compound and daily flour consumption were reported by Hurrell *et al* (2010),[60] 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.[61-64]

***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.[65,66]

Multiple micronutrient supplementation as compared to iron-folate during pregnancy has been recommended by a group of researchers in Pakistan.[67] Contrarily, daily iron supplementation has been suggested during pregnancy instead of intermittent iron supplementation in developing countries to avoid complications in pregnancy.[68]

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 .[40]

***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.[69]

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.[26,70]

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.[71,72] Contrarily, tea containing tannins and legumes with calcium, polyphenols, and phytates decrease absorption of non-heme iron.[73,74] Similarly, absorption of non-heme iron is also retarded by certain anti-nutrients in soybeans.[75]

***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.[76] It is estimated that 1,500 million people are affected by geohelminths of whom ~300 million has severe morbidity including that of anemia.[77,78] Hookworm is a substantial determinant of anemia among children in developing economies. It is also linked to anemia in pregnant women in poor countries.[79]

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.[80] Similarly, intestinal parasitic infestation in children aged 5-12 years has been reported in Abbottabad Pakistan.[81] 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 helminthe and protozoa have been detected in fecal specimens with *Ascaris lumbricoides* 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.[76] An integrated, long-term and concerted effort is needed for the elimination of hookworm infestation in developing regions like Pakistan.[82,83]

## 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. Bio-fortification 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

1. Fairbanks VF. Iron in medicine and nutrition. In: Shils ME, Olson JA, Shike M, Editors. Modern nutrition in health and disease. Philadelphia: Lea & Febiger; 1994. pp. 185-213.
2. Viteri FE. Iron supplementation for the control of ID in population on risk. Nutr Rev. 1997;55:165-209.
3. Siddiqui MS. Siddiqui KS. Public health significance of iron deficiency Anaemia. Pak Armed Forces Med J. 2008;58: 319-30
4. Thompson B. Combating ID: Food–Based approaches. In: Thompson B, Amorose L ed. Micronutrient deficiencies-Food based approaches. Italy: CAB International and FAO; 2011. pp. 285.
5. Noronha JA, Al Khasawneh E, Seshan V, Ramasubramaniam S, Raman S. Anemia in pregnancy-consequences and challenges: A review of literature. J S Asian Fed Obstet Gynecol. 2012;4:64-70. doi: 10.5005/jp-journals-10006-1177
6. Allen LH. Anemia and iron deficiency: Effects on pregnancy outcome. Am J Clin Nutr. 2000;7:1280-4.
7. Steer PJ. Maternal hemoglobin concentration and birth weight. Am J Clin Nutr. 2000;71:1285-7.
8. Thompson B. Food-based approaches for combating iron deficiency. In: Kraemer K, Zimmemann MB, editors. Nutritional Anemia. Basel, Switzerland: Sight and Life Press; 2007. pp.337-58.
9. WHO (World Health Organization). Global database on child growth and malnutrition. Geneva: WHO; 2001. [Cited 2013/3/25]; Available from: http://www.who.int/nutgrowthdb/en/
10. Allen LH. Vitamin A and ID: effects on pregnancy outcome. Am J Clin Nutr. 2007;71:1280-4.
11. Paracha PI, Khan SM, Ahmad I, Nawab G. Effect of iron supplementation on biochemical indices of iron status in selected preadolescent school girls in Northwest frontier province Pakistan. Asia Pac J Clin Nutr. 2007;2:177-81.
12. Zlotkin SH, Christofides AL, Hyder SM, Schauer CS, Tondeur MC, Sharieff W. Controlling ID A through the use of home-fortified complementary foods. Indian J Ped. 2004; 71:1015-9. doi: 10.1007/BF02828118
13. PDHS (Pakistan Demographic and Health Survey 2006-07). National Institute of Population Studies, Islamabad, Pakistan. [cited 2013/2/24]; Available from: http://www.measur/edhs.com/pubs/pdf/FR200/FR200.pdf
14. WHO. Fortification of flour to control iron deficiencies in the Middle East and North Africa. Report of a joint WHO/UNICEF/MI/ILSI workshop 1999. pp. 13-6. [cited 2013/3/23]; Available from: http://whqlibdoc.who.int/hq/1999/WHO-EM_NUT_203_E_L.pdf
15. Asian Development Bank. Consensus statement on wheat flour fortification developed at the Regional Workshop on flour and cooking oil fortification. Manila Philippines; 2001.

16. Baig-Ansari N, Badruddin SH, Karmaliani R, Harris H, Jehan I, Pasha O et al. Prevalence and risk factors in pregnant women in an urban area of Pakistan. Food Nutr Bull. 2008;29:132-9.
17. NNS (National Nutrition Survey). (2001-2002). Ministry of Health, Government of Pakistan, Islamabad, 2002. [cited 2013/2/23]; Available from: http://pakresponse.info/LinkClick.aspx?fileticket=BY8AFPcHZQo=
18. Khalil AK, Jabbar T, Akhtar S, Mohyuddin S. Frequency and types of A in an antenatal clinic in the third trimester of Pregnancy. Pak Armed Forces Med J. 2007;57:273-8.
19. Abbassi RM, Ansari S, Ram DB, Abbasi S. The prevalence and risk factors of anemia in pregnant women. Med Channel. 2009;15:70-3.
20. NNS. National Nutrition Survey Report. Govt, of Pakistan, 2011. [cited 2013/3]; Available from: http://pakresponse.info/LinkClick.aspx?fileticket=scqw_AUZ5Dw%3D&tabid=117&mid=752
21. Awan M, Akbar MA, Khan MI. A study of vitamin A in pregnant women of railway colony, Multan. Pak J Med Res. 2004;43:11-4.
22. Bhutta Z, Klemm R, Shahid F, Rizvi A, Rah JH, Christian P. Treatment response to iron and folic acid alone is the same as with multivitamins and/or anthelminthics in severely anemic 6- to 24-month-old children. J Nutr. 2009;139:1568-74. doi: 10.3945/jn.108.103507
23. Jalil F, Khan AM Nutritional anaemia, classification and effect of a therapeutic trial for proposed fortification program. Islamabad, Planning and Development Division, Nutrition Cell, Government of Pakistan, 1986-1988, p. 15.
24. Federal Bureau of Statistics. Pakistan integrated household survey. Government of Pakistan. Islamabad, Pakistan; 1991.
25. Kundi A. 50 pc of children under five die of malnutrition every year. Pakistan Today, Oct 17, 2011. [cited 2013/2/14]; Available from: http://www.pakistantoday.com.pk/2011/10/%E2%80%9850pc-of-children-under-five-die-of-malnutrition-every-year%E2%80%99/
26. Nestel P, Ritu N. Manual for flour fortification with iron. Guidelines for the development, implementation, monitoring and evaluation of a program for wheat flour fortification with iron. 2000. (Part 1 of 3). Micronutrient Initiative/OMNI/USAID. [cited 2013/2/4]; Available from: http://www.idpas.org/pdf/721MostManual1.pdf
27. Molla A, Khurshid M, Molla AM. Prevalence of ID anemia in children of the urban slums of Karachi. J Pak Med Assoc. 1992;42:118-21.
28. Jhaveir JH, Baig L. Anaemia in Children Part I –Can simple observation by primary care provider help in diagnosis? J Pak Med Assoc. 1994;44:282-4.
29. Paracha PI, Hameed A, Simon J, Jamil A, Nawab G. Prevalence of anaemia in semi-urban areas of Peshawar, Pakistan: A challenge for health professionals and policy makers. J Pak Med Assoc. 1997;47:49-53.
30. Idris M, Rehman AU. ID anaemia in moderate to severely anemic patients. J Ayub Med Coll Abbottabad. 2005;17:45-7.
31. Rahbar MH, Hozhabri S, Wang J. Prevalence of anaemia among children living in five communities in and near Karachi, Pakistan. Toxicol Environ Chem. 2007;89:337-46. doi: 10.1080/02772240601025038
32. Agha F, Sadaruddin A, Khan RA, Ghafoor A. Iron deficiency in adolescents. J Pak Med Assoc. 1992;42:3-5.
33. Huma N, Rehman SU, Anjum FM, Murtaza MA, Sheikh MA. Food fortification strategy--preventing ID A: A review. Crit Rev Food Sci. 2007;47:259-65. doi: 10.1080/10408390600698262
34. Hamedani P, Hashmi KZ, Manji M. Iron depletion and anaemia: Prevalence, consequences, diagnostic and therapeutic implications in a developing Pakistani population. Curr Med Res Opin. 1987;10:480-5. doi: 10.1185/03007998709112407
35. Khor GL. Micronutrient status and intervention programs in Malaysia. Food Nutr Bull. 2005;26:281-5.
36. WHO. 2008. Worldwide Prevalence of Anemia 1993-2005. WHO Global Database on Anemia. [cited 2013/3/20]; Available from: http://whqlibdoc.who.int/publications/2008/9789241596657_eng.pdf
37. Cordain L. Cereal grains: Humanity's double-edged sword. World Rev Nutr Diet. 1999;84:19-73.
38. Coad J, Conlon C. Iron deficiency in women: assessment, causes and consequences. Curr Opin Clin Nutr. 2011;14:625.
39. Anon. Institute of medicine. food and nutrition board. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc. Washington DC: National Academy Press; 2001. [cited 2013/1/17]; Available from: http://ods.od.nih.gov/ factsheets/Iron-HealthProfessional/
40. Yakoob MY, Bhutta ZA. Effect of routine iron supplementation with or without folic acid on anemia during pregnancy. BMC Public Health. 2011;11(suppl 3):S21. doi: 10.1186/1471-2458-11-S3-S21
41. Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian S. Anemia in low-income and middle-income countries. Lancet. 2012;378:2123-35. doi: 10.1016/S0140-6736(10)62304-5
42. Carriere R. Public-private sector alliances for food fortification: Time for optimism. Food Nutr Bull. 2003;24:S155-9.
43. UNICEF. State of the World's children. Maternal and child health. 2009. [cited 2013/2/3]; Available from: http://www.unicef.org/sowc09/
44. Horton S, Ross J. The economics of iron deficiency. Food Policy. 2003;28:51-7.
45. Beaton G, Martorell R, Aronson KJ, Edmonston B, McCabe G, Ross AC et al. Effectiveness of vitamin A supplementation in the control of young child morbidity and mortality in developing countries. ACC/SCN State-of the-Art Series, Nutrition Policy Paper 1993: No. 13.
46. UNICEF and the Micronutrient Initiative. Vitamin and mineral deficiency: A global progress report. 2004. [cited 2013/3/20]; Available from: http://www.micronutrient.org/english/View.asp?x=614
47. World Bank. World development indicators (Database). 2009. [cited 2013/2/17]; Available from: http://data.worldbank.org/
48. World Bank. World Development Report 1993. Washington, DC: World Bank; 1993. pp. 329.
49. Ross JS, Susan H. Economic consequences of iron deficiency. Micronutrient Initiative. Ottawa: 2008.
50. Lynch SR. Why nutritional iron deficiency persists as a worldwide problem. J Nutr. 2011;141:763S-8. doi: 10.3945/jn.110.130609
51. Akhtar S, Anjum FM, Anjum MA. Micronutrient fortification of wheat flour: recent development and strategies. Food Res Int. 2011;44:652-9. doi: 10.1016/j.foodres.2010.12.033
52. Allen L, Gillespie S. What works? A reviewof the efficacy and effectiveness of nutrition interventions. ACC/SCN Nutrition Policy Paper Sries. 2001;19:43-54.
53. Maberly G, Grummer-Strawn L, Jefferds ME, Pena-Rosas JP, Serdula MK, Tyler VQ et al. Trends in wheat-flour fortification with folic acid and iron. 2008. [cited ] Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5701a4.htm

54. Akhtar S, Anjum FM, Rehman SU, Sheikh MA, Farzana K. Effect of fortification on physico chemical and microbiological stability of whole wheat flour. Food Chem. 2008;110:113-9. doi: 10.1016/j.foodchem.2008.01.065
55. Akhtar S. Food safety challenges -A Pakistan's perspective. Crit Rev Food Sci. 2012. doi:10.1080/10408398.2011. 650801.
56. Ranum P, Wesley A. Cereal fortification handbook. Micronutrient Initiative. Ottawa: 2008.
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#ancor.
58. GAIN (Global Alliance for Improved Nutrition). Pakistan Wheat Flour Fortification Project 2005. [cited 2013/3/23]; Available from: http://www.gainhealth.org/project/pakistan-wheat-flour-fortification project
59. Akhtar S, Asghar A. Mineral fortification of whole wheat flours an overview. In: Preedy VR, Watson RR, Patel VB, editors. Fortification of flours and breads and their metabolic effects. Boston: Elsevier/Academic Press; 2011. pp. 263-71.
60. Hurrell R, Ranum P, de Pee S, Biebinger R, Hulthen L, Johnson Q et al. Revised recommendations for iron fortification of wheat flour and an evaluation of the expected impact of current national wheat flour fortification programs. Food Nutr Bull. 2010;31(suppl 1):S7-21.
61. MacPhail AP, Bothwell TH. The prevalence and causes of nutritional ID A. In: Fomon S, Zlotkin S. Editors. Nutritional As. Nestle nutrition workshop series 30. New York: Raven Press; 1992. pp. 1-12.
62. Lotfi M, Mannar MGV, Merx RH, van den N, Heuvel P. Micronutrient fortification of foods: Current practices, research and opportunities. Ottawa: The Micronutrient Initiative, and International Agriculture Centre. Wageningen; 1996.
63. Akhtar S, Anjum FM, Rehman SU, Sheikh MA. Effect of storage and baking on mineral contents of fortified whole wheat flour. J Food Process Pres. 2010;34:335-49. doi: 10. 1111/j.1745-4549.2009.00405.x
64. Akhtar S, Anjum FM, Rehman SU, Sheikh MA. Effect of mineral fortification on rheological properties of wheat flour. J Texture Stud. 2009;40:52-60. doi: 10.1111/j.1745-4603. 2008.00169.x
65. Stoltzfus RJ, Dreyfuss ML. Guidelines for the use of iron supplements to prevent and treat iron deficiency anemia Washington DC: ILSI Press; 1998. pp. 1-39.
66. Beinner MA, Lamounier JA. Recent experience with fortification of foods and beverages with iron for the control of iron-deficiency A in Brazilian children. Food Nutr Bull. 2003;24:268-74.
67. Haider BA, Yakoob MY, Bhutta ZA. Effect of multiple micronutrient supplementations during pregnancy on maternal and birth outcomes. BMC Public Health. 2011;11 (suppl 3):S19. doi: 10.1186/1471-2458-11-S3-S19
68. Mumtaz Z, Shahab S, Butt N, Rab MA, Muynck AD. Daily iron supplementation is more effective than twice weekly iron supplementation in pregnant women in Pakistan in a randomized double-blind clinical trial 1. J Nutr. 2000;130: 2697-702.
69. Graebner IT, Siqueira EMA, Arruda SF, de Souza EMT. Carotenoids from native Brazilian dark-green vegetables are bioavailable: A study in rats. Nutr Res. 2004;24:671-9. doi: 10.1016/j.nutres.2003.10.012
70. Nestle P, Ritu N. Manual for wheat flour fortification with Iron. Arlington: MOST; 2000.
71. Siegenberg D, Baynes RD, Bothwell TH, Macfarlane BJ, Lamparelli RD, Car NG et al. Ascorbic acid prevents the dose-dependent inhibitory effects of polyphenols and phytates on nonheme-iron absorption. Am J Clin Nutr. 1991; 53:537-41.
72. Hunt JR, Gallagher SK. Johnson LK. Effect of ascorbic acid on apparent iron absorption by women with low iron stores. Am J Clin Nutr. 1994;59:1381-5.
73. Cook JD, Reddy MB, Burri J, Juillerat MA, Hurrell RF. The influence of different cereal grains on iron absorption from infant cereal foods. Am J Clin Nutr. 1997;65:964-9.
74. Samman S, Sandstrom B, Toft MB, Bukhave K, Jensen M, Sorensen SS et al. Green tea or rosemary extract added to foods reduces nonheme-iron absorption. Am J Clin Nutr. 2001;73:607-12.
75. Lynch SR, Dassenko SA, Cook JD, Juillerat MA, Hurrell RF. Inhibitory effect of a soybean-protein-related moiety on iron absorption in humans. Am J Clin Nutr. 1994;60:567-72.
76. Watthanakulpanich D, Maipanich W, Pubampen S, Sa-Nguankiat S, Pooudoung S, Chantaranipapong Y et al. Impact of hookworm deworming on anemia and nutritional status among children in Thailand. Southeast Asian J Trop Med Public Health. 2011;42:782.
77. Montresor A, Crompton DWT, Gyorkos TW, Savioli L. Helminth control in school-age children: a guide for managers of control programmes. Geneva: World Health Organization; 2002.
78. Kung'u JK, Goodman D, Haji HJ, Ramsan M, Wright VJ, Bickle QD, Tielsch JM, Raynes JG, Stoltzfus RJ. Early helminth infections are inversely related to anemia, malnutrition, and malaria and are not associated with inflammation in 6- to 23-month-old Zanzibari children. Am J Trop Med Hyg. 2009;81:1062-70. doi: 10.4269/ajtmh.2009. 09-0091
79. Simon B, Hotez PJ, Bundy DAP. Hookworm-related anaemia among pregnant women: a systematic review. Plos Neglect Trop D. 2008;2.9 e291. doi: 10.1371/journal.pntd. 0000291
80. Ensink JH, van der Hoek W, Mukhtar M, Tahir Z, Amerasinghe FP. High risk of hookworm infection among wastewater farmers in Pakistan. Trans R Soc Trop Med Hyg. 2005;99:809-18. doi: 10.1016/j.trstmh.2005.01.005
81. Ahmed AK, Malik B, Shaheen B, Yasmeen G, Dar JB, Mona AK et al. Frequency of intestinal parasitic infestation in children of 5-12 years of age in Abbottabad. J Ayub Med Coll Abbottabad. 2003;15:28-30.
82. Smith JL, Brooker S. Impact of hookworm infection and deworming on anaemia in non-pregnant populations: a systematic review. Trop Med Int Health. 2010;15:776-95. doi: 10.1111/j.1365-3156.2010.02542.x
83. Akhtar S, Ismail T, Atukorala S, Arlappa N. Micronutrient deficiencies in South Asia-current status and strategies. Trends Food Sci Technol. 2013:31;55-62.

Review Article

# Iron status of the Pakistani population-current issues and strategies

Saeed Akhtar PhD[1], Anwaar Ahmed PhD[2], Asif Ahmad PhD[2], Zulfiqar Ali PhD[3], Muhammad Riaz PhD[1], Tariq Ismail MSc[1]

*[1]Department of Food Science and Technology, Bahauddin Zakariya University Multan -Pakistan, Pakistan*
*[2]Department of Food Technology, PMAS-Arid Agriculture University, Rawalpindi, Pakistan*
*[3]Department of Agriculture and Food Technology, Karakoram International University, Gilgit-Baltistan, Pakistan*

# 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**